P100

Facilities Standards for the Public Buildings Service

U.S. GENERAL SERVICES ADMINISTRATION

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P100 Facilities Standards for the Public Buildings Service

ON THE COVER:

UNITED STATES COURTHOUSE
SPRINGFIELD, MASSACHUSETTS

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Our Design Philosophy: Achieving Lasting Value

As the builder of the nation's civilian Federal buildings, the General Services Administration (GSA) is committed to designing and constructing buildings that are world-class, environmentally responsible facilities in which to conduct Government business safely and serve the public effectively. Federal buildings must also reach beyond their function to embrace the public at large, create a sense of community, and instill the trust that is essential to making our democracy successful. This requires an integrated, holistic design and construction approach in which GSA, its tenant customers, the design team, users, and the construction team collaborate fully and communicate effectively.

Through these collaborative partnerships, GSA seeks to implement the goals of the Guiding Principles for Federal Architecture set out in the Report to the President by the Ad Hoc Committee on Federal Office Space on June 1, 1962:

Provide requisite and adequate facilities in an architectural style and form that is distinguished and that will reflect the dignity, enterprise, vigor, and stability of the American National Government. Major emphasis should be placed on choosing designs that embody the finest contemporary American architectural thought. Specific attention should be paid to the possibilities of incorporating into such designs the qualities that reflect the regional architectural traditions of that part of the Nation in which buildings are located. Where appropriate, fine art should be incorporated in the designs, with emphasis on the work of living American artists. Designs must adhere to sound construction practice and use materials, methods and equipment of proven dependability. Buildings must be economical to build, operate, and maintain, and should be accessible to the handicapped.

Avoid development of an official style. Design must flow from the architectural profession to the Government, and not vice versa. The Government should be willing to pay some additional cost to avoid excessive uniformity in design of Federal buildings. Competitions for the design of Federal buildings may be held where appropriate. The advice of distinguished architects, as a rule, ought to be sought prior to the award of important design contracts.

Consider the choice and development of the building site as the first step of the design process. This choice should be made in cooperation with local agencies. Special attention should be paid to the general ensemble of streets and public places of which Federal buildings will form a part. Where possible, buildings should be located so as to permit a generous development of landscape.

GSA is committed to incorporating principles of sustainable design and energy efficiency into all of its building projects. Sustainable design seeks to design, construct, and operate buildings to reduce negative impact on the environment and the consumption of natural resources. Sustainable design improves building performance while keeping in mind the health and comfort of building occupants. It is an integrated, synergistic approach, in which all phases of the facility lifecycle are considered. The result is an optimal balance of cost and environmental, societal, and human benefits, with the mission and function of the intended facility or infrastructure.

Public Buildings Service

GSA's Public Buildings Service (PBS) manages more than 8,600 owned and leased buildings with a gross floor area in excess of 351 million square feet. GSA is responsible for 175 million square feet in over 1,500 buildings, and the remainder is leased from private owners. The three primary types of facilities are Federal buildings, courthouses, and land ports of entry. GSA buildings are located in more than 2,100 communities, serve more than 400 Federal agencies, and house more than one million Federal workers. More importantly, these buildings function as a public interface between citizens and the services provided by their Government.

Design and construction of new Federal facilities, major repairs and alterations of existing buildings, management of facilities, and leasing of private properties are ongoing efforts in GSA. *The Facilities Standards for the Public Buildings Service* is a product of the knowledge and best practices GSA has learned from more than sixty years of managing real property for the Federal Government and the American people.

This introduction provides an overview of the policies that are the foundation for the *Facilities Standards*. The eight chapters that follow set out mandatory requirements, with recommendations and best practices highlighted.

Design Excellence

Since 1994, GSA's Design Excellence program in the Office of the Chief Architect has resulted in dramatic improvements in the design, preservation, and construction of Federal buildings. Its mission is to create Federal buildings of enduring value and ensure the continued viability of GSA's existing portfolio of building types ranging from courthouses to land ports of entry and Federal office buildings. Grounded in the 1962 Guiding Principles for Federal Architecture, the program engages the broad and diverse spectrum of America's most creative designers, engineers, and artists who have successfully delivered buildings that embody the finest design quality and enhance the communities in which they are built. Buildings of enduring value fulfill our customer's changing needs in safe, cost-sustainable, and energy efficient environments while meeting programmatic, budgetary, schedule, and high-performance green building objectives.

The Design Excellence program involves participation from distinguished private-sector professional peers ranging in expertise from architecture, historic preservation, landscape architecture, urban planning, interior design, civil engineering, transportation, mechanical engineering, and structural engineering. Peers, appointed biennially to the PBS Commissioner's National Register of Peer Professionals, serve as independent voices on evaluation boards in the selection of the lead designer and architect/engineer (A/E) team and during project critiques in peer reviews—from concept design through construction. The insights and expertise of these individuals are invaluable in ensuring that GSA fulfills its Design Excellence goals and mandates for each project.

For additional information see the Design Excellence Policies and Procedures: **www.gsa.gov/designexcellence**.

Art Programs

GSA has a long-standing commitment to supporting its two art programs—Art in Architecture and Fine Arts. The Art in Architecture program commissions contemporary artists to create works for new buildings and major modernizations. The Fine Arts program is responsible for the portfolio of fine arts assets under GSA's stewardship, including establishing policy for the placement and removal of artworks, conservation of the works, access, and creation of educational materials. The Fine Arts Collection consists of permanently installed and moveable mural paintings, sculpture, architectural and environmental works of art, and works on paper dating from the 1850s to the present day. These civic works of art are located in Federal buildings and courthouses across the United States. An additional 18,000 small moveable works of art created under the New Deal art programs are on long-term loan to museums and other nonprofit institutions.

The source of GSA's policy to commission art through the Art in Architecture program is the Guiding Principles for Federal Architecture, issued by the Kennedy administration in 1962. These guidelines established a new, quality-conscious Federal attitude toward architecture, and advocated the inclusion of fine art in public buildings.

GSA's review and selection process for commissioning artists through the Art in Architecture program follows policies and procedures developed over the past four decades. One-half of one percent (.5%) of the estimated construction cost of new and major repair and alteration projects is reserved for commissioning works by living

Sol LeWitt, Artist
Wall Drawing #1259: Loopy Doopy

United States Courthouse
Springfield, Massachusetts

Undulating lines sweep across the curved wall that visitors pass by as they enter the building's courtrooms. Shown is a small detail of Sol LeWitt's enormous wall drawing.

American artists. The A/E team must work with GSA to ensure that art is an integral component of the building.

For each Art in Architecture project, GSA relies upon a panel of local and national art experts, the project's A/E lead designer, client and community representatives, and GSA staff to assist in the commissioning process by conducting a search for candidates, reviewing artists' portfolios, and recommending a small pool of finalists. GSA evaluates this group and awards the commission to the strongest candidate, who develops a design concept. The panel and GSA review the artist's concept and, once approved, the artwork is fabricated and installed.

Historic Buildings Program

The Historic Buildings program, initiated in compliance with the National Historic Preservation Act (NHPA) of 1966, provides strategic and technical support to promote the reuse, viability, and architectural design integrity of historic buildings GSA owns and leases. Meeting these goals requires GSA to develop innovative design solutions that are affordable, extend the useful life of historic structures, and minimize the negative effects of changes needed to keep buildings safe, functional, and efficient.

Nearly one-fourth of the space in GSA's owned inventory is in historic buildings. Regional historic preservation officers coordinate external design reviews required under the NHPA and serve as first points of contact within each region. They ensure that projects follow the *Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings (36 CFR 67)*, while satisfying GSA's performance requirements. The success of every project affecting historic structures depends on the integral involvement of preservation design professionals within the A/E team and on effective coordination between the A/E team, GSA preservation staff, and outside review groups.

GSA Technical Preservation Guidelines, available online at **www.gsa.gov/technicalpreservationguidelines**, document creative design solutions to resolve conflicts among preservation, codes, and functional requirements of modern office use. GSA's Technical Procedures database, compact Preservation Notes, and additional preservation design studies may be accessed at **www.gsa.gov/historicpreservation>technical resources**.

HVAC Excellence Program

The HVAC Excellence Initiative fosters an integrated design approach that teams architects and engineers throughout all phases of a building's design, construction. and ongoing use; improves workplace productivity by enhancing thermal comfort and indoor air quality; and improves energy efficiency, and operations and maintenance.

Sustainability

Sustainability is an integral part of design excellence and is vital to GSA's mission of providing superior workplaces for the federal worker and superior value for the American taxpayer. GSA supports high-performance design strategies that can produce efficient buildings to operate with increased asset value and higher occupant productivity. GSA desires to be a green proving ground for new sustainable products and designs. Utilizing a sustainable design philosophy encourages decisions at each phase of the design process that will reduce negative impacts on the environment and the health of the occupants, without compromising the bottom line. It is an integrated, holistic approach that encourages compromise and tradeoffs. Such an integrated approach positively impacts all phases of a building's life-cycle, including design, construction, operation, and decommissioning. For more information, see **www.gsa.gov/sustainabledesign**.

Urban Development/Good Neighbor Program

GSA is committed to leveraging its investments in ways that support communities wherever possible.

GSA must consult with local officials while preparing plans for the facility. Designs must, to the extent practicable within security constraints, encourage public access to and stimulate public pedestrian traffic around, into, and through public buildings. This permits cooperative improvements to and uses of the area between the building and the street, so that such activities complement the neighborhood and encourage public and commercial use of public buildings for cultural, educational, and recreational activities.

These requirements are based on sound urban design principles as well as legal directives including the Federal Management Regulation related to Executive Order 12072, the Public Buildings Amendments of 1988, the Public Buildings Cooperative Use Act, and Executive Order 13514 Federal Leadership in Environmental, Energy, and Economic Performance. Project teams should seek out potential issues and collaborate with neighboring property owners, residents, and other stakeholders to solve them.

Other more prescribed planning directives, such as those required by the National Environmental Policy Act (NEPA) or Section 106 of the NHPA, may be addressed during site selection, and any agreements made thereby with the community must be made known to the A/E. However, less formal collaboration, information sharing, and problem-solving activities with local officials involving architecture, urban design, and transportation issues must occur throughout the design process. These can be equally valuable to the project team and the community. For more information, visit **www.gsa.gov/urbandevelopment**.

First Impressions Program

First Impressions is a comprehensive, nationwide effort that extends GSA's commitment to Design Excellence into the interior and exterior public spaces of existing Federal buildings. In refreshing lobbies and redesigning plazas, the program creates lively spaces that welcome visitors while maintaining safe, quality workplaces for Federal employees.

To this end, First Impressions promotes five basic principles: streamlining security, consolidating functions, unifying signage, reducing clutter, and implementing architectural modifications that transform a building's overall image.

These principles suggest steps both large and small that project teams should incorporate into any building modernization, repair and alteration, security upgrade, or landscape improvement that affects the public areas of a property. For more information, please visit: **www.gsa.gov/firstimpressions**.

Richard Bolling Federal Building
Kansas City, Missouri

Through the First Impressions program, this 1960s bunker-style building was transformed into an inviting, secure facility. The primary entrance is now an airy, glass entrance pavilion, and aluminum tube cladding, reconstructed in a wave form, enlivens the façade and reinforces the entry location.

Superior Workplace Program

High-performance workplaces that enable work tasks and provide best value reflect the attributes defined by GSA's *Hallmarks of the Productive Workplace*. Good interior design incorporates these characteristics, resulting in work settings that both best fit the organization's current needs and can be easily adapted to accommodate future needs, thus offering best long-term value.

The GSA Hallmarks of the Productive Workplace are:

Equitable: Design the workplace to meet the functional needs of the users by accommodating the tasks to be undertaken without compromising individual access to privacy, daylight, outside views, and aesthetics.

Sustainable: Create workplaces using environmentally sustainable ("green") products and processes that provide a clean, healthy workplace environment, free of harmful contaminants and excessive noise, with access to quality air, light, and water.

Flexible: Choose workplace components that can be easily adapted to organizational or work process and functional changes and readily restructured with a minimum of time, effort, and waste.

Comfortable: Provide workplace services, systems, and components that allow occupants to adjust thermal, lighting, acoustic, and furnishing systems to meet personal and group comfort levels.

Connectable: Enable full communication and simultaneous data access among distributed coworkers for both on-site workplaces (including individual workstations, team space, conference/multimedia space, "hoteling" (transients') space, etc.) and off-site workplaces (including telework or commuting centers, home offices, travel venues, etc.).

Reliable: Support the workplace with efficient, state-of-the-art heating, ventilating, air conditioning (HVAC), lighting, power, security, and telecommunications systems and equipment that require little maintenance and are designed with backup capabilities to ensure minimal loss of service or downtime.

Identifiable: Endow the workplace with a unique familiarity, character, image, and business identity or "sense of place" that enable and convey a sense of pride, purpose, and dedication in both the individual and the workplace community.

Safe: Provide workplaces that are healthful, free from hazards, and safe from fire.

National Accessibility Program

The Architectural Barriers Act of 1968 (ABA) requires that facilities designed, built, altered, or leased with certain Federal funds be accessible to persons with disabilities. The ABA designates GSA, the United States Postal Service, the Department of Housing and Urban Development, and the Department of Defense as the agencies responsible for creating the design standards that implement the ABA.

Since the 1970s, GSA has been at the forefront of removing architectural barriers in our public buildings. PBS manages the National Accessibility Program for GSA and has demonstrated a continuous commitment to providing accessible facilities. In November 2005, GSA published a new accessibility standard (the Architectural Barriers Act Accessibility Standard or ABAAS) in the *Federal Register*, effective May 2006, to replace the Uniform Federal Accessibility Standards (UFAS.) However, GSA policy requires the use of local accessibility standards if they are more stringent than the ABAAS.

The designs of all new Federal facilities, and major modernizations and alterations of existing facilities, must incorporate the accessibility requirements of the ABAAS. The A/E design team must recognize the need to meet these requirements at the concept planning phase to avoid costly redesign and project delays at a later date.

1

SAN FRANCISCO FEDERAL BUILDING
SAN FRANCISCO, CALIFORNIA

ARCHITECT: MORPHOSIS
PROJECT MANAGER: MARIA T. CIPRAZO

General Requirements

Chapter 1 General Requirements

1.1 Purpose of the Facilities Standards

The Facilities Standards for the Public Buildings Service PBS P100 (known as the P100) establishes design standards and criteria for new buildings, repairs and alterations, and modernizations for the Public Buildings Service (PBS) of the General Services Administration (GSA). This document also applies to lease construction with government option to purchase buildings. This document contains policy and technical criteria to be used in the programming, design, and documentation of GSA facilities.

The P100 is a mandatory standard. It is not a guideline, textbook, handbook, training manual, nor substitute for technical competence. The P100 represents the current state of practice in designing facilities to meet GSA's commitments, maximize the efficiency of business processes, and comply with the requirements of law.

In the P100 the word "must" means the requirement is mandatory; the word "should" indicates a preferred approach that the architect/engineer (A/E) needs to consider in developing their design solution to the facility.

The P100 must be used in conjunction with the governing standards referenced in this document, as well as the building program for each project. If conflicts exist between the facilities standards and a specific program and project requirements, contact the Office of Design and Construction for resolution.

The design team must review compliance with the building program at each stage of the project, as required in Appendix A, to ensure that the requirements of the program, the P100, and relevant codes and standards have been met and to guard against unplanned expansion of the program because of design and engineering choices.

FACILITIES STANDARDS
BEST PRACTICES

Best practices are included in this document and shown graphically in this sidebar format. These are recommendations and are not mandatory requirements.

San Francisco Federal Building
San Francisco, California

Manually controlled windows allow fresh air into upper floor levels, conserving energy used for air conditioning and improving air quality in the workplace environment.

1.2 Deviations from the P100

BEST PRACTICE
ALTERNATIVE APPROACHES

Alternatives to the P100 requirements should be proposed by the A/E at the earliest possible stage in the design process to allow GSA to consider and take action on the proposal before design has proceeded to a point where denial of the proposal would disrupt the project and its progress.

BEST PRACTICE
VALUE ENGINEERING

VE should be conducted before completion of the design development submission, and any recommendations arising from the VE must be incorporated into the design development submission.

Waivers

Deviations from the P100 require an approved waiver. Waivers must be requested in writing by the regional commissioners and approved by the Office of Design and Construction before the concept submission is presented. Waivers must be processed through the responsible regional program coordinator in the Office of Design and Construction.

Proposed Alternatives

GSA encourages the development of new, innovative building systems.The provisions of this document are not intended to prohibit the use of alternative systems, methods, or devices not specifically addressed by the P100.

Generally, all technical documentation for alternatives must be submitted and approved before the final concept submission. Fire protection and life safety issues must first be reviewed and approved by the GSA regional fire protection engineer. Proposed alternatives must be equivalent or superior to the P100 requirements concerning quality, cost, strength, effectiveness, fire resistance, durability, efficiency, and safety. All proposed alternatives must be accomplished within the project budget and schedule. The approved alternative will be recognized as being an equivalent design solution and compliant with the P100.

Value Engineering

Value engineering (VE) is required of GSA by Office of Management and Budget (OMB) Circular A-131, Value Engineering. VE is an organized effort directed at analyzing the functions of systems, equipment, facilities, services, and supplies for achieving essential functions at the lowest life-cycle cost consistent with required performance, reliability, quality, sustainability, and safety. VE increases value, raises productivity, and improves quality. VE is not a means of reducing cost at the expense of performance. VE cannot be allowed to adversely affect building energy efficiency performance.

VE is most effective when applied as early in the design process as possible. VE can be performed by the A/E or by a separate contract.

The Office of Design and Construction must approve, in writing, VE proposals that modify the approved concept design before changes are incorporated in the construction documents. If VE affects energy usage or sustainability goals, the energy analysis must be revised and an analysis of sustainability impacts must be submitted.

Cost Reduction

The Federal Acquisition Regulation (FAR) 52.236-22, Design Within Funding Limitations (cited in the A/E contract), requires the A/E to design the project within the contractually stipulated funding limitation and states that the A/E will be required to make revisions to the design if the funding limitation is exceeded by the lowest bid, except when the causes for such excess are beyond the A/E's control.

Cost reduction measures are needed when the estimate for a project as designed exceeds the funding limitation. Cost overruns in one discipline must not be funded by reducing the budget and available funds in other disciplines. Cost reductions must not be accomplished through reduction of scope or deviations from the P100. All reductions in cost must be analyzed based on life-cycle cost, not just the first cost. The Office of Design and Construction must approve, in writing, changes to the project design proposed through the cost reduction process.

1.3 Application of the P100

The P100 applies to all new construction projects. New construction includes additions and annexes to existing facilities. In addition, this section describes how to apply the P100 to projects for repair and alterations, modernizations, lease construction, and lease construction with Government option to purchase.

Repairs & Alterations

Repairs & Alterations (R&A) are improvements made to existing facilities. Generally, building systems need only be upgraded to correct deficiencies identified by GSA, unless the entire building is being renovated. All new work is required to meet the applicable national codes and standards adopted by GSA. If a major portion of the building is being renovated, the specific codes must be evaluated to determine if the entire building must be brought into compliance with the code. Any questions or concerns must be discussed with the GSA project manager.

The requirements of the P100 apply to renovations and alterations to the extent those renovations and alterations are identified in the approved and funded project prospectus. All items within the designer's scope of work need to be designed in accordance with the P100. The designer should have any ambiguities clarified in writing before beginning the design.

Lease Construction

Lease construction is new construction of a facility for Government use required by GSA's formal lease Solicitation for Offers (SFO). The construction may be either on a preselected site assigned by GSA to the successful offeror or on the offeror's site. Specific requirements for lease construction, such as seismic, security, environmental, fire protection, life safety, accessibility, and others, are described in the SFO.

Lease Construction with Government Option to Purchase

In cases where GSA's formal SFO has an option for GSA to purchase the building at a future date, the requirements of the P100 may be considered for inclusion in the SFO on a case by case basis. In addition to the GSA-adopted nationally recognized codes and requirements, State and local government codes apply. If a conflict exists between applicable State and local government codes and the GSA requirements, the developer must identify these conflicts in writing and request a resolution from the GSA contracting officer.

Tenant Improvements

Tenant improvements are defined in the *GSA Pricing Desk Guide* at **http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/pricing_guide_R2F-cl-v_0Z5RDZ-i34K-pR.pdf**.

Internal Revenue Service Center
Kansas City, Missouri

The 1.14-million-square-foot facility is a model of design excellence in lease construction projects.

1.4 Federal Laws, Regulations, and Standards

The following are Federal laws, regulations, and standards applicable to all projects.

Public Buildings Amendments of 1988

The Public Buildings Amendments of 1988, 40 U.S.C. 3312, require that each building constructed or altered by GSA or any other Federal agency must, to the maximum extent feasible, comply with one of the nationally recognized model building codes and with other applicable nationally recognized codes.

Environmental Protection

In addition to building-specific codes, all projects must comply with all Federal, State, and local environmental laws, regulations, and Executive Orders. Federal regulations are found typically, but not exclusively, in the Code of Federal Regulations (CFR) Title 40, Protection of Environment, Executive Order 13423—Strengthening Federal Environmental, Energy, and Transportation Management, and Executive Order 13514—Federal Leadership in Environmental, Energy, and Economic Performance. In matters of environmental compliance, GSA's policy is voluntary conformity to certain State and local code requirements even when permitting or approvals from local regulators are not required. Confer with the regional environmental coordinator for specific applicability.

**The Lewis F. Powell, Jr. U.S. Courthouse
Richmond, Virginia**

One of only two buildings in the historic core of Richmond to survive the devastating 1865 fire during the last days of the Civil War, the courthouse is the second oldest in GSA's inventory. Shown is the restored lobby.

Energy and Sustainable Design

Legislation directed toward energy efficiency and sustainability continues to increase.

Laws, regulations, and Executive Orders affecting the design and operation of Federal buildings include:

- Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance
- Energy Independence and Security Act of 2007 (EISA 2007)
- Executive Order 13423: Strengthening Federal Environmental, Energy, and Transportation Management
- Energy Policy Act of 2005 (EPAct 2005)

For information on the implementation of sustainable design and energy, see Section 1.8, Sustainability.

Historic Preservation

The National Historic Preservation Act (NHPA) of 1966 mandates that Federal agencies use historic properties to the greatest extent possible and strive to rehabilitate them in a manner that preserves their architectural character, in accordance with the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings (36 CFR 67).

Accessibility

GSA policy is to make all Federal buildings accessible without the use of special facilities for persons with disabilities. The intent of this policy is to use standard building products set at prescribed heights and with prescribed maneuvering clearances to allow easy access by disabled employees and visitors. Building elements designated specifically for use by persons with disabilities should be kept to a minimum.

The Architectural Barriers Act Accessibility Standard (ABAAS) is mandatory for all GSA projects. If local accessibility standards exist, the A/E must follow the most stringent requirements between the local standards and ABAAS.

The criteria of these standards should be considered a minimum in providing access for persons with disabilities. Dimensions that are not stated as "maximum" or "minimum" are absolute. All dimensions are subject to conventional industry tolerances except where the requirement is stated as a range with specific minimum and maximum end points.

Accessible Public Entrances

All public entrances provided in accordance with Paragraph F206.4.1 (Public Entrances) of the ABAAS must have at least one entrance door complying with Section 404.3 (Automatic and Power-Assisted Doors and Gates) of the ABAAS. Where an accessible public entrance has a vestibule with exterior and interior entrance doors, at least one exterior door and one interior door must comply with Section 404.3.

Accessibility in Federal Courthouses

Please refer to Chapter 8, Design Standards for U.S. Court Facilities, Section 8.2, Planning for Accessibility, and Table 8.1, Accessibility Requirements.

Occupational Safety and Health Regulations

The Occupational Safety and Health Administration (OSHA) does not directly regulate facility design; however, the construction, operation, and occupation of facilities must comply with OSHA regulations. The A/E must ensure that facilities can be constructed in a manner compliant with 29 CFR 1926; the design must anticipate facility operations and maintenance and ensure they can be performed in compliance with 29 CFR 1910; and must not subject building occupants to conditions in violation of 29 CFR 1910.

Randolph-Sheppard Act

The Randolph-Sheppard Act provides qualified blind persons the opportunity to operate businesses on Federal, State, or other property. The A/E must coordinate design with the vending facility operators to meet the needs of vendors covered by the act.

1.5 Nationally Recognized Codes and Standards

For all design and construction work performed on Federal buildings by GSA or those functions under GSA's construction authority, GSA has adopted the technical requirements of the nationally recognized codes and standards referred to in this subsection. The technical requirements of these codes and standards are supplemented by mandates of Federal laws and executive orders, as well as GSA and other Federal agency criteria. The latest edition of these codes and standards, in effect at the time of design contract award, must be used throughout design and construction of the project.

Social Security Administration Teleservice Center Auburn, Washington

In an exceptional case of adaptive reuse, Warehouse 7, one of eight almost identical 1940s storage buildings on the 138-acre GSA Auburn Campus, has become a gleaming model of sustainability and workplace quality.

Conflicts between Codes or Standards and GSA Requirements

To ensure flexibility, GSA's policy is to make maximum use of equivalency clauses in all codes and standards. If a conflict exists between GSA requirements and the GSA-adopted codes or standards, the GSA requirements take precedence. All such conflicts must be brought to the attention of the GSA project manager as appropriate for resolution.

ICC Family of Codes

GSA has adopted the technical requirements of the family of codes issued by the International Code Council (ICC), except as noted below. The ICC family of codes is available through **www.iccsafe.org**.

NFPA Life Safety Code

GSA has adopted the technical egress requirements of the National Fire Protection Association (NFPA), Life Safety Code (NFPA 101), in lieu of the technical egress requirements of the International Building Code (IBC). The Life Safety Code is available through **www.nfpa.org**.

NFPA National Electrical Code

GSA has adopted the technical electrical requirements of the NFPA, National Electrical Code (NFPA 70). The National Electrical Code is available through **www.nfpa.org**.

National Standards

Organizations writing voluntary national standards, including NFPA, the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), the Institute of Electrical and Electronics Engineers (IEEE), and the American Society of Mechanical Engineers (ASME), publish standards on health, safety, welfare, and security that are recognized by GSA in various chapters of the P100. Consistent with GSA's long-standing policy to comply with nationally recognized standards to the extent practicable, these standards must be used as indicated in the P100. The latest edition of the nationally recognized standards herein, in effect at the time of design contract award, must be used during design and construction.

1.6 State and Local Codes

Facilities built on Federal property are exempt from State and local building codes. GSA recognizes that the national building codes are typically the foundation of State and local building codes, and that State and local codes represent important regional interests and conditions. It is GSA's policy to comply with State and local building codes to the maximum extent practicable; however, GSA has the final authority to accept or reject any recommendation from State and/or local government officials.

State and Local Government Consultation and Review

The GSA project manager must provide the appropriate State and/or local government officials the opportunity to review the project for compatibility with local planning and zoning compliance. Local reviews must occur early in project development so that the design can easily respond to appropriate recommendations. These reviews include, but are not limited to, the review of drawings and specifications, making recommendations for compliance with local regulations, compatibility with local planning goals, and alignment with first responder requirements. The GSA project manager must inform State and local government officials that GSA and its contractors are not allowed to pay any fee for any actions taken by the State and/or local government officials in connection with local reviews or inspections. GSA will review all recommendations made by State and local government officials. Each recommendation will be carefully considered based on adequacy, cost, and nationally accepted practice. GSA has the final authority to accept or reject any recommendation from State and/or local government officials. The GSA project manager will maintain a record of all recommendations and comments from State and local government officials for the duration of the project.

Zoning and Related Issues

The A/E team must offer local officials an opportunity to review and comment on the design concepts for compatibility with local plans, zoning, and design guidelines. Local review must be done in coordination with the project design schedule. If local officials choose not to review the design concept, the project manager must document this in the project file.

By law, the A/E must incorporate the National Environmental Policy Act (NEPA) record of decision (ROD) requirements in the design documents.

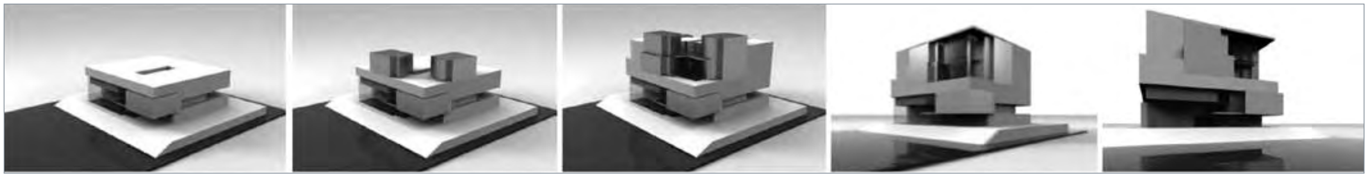
BEST PRACTICE

PARKING AND TRANSIT

Parking as required by the building program takes precedence over zoning ordinances. The project team must seek creative alternatives and partnerships to address local parking concerns brought about by GSA's development. Considerations may include shared parking facilities and strategies to encourage transit use.

United States Courthouse
Austin, Texas

Sited on a full city block of a historic square, model renderings show the building mass from various angles.



BEST PRACTICE
LOCAL REVIEW

Local officials should be provided a specific time for their review (e.g., 30 calendar days), in coordination with the project design schedule. Comments should be received in writing. If comments are not received after the allotted time frame (e.g., 30 calendar days), the GSA project manager proceeds with project execution.

BEST PRACTICE
COMMENTS LOG

The GSA project manager should maintain a project record of comments made by local officials.

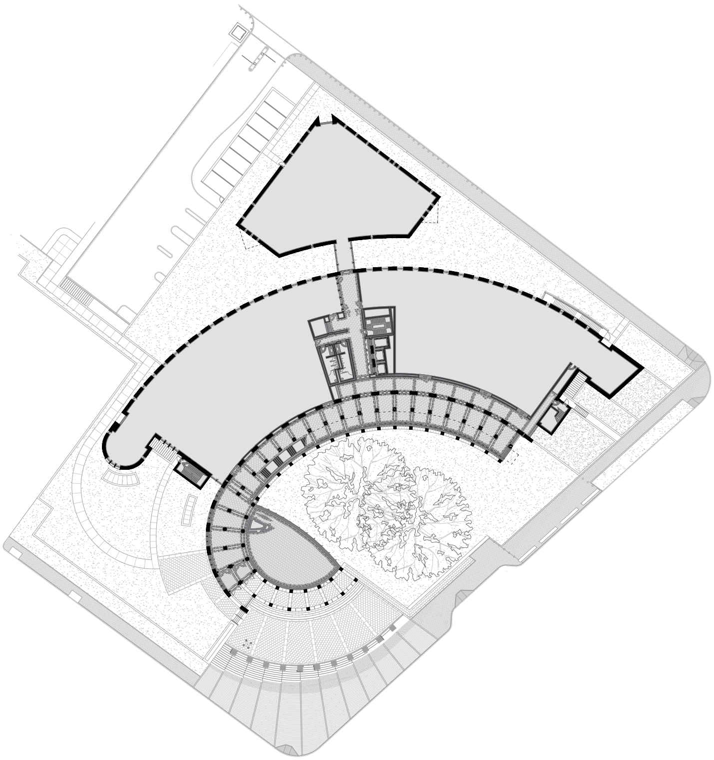
Local regulations must be followed without exception in the design of systems that have a direct impact on off-site terrain or infrastructure. These systems include, but are not limited to, fire protection services, storm water runoff, erosion control, sanitary sewers and storm drains, water, gas, electrical power, communications, emergency vehicle access, roads, and bridges.

Design Review for Code Compliance

The GSA project manager must provide the appropriate State and/or local government officials the opportunity to review the design for building code compliance. The GSA project manager will officially forward design submissions to the appropriate local officials.

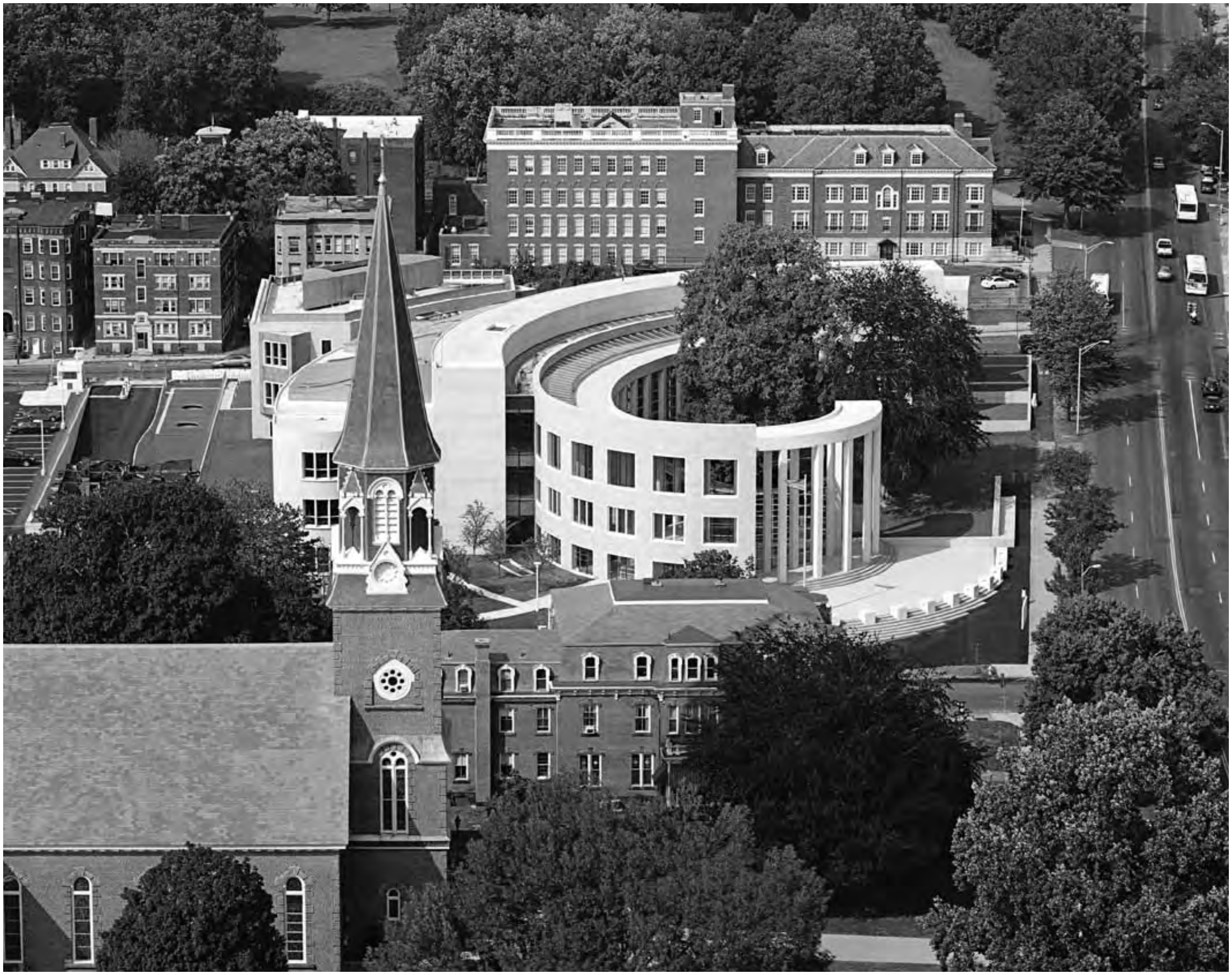
Construction Inspections

If State and local government officials elect to perform code compliance construction inspections, the GSA project manager must include provisions in both the A/E and construction contract for coordination of the work with local officials. State and local government officials do not have the authority to reject, accept, or make changes to the work, and their inspections are done only to assist GSA in achieving code compliance.



United States Courthouse Springfield, Massachusetts

A catalyst for civic redevelopment, the new courthouse has transformed an urban site.



1.7 Program-Specific Guides and Standards

In addition to the P100, GSA and its customer agencies use a number of specific guides and standards that address program requirements. Use of these guides is mandatory. In case of conflicts between the P100 and a specific building guide, the guide takes precedence. If conflicts exist between the facilities standards and specific program and project requirements, contact the Office of Design and Construction for clarification. The websites for these guides are listed in Appendix Section B1, References.

Federal Courthouses

The Office of Design and Construction provides guidance on all levels of development of courthouse projects between Congress, OMB, the Administrative Office of the United States Courts (AOUSC), and GSA and serves as a liaison for all courthouse projects. See Chapter 8, Design Standards for U.S. Court Facilities, for detailed descriptions of the publications listed below and their application.

- *GSA Courthouse Visitor's Guide,* February 2003
- *GSA Courthouse Project Handbook,* August 2004
- *U.S. Courts Design Guide*
- *U.S. Marshals Service Judicial Security Systems Requirements and Specifications,* Volume 3, Publication 64, 2005
- *U.S. Marshals Service Requirements and Specifications for Special Purpose and Support Space, Volume One: Architectural & Engineering,* 2007; *Volume Two: Electronic Security & Hardware,* 2007

Land Ports of Entry

The Office of Design and Construction provides guidance on the management of the border station program, including strategic planning, budgeting, benchmarking, and design guidance. For more information see:

- *United States Land Port of Entry Design Guide,* 2010

Child Care Centers

Requirements for child care centers must be incorporated early in the design and planning process. The references below provide guidance on such topics as site design, emergency evacuation, food services, safety, security, mechanical, electrical, and plumbing:

- *Child Care Center Design Guide* (PBS-P140)
- Accreditation Criteria and Procedures of the National Association for the Education of Young Children (NAEYC)

Security

Please see the following documents for more information on the security design requirements for Federal buildings:

- Interagency Security Criteria (ISC)—Physical Security Criteria for Federal Facilities
- *GSA PBS Site Security Design Guide*
- *GSA PBS Design Notebook for Federal Lobby Security*

Other Guides

- GSA National Business Space Assignment Policy
- GSA P120 Project Estimating Requirements
- GSA Order 8000.1C GSA Metric Program
- GSA 3490.1A on Document Security for Sensitive But Unclassified Building Information
- Executive Order 13502, Use of Project Labor Agreements for Federal Construction Projects

1.8 Sustainability

Sustainability is the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations. Sustainable design seeks to ensure that future generations are not disadvantaged by the depletion of natural or nonrenewable resources by the current generation. Sustainable designs follow an integrated, synergistic approach, in which all phases of the facility lifecycle are considered. Following sustainable design principles improves building performance, promotes the health and comfort of building occupants, minimizes environmental impacts, and supports natural resource availability. The result must be an optimal synergy of cost, environmental, societal, and human benefits while meeting the mission and function of the intended facility or infrastructure. Subsequent chapters of the P100 include requirements and recommendations to meet these objectives.

The essential principles of sustainable design and development are:

- Optimize site potential
- Minimize nonrenewable energy consumption
- Protect and conserve water
- Use environmentally preferable products and materials
- Enhance indoor environmental quality, and
- Optimize operations and maintenance practices

These principles must serve as the basis for planning, programming, design, budgeting, construction, commissioning, operation, maintenance, and disposal of all new facilities, major renovations, and existing building alterations. These principles must be applied as appropriate to every project scope. Applicable strategies and opportunities to improve sustainable performance must be included in all projects.

New construction and major renovations of GSA buildings, as well as applicable work in existing GSA buildings, must comply with the Guiding Principles for Federal

BEST PRACTICE

AIMING FOR TRUE SUSTAINABILITY

While Federal sustainability mandates establish minimum performance levels, designers can gain multiple benefits by maximizing environmental performance. For this reason, GSA has set a goal for Federal buildings of achieving a *zero environmental footprint.* High performance green buildings need not be more expensive when inspired design identifies creative solutions. For example, highly energy efficient buildings can save money by downsizing their HVAC systems to meet the reduced load. One green building system that promotes strategies and deeper systems thinking in pursuit of true sustainability is the Living Building Challenge **(www.ilbi.org).**

Another important strategy is *passive survivability,* which supports the ability of a facility to maintain life-support conditions for occupants if essential utilities are lost for an extended period. Passive design protects occupants and the public if events such as a natural disaster or terrorist act interrupt access to critical resources. Key passive design features include: cooling-load avoidance strategies, natural ventilation capabilities, a highly efficient thermal envelope, passive solar gain, and daylighting.

A third strategy to maximize environmental benefits is *design for deconstruction & reuse*— see the Lifecycle Building Challenge **(www.lifecyclebuilding.org)** for more information and ideas.

Leadership in High Performance and Sustainable Buildings. Strategies to meet the Guiding Principles are included in each appropriate chapter of the P100. For the latest guidance on implementing the Guiding Principles see **www.wbdg.org/sustainableEO**.

LEED Certification

Through integrative design and application of sustainable design principles, all new construction projects and substantial renovations must achieve, at a minimum, a LEED Gold rating through the Leadership in Energy and Environmental Design (LEED) Green Building Rating System of the U.S. Green Building Council. GSA's use of LEED is to measure and quantify building performance achievements in relation to our mandates and goals. Pursue LEED credits appropriate to the goals of GSA and to the type of project being designed.

For projects seeking LEED certification, the following prerequisites and credits must be achieved to comply with the Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings, unless specifically exempted from the project scope. Credits are listed under each Guiding Principle. Additional credits listed are interrelated and synergize with the Guiding Principles but are discretionary to achieve.

NOAA Satellite Operations Facility Suitland, Maryland

The facility, featuring restored native and adaptive plants, earned a LEED Gold rating the year following its completion in 2006.

I. Employ Integrated Design Principles

Integrated Design

Innovation & Design:
LEED Accredited Professional

Commissioning

Energy & Atmosphere Prerequisite: Fundamental Commissioning of the Building Energy Systems

Energy & Atmosphere:
Enhanced Commissioning

II. Optimize Energy Performance

Energy Efficiency

Energy & Atmosphere Prerequisite:
Minimum Energy Performance

Energy & Atmosphere: Optimize Energy Performance—Improve by 30 percent for New Buildings or 20 percent below prerenovations 2003 energy use baseline for major renovations

On-Site Renewable Energy—interrelated discretionary credit

Energy & Atmosphere: On-Site Renewable Energy (solar hot water)

Measurement and Verification/Benchmarking

Energy & Atmosphere:
Measurement and Verification

III. Protect and Conserve Water

Indoor Water

Water Efficiency Prerequisite: Water Use Reduction (20 percent reduction)

Outdoor Water

Water Efficiency: Water Efficient Landscaping—Reduce by 50 percent

Sustainable Sites: Stormwater Design—Quantity Control (Imperviousness)

Sustainable Sites: Stormwater Design—Quality Control (Best Management Practices)

IV. Enhance Indoor Environmental Quality

Ventilation and Thermal Comfort

Indoor Environmental Quality Prerequisite: Minimum Indoor Air Quality Performance

Indoor Environmental Quality:
Thermal Comfort—Design

Daylighting

Indoor Environmental Quality: Daylight and Views—Daylight 75 percent of Spaces

Low-Emitting Materials

Indoor Environmental Quality: Low Emitting Materials—Adhesives and Sealants

Indoor Environmental Quality: Low Emitting Materials—Paints and Coatings

Indoor Environmental Quality: Low Emitting Materials—Flooring Systems

Indoor Environmental Quality: Low Emitting Materials—Composite Wood and Agrifiber Products

Protect Indoor Air Quality during Construction

Indoor Environmental Quality: Construction IAQ Management Plan—During Construction

Indoor Environmental Quality: Construction IAQ Management Plan—Before Occupancy

Environmental Tobacco Smoke Control

Indoor Environmental Quality Prerequisite: Environmental Tobacco Smoke (ETS) Control

V. Reduce Environmental Impact of Materials

Recycled Content

Materials & Resources: Recycled Content—10 percent (post consumer + ½ preconsumer)

Biobased Content—interrelated discretionary credit

Materials & Resources:
Rapidly Renewable Materials

Materials & Resources: Certified Wood

Environmentally Preferable Products—interrelated discretionary credit

Consult the Federal Green Construction Guide for Specifiers at **www.wbdg.org/design/greenspec.php**

Materials & Resources: Materials Reuse—5 percent of total value of materials

Materials & Resources: Regional Materials—10 percent Extracted, Processed & Manufactured Regionally

Waste and Materials Management

Materials & Resources Prerequisite:
Storage and Collection of Recyclables

Materials & Resources: Construction Waste Management—50 percent Recycled or Salvaged

Ozone Depleting Compounds

Energy & Atmosphere Prerequisite:
Fundamental Refrigerant Management

Energy & Atmosphere: Enhanced Refrigerant Management

1.9 Energy Use Targets

Buildings must be designed to comply with the energy performance requirements of EPAct 2005 and EISA 2007.

EPAct 2005 Building Design Energy Compliance

EPAct 2005 requires buildings to be designed to be at least 30 percent more efficient than the design required by ASHRAE 90.1 if life cycle cost effective. For guidance to achieve a level of energy efficiency 30 percent greater than ASHRAE Standard 90.1-2004, see the final rule 10 CFR, Energy, Parts 433-435 issued by DOE at **www1.eere.energy.gov/femp/pdfs/fr_notice_cfr433_434_435.pdf**.

EISA 2007 Fossil Fuel Reduction Compliance

EISA 2007 requires buildings to be designed so that the fossil fuel generated energy use is reduced by the following percentages over CBECS 2003 in designs for prospectus-level new construction and major renovations:

FY2010	55% reduction
FY2015	65% reduction
FY2020	80% reduction
FY2025	90% reduction
FY2030	100% reduction

A February 2008 study on high performance buildings conducted by the Office of Energy Efficiency and Renewable Energy of the Department of Energy shows that designing to 30 percent below ASHRAE 90.1-2004 results in a target energy use intensity slightly less than the 55 percent reduction required by EISA 2007. The study is available at: **http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/energy_use_intensity_targets.pdf**. Based on this study, a new building design that is at least 30 percent more efficient than ASHRAE 90.1-2004 will satisfy the requirements of EISA 2007 for designs started from 2010 to 2014.

Major Renovations

Pending the final rule on fossil fuel reduction for major renovations, the A/E must design all systems to be replaced with systems that offer the highest level of energy performance available. All designs that improve HVAC systems must include recommissioning of the entire HVAC system. For modernizations where all systems are replaced, the A/E must target at least a 20 percent reduction from the 2003 energy usage of the building. The building's 2003 energy usage can be obtained from the Office of Design and Construction.

Energy Use Intensities Design Maximums

Both EPAct 2005 and EISA 2007 require reductions in the energy use of the overall portfolio of buildings owned by GSA. To meet the goal of reducing total site energy usage by 30 percent by 2015 as compared to a 2003 baseline, energy targets are established for all new construction. Table 1.1 provides the maximum building energy use for each ASHRAE climatic zone. The A/E must design all new buildings to have an energy performance below the energy target or 30 percent below ASHRAE 90.1, whichever is lower.

From concept design through each design phase, the project must demonstrate that it meets the energy target. Use energy modeling that includes the building enclosure systems in concert with mechanical systems and provides documentation showing that systems were chosen based on a life-cycle cost analysis.

For courthouses use the public safety buildings target. For land ports of entry perform the energy analysis for the main building, commercial building, and headhouse, and use public safety target.

Energy Use Intensity Design Targets

Building Type	Climate Zones													
	1A	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	6A	6B	7
Office	39	42	45	37	32	31	42	41	37	42	33	43	43	47
Public Safety	38	38	38	47	47	47	42	42	42	55	54	51	61	61

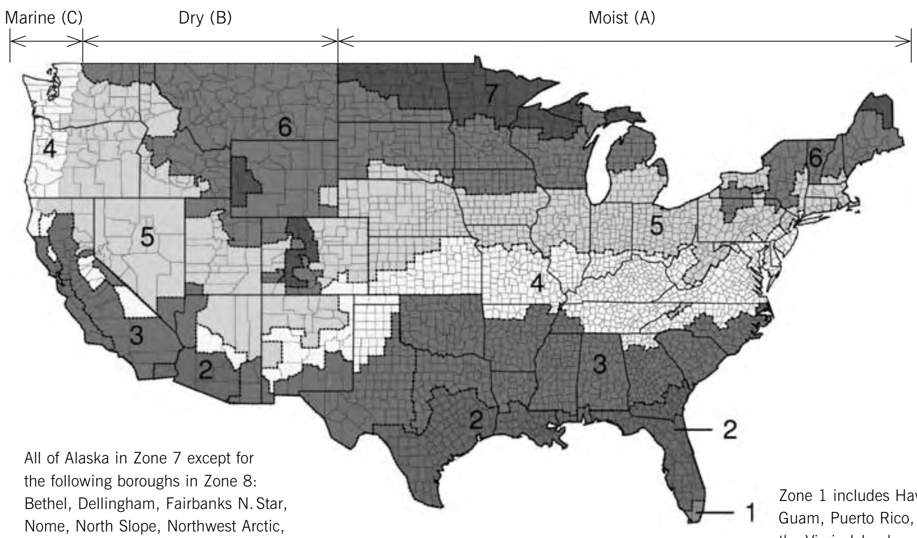
Targets are for kBtu/GSF/yr

Climate Zones are defined in ANSI/ASHRAE Standard 169-2006, see Figure 1-1.

Data is from: **http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/energy_use_intensity_targets.pdf.-Table1**.

Figure 1-1

ASHRAE Climate Zones



All of Alaska in Zone 7 except for the following boroughs in Zone 8: Bethel, Dellingham, Fairbanks N. Star, Nome, North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, Yukon-Koyukuk

Zone 1 includes Hawaii, Guam, Puerto Rico, and the Virgin Islands

1.10 Health and Safety

BEST PRACTICE

MITIGATION METHODS

Mitigation with preferred methods generally requires higher initial cost. However, these methods provide the most effective protection, often with lower life-cycle costs. Where preferred methods are too costly, less preferred recommendations may be combined to provide redundant or overlapping solutions.

Health and safety regulations are primarily operation-oriented and usually do not directly stipulate building design requirements. The A/E must take a systems approach to risk management, utilizing codes, regulations, guidelines, and best practices to identify and mitigate facility-created health and safety risks early in the design phases of the project life cycle.

Order of Precedence

At each phase of the design, the A/E must identify and mitigate safety and health risks in accordance with the following order of precedence (refer to ANSI/AIHA Z10-2005):

Eliminate or reduce the hazard

If the hazard cannot be eliminated, the associated risk must be reduced to an acceptable level through design.

Isolate the hazard

If the hazard cannot be eliminated through design, the risk must be reduced to an acceptable level using engineering controls, protective safety features, or devices.

Provide warning devices

If safety devices do not adequately lower the risk of the hazard, cautions and warnings must be provided using detection and warning systems, as appropriate.

Develop procedures and training

Where it is impractical to eliminate hazards through design selection or to reduce the associated risk to an acceptable level with detection and warning devices, incorporate special procedures and training. Procedures may include the use of personal protective equipment. For high-consequence hazards, warnings, cautions, or other written advisories must not be the only risk reduction method.

Specific Health and Safety Requirements

Asbestos

Total renovations of occupied spaces must include the removal of all asbestos-containing material (ACM). Encapsulation, enclosure, or management in place of ACM in occupied spaces is prohibited.

Lead-Based Paint

Paint must be tested for lead content when alterations or demolitions require the sanding, burning, welding, or scraping of painted surfaces. Lead-based paint controls must be implemented in accordance with 29 CFR 1926.62. Lead-based paint that is intact and in good condition must not be abated, unless required for alteration or demolition. Lead-based paint must be abated in child care centers. Refer to PBS-P140 for specific details. Construction waste containing lead-based paint must be considered hazardous waste unless testing proves otherwise.

Confined Spaces

The designer must avoid the creation of confined spaces except where required as part of a system (e.g., tanks, pits). Confined space is defined in 29 CFR 1910.

Fall Protection

The design must consider the inspection, operations, and maintenance of the site, facility, and equipment. Access and fall protection, especially to difficult maintenance needs in high locations, including lighting fixtures, mechanical equipment, and skylights, must be considered in the design. Specific detail is provided in the appropriate technical chapters.

Soil Contamination

If soil or water contamination is a concern during construction of new buildings, major and minor alterations, and work in historic structures, EPA regulations under 40 CFR must be followed.

1.11 Design for Physical Security

Federal facilities must be safe and secure, yet still be accessible, welcoming, and effective workplaces. Each building design must reduce risks to people and property through proper security design.

Zoned or Concentric Protection

A zoned or concentric protection system must be used, with intensifying areas of security beginning outside or at the site perimeter and moving to the interior of the building. The designer's plan for physical security is an important part of the concept design presentation.

ISC Security Design Criteria

GSA is a member of the ISC and uses the ISC Physical Security Criteria for Federal Facilities. This document is restricted to Official Use Only, and the A/E must request a copy from GSA/PBS Office of Design and Construction.

The ISC security criteria are applied only in response to a specific risk assessment for that facility. The Federal Protective Service of the Department of Homeland Security (DHS) conducts regular risk assessments of all Federal buildings. GSA and the Facility Security Committee (FSC), with the design team, determine how to most effectively mitigate identified risks.

For the design and renovation of courthouses, also see criteria from the U.S. Marshals Service (USMS) Judicial Security Systems Requirement and Specifications.

Security Risk Assessment

Each team must develop an effective and realistic strategy for its unique project requirements, resources, and location, using a collaborative, multidisciplinary approach to security design. The team must include appropriate specialists, including a blast mitigation specialist and the fire protection engineer.

BEST PRACTICE

SECURITY COSTS

The security budget is a product of a project-specific risk assessment. To facilitate funding, cost control, and risk management, customer agencies are required to consider a work breakdown structure, which summarizes security expenditures in a specific account that can be clearly identified and monitored throughout design phases. The Standard Practice for Measuring Cost Risk of Buildings and Building Systems, ASTM E1946, may be used to manage cost risk.

**Oklahoma City Federal Building
Oklahoma City, Oklahoma**

This building successfully addresses security in an open and humane way, providing users a sense of the outdoors.

1.12 Methodologies

TARGET:
SPACE EFFICIENCY

The target for the usable-to-gross ratio in new building construction is 80 percent. In all building types, space efficiency must be balanced against effectively achieving space requirements and desired aesthetics.

Space Measurement and Building Efficiency

The A/E must design to the area authorized in the approved prospectus and delineated in the program of requirements. The area must be confirmed at each phase of design and is to be measured in accordance with the GSA National Business Space Assignment Policy dated May 2009 or current edition, including any addendums or other clarifications. Projects that exceed the congressionally authorized area will need to be redesigned.

GSA's National Business Space Assignment Policy establishes current PBS practices for the assignment of space within the federally owned and leased inventory. It provides the methodology and information necessary for the correct assignment of space.

Additionally, this policy document provides details and illustrations of how PBS uses the commercial American National Standards Institute (ANSI) and Building Owners and Managers Association International (BOMA) Standard Method for Measuring Floor Area in Office Buildings (ANSI/BOMA Z65.1) as the foundation for space measurement and assignment.

PBS's measurement and assignment principles are not 100 percent compliant with ANSI/BOMA measurement standards. For example, PBS uses a PBS-specific category in conjunction with ANSI/BOMA's categories. This document provides the details and illustrations showing how PBS's assignment and measurement processes relate to and differ from ANSI/BOMA processes.

Space efficiency is defined as the minimum necessary space for the desired functions to be properly accommodated, with minimum 'waste' between usable area and gross area. The target for the usable-to-gross ratio in new building construction is 80 percent. The National Business Space Assignment Policy established the definition of usable and gross area. In all building types, space efficiency must be balanced against effectively achieving space requirements and desired aesthetics.

The plan configuration, floor-plate depth, planning module, and circulation patterns together determine the space efficiencies of a building. The historic character of a building can create major inefficiencies where the primary circulation is typically wider and thereby affects the amount of usable space available. However, a building's historic value or design aesthetics should not be compromised to achieve greater space efficiencies.

Plan configuration describes the geometry of a typical floor within a building. A square or rectangular plan with a single central core will be inherently more efficient than a plan that is highly irregular, with distributed service cores. Building types other than office buildings, like courthouses and Land Ports of Entry (LPOE), will likely have lower usable to gross ratios based on numerous special requirements that are addressed in their design guides. When efficiency ratios fall, the floor plan is likely to have more irregularities that, in turn, will increase space utilizations per full-time equivalent (FTE) and restrict furniture and tenant space planning. Configuration of space is an important consideration when selecting a new building design or comparing one with another.

Workplace Tools and Processes

Use workplace program analysis and development tools and processes that provide cost- and time-effective ways to analyze existing space performance, space constraints, and organizational mission and goals, and provide design criteria that directly address these issues. The analysis should include the following.

A Balanced Scorecard Approach

Developed by Harvard's Kaplan and Norton, this provides a framework to analyze and measure the performance of an organization in four domains—finance, business process, customer, and human capital. GSA uniquely uses this framework to directly link workplace solutions to the organization's goals.

Quantitative and Qualitative Discovery Processes and Tools

These are used to derive design concepts and solutions from an understanding of the organization—its goals, culture, and current and desired work practices—using both quantitative and qualitative data. This includes gathering quantitative and qualitative data, gaining in-depth knowledge of the customer organization, conducting on-site observations, interviews, and focus groups, and developing written guidelines to inform the design and design review processes.

Change Management

This involves a broad segment of the organization to help define workplace needs and build project consensus. By engaging occupants early on, change management can be approached as an organizational opportunity, and occupant expectations can be managed proactively.

Feedback Loop

This involves identifying connections between business and workplace goals and design solutions, measuring for desired outcomes, and using the findings to improve existing and future organizational operations and work-place projects. This includes preoccupancy and post occupancy surveys, design commissioning, testing, and measurement.

For more information on workplace analysis processes and tools, visit **www.gsa.gov/workplace**.

Building Information Modeling (BIM)

A Building Information Model (Model) is a digital representation of physical and functional characteristics of a facility. As such, it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward.

A basic premise of Building Information Modeling is collaboration by different stakeholders at different phases of the life-cycle of a facility to insert, extract, update or modify information in the Model to support and reflect the roles of that stakeholder. The Model is a shared digital representation founded on open standards for interoperability.

BIM standards have many objectives but one of the most important is to improve business function so that collection, use and maintenance of facility information are a part of doing business by the authoritative source and not a separate activity.

2008, Dana Smith, Alan Edgar
The Whole Building Design Guide
www.wbdg.org

The primary goal of the GSA 3D-4D-BIM program is to incorporate digital visualization, simulation, and optimization technologies in project planning and design and to increase quality and efficiency of business processes throughout GSA project life-cycle.

All major projects are required to have a spatial BIM program submitted to GSA before final concept presentation. GSA uses BIM to validate spatial program requirements (e.g., area and efficiency ratios). See the GSA BIM Guide Series 02 Spatial Program Validation for specific requirements at **http://www.gsa.gov/bim**.

BEST PRACTICE

3D, 4D, AND BIM

GSA encourages project teams to adopt 3D, 4D, and BIM technologies beyond the minimum requirement and to explore potential efficiencies created by the application of such technologies throughout a project's life cycle. BIM analyses can include 4D phasing optimization, virtual construction, collision detection, energy analysis, cost analysis, life-cycle cost analysis, circulation validation, and use in operations and maintenance.

Total Building Commissioning

Total Building Commissioning (TBC) is a systematic process of ensuring by verification and documentation, from the design phase to a minimum of one year after construction, that facility systems perform interactively in accordance with the design documentation and intent, and in accordance with the owner's operational needs to include preparation of operation personnel.

TBC recognizes the integrated nature of all building systems' performance, which affects sustainability, workplace productivity, occupant safety, and security. All GSA capital construction projects must employ TBC practices.

REQUIRED:
LIFE-CYCLE COSTING

The project team must integrate the LCC analysis into the concept design process, and the analysis must be completed by the design development phase.

For more information describing how the designer must include commissioning requirements, see the Building Commissioning Guide, available at **http://www.wbdg.org/ccb/GSAMAN/buildingcommissioningguide.pdf**.

See Chapter 7, Fire Protection and Life Safety for additional information on commissioning the fire protection and life safety systems.

Building Operations and Maintenance

Long-term operations and maintenance costs are significantly higher over time than first costs. Systems must be designed for ease of operation and cost-effective maintenance and repair. System accessibility is a critical consideration in building design. The A/E must ensure building systems and elements are physically accessible for cleaning, maintenance, repair, and replacement.

As an example, design of atrium spaces must provide methods to clean skylights, replace lamps, and maintain fire alarm devices.

The A/E must collaborate with GSA operations and maintenance personnel during design to provide for optimal life-cycle performance.

In addition to hard copies, the A/E must specify that operation and maintenance manuals be provided in electronic format with training videos for the start up and maintenance of all major equipment. At the conclusion of design, the A/E must provide an electronic document describing the design intent for all building systems. These instructions must be developed during the design phase and incorporated into the comprehensive training for operations and maintenance personnel.

Life-Cycle Costing

Federal facilities must be designed to achieve the lowest life-cycle cost. A project's design must comprehensively define reasonable scope and performance requirements within the appropriated budget and authorized prospectus for design and construction. Consistent with these constraints, building systems and features must be analyzed and selected to achieve lowest life-cycle cost.

Life-cycle costing (LCC) must be used when selecting a system from several alternative systems or components for a project. LCC is the economic analysis method required by CFR Title 10, Part 436, Subpart A, "Program Rules of the Federal Energy Management Program." OMB requires this methodology, through the Federal Energy Management Program, to evaluate the cost effectiveness of systems that use energy and water. LCC compares initial investment options and operating and salvage costs over the life of the equipment and identifies the least costly alternatives. Examples of building systems that affect energy use are the building thermal envelope, passive solar features, fenestration, HVAC, domestic hot water, building automation, and lighting.

Many established guidelines and computer-based tools that effectively support present value LCC analyses are available. The National Institute of Standards and Technology (NIST) has prepared the *Life Cycle Costing*

Manual for the Federal Energy Management Program (NIST Handbook 135) and annually issues real growth energy price indices and discount factors for life cycle cost analysis. As a companion product, NIST has also established the Building Life Cycle Cost (BLCC) computer program to perform LCC analyses. The latest versions of the BLCC program not only structure the analysis but also include current energy price indices and discount factor references. These NIST materials define all required LCC methodologies used in GSA design applications. The A/E may obtain the BLCC software and updates from NIST. The latest BLCC software is available at **www.eere.energy.gov/femp**.

The project team must integrate the LCC analysis into the concept design process, and the analysis must be completed by the design development phase.

Design alternatives must be compared against a baseline reference that is the lowest first cost of the alternatives being considered.

The analysis period should be chosen to fully represent all costs. When optimizing the design of a single system, all compared alternatives must be considered over the same analysis period. Where possible, the analysis period should be the smallest whole multiple of the service lives for the major systems involved in the analysis. Service lives of HVAC equipment can be found in the ASHRAE applications manual. In any case, the analysis period should not be over 40 years unless otherwise directed by GSA.

Investment and replacement actions over time may have an impact on recurring costs. For simplicity, fluctuating recurring cost savings may be assumed to be proportionate to the savings realized at the start of the analysis period.

The savings to investment ratio (SIR) must be used for comparisons of dissimilar alternatives, such as comparing an HVAC alternative to a lighting alternative. The net savings economic analysis must be used for comparisons of similar alternatives, such as optimizing insulation thickness in a wall. Both of these methodologies are described in NIST 135.

A sensitivity analysis must be conducted using extremes of the cost parameters in question.

Due to margins of error in estimating costs, alternatives with a life-cycle cost differential of less than 10 percent are considered inconclusive.

Metric Standards

Federal requirements for metric design are detailed in the *Metric Design Guide* (PBS-PQ260). All projects must comply with GSA Order 8000.1C GSA Metric Program dated 01-06-2004.

A project is “metric” when:

- Specifications show International System (SI) units only
- Drawings show units only
- Construction takes place in SI units only
- Inspection occurs in SI units only
- Cost estimating is based on SI units only

English and Metric Measurement Reference

A majority of dimensions set by standards and codes currently remain in the English measurement system. GSA supports the conversion to metric measurements. Therefore, when a dimensional requirement is stated in this document, the dimension designated by code or regulation is placed in parentheses and the corresponding metric designation precedes it. For example: 1.52 m (5 ft.) diameter clearance for navigation of a wheeled chair in an accessible toilet room.

Criteria Change Request for the P100

Users are permitted to request criteria changes to the P100 by utilizing the Criteria Change Request (CCR) Public Submission form available at: **https://www.projnet.org**.

Here are the steps for a public user to submit a CCR

- Point your Web browser to **https://www.projnet.org**.
- In the "Home/Design/Bid/Build" menu bar across the top of the page, move your mouse over the "Design" button and click on "CCR" from the resulting drop-down menu that appears.
- Under the "Public Submission" header, click on the link to access the "CCR Public Submission" form.
- The "CCR Agency Select" form displays.
- Choose GSA as the Agency from the drop-down list.
- Click on the "Select Agency" button.
- Select the Document Type from the "b. Doc Type" drop-down list.
- Click on the "Select Doc Type" button.
- The "CCR Add" form displays. Select the specific document for which you are submitting a CCR from the "a. Document" drop-down list.
- Enter a detailed description of the problem in the field marked "b. Problem."
- Type a proposed solution in the field marked "c. Solution."
- Enter your personal information (first name, last name, office name if applicable, e-mail address, and phone number) in boxes d through e. (Note: You will receive an e-mail confirmation following submission of your CCR that will be sent to the e-mail address you provided in field marked "g. Email." Make sure the information entered in this field is correct.)
- Click on the "Submit CCR" button.

Registered ProjNet users are able to submit CCRs using a similar process, as follows

- Log in to ProjNet (**www.projnet.org**).
- In the "My Account/Design/Bid/Build" menu bar across the top of the page, move your mouse over the "Design" button and click on "CCR" from the resulting drop-down menu that appears.
- The "CCR Agency Select" form displays.
- Choose GSA as the Agency from the drop-down list in the field marked "a. Preparing Activity."
- Click on the "Select Agency" button.
- Select the Document Type from the "b. Doc Type" drop-down list.
- Click on the "Select Doc Type" button.
- The "CCR Add" form displays. Select the specific document for which you are submitting a CCR from the "a. Document" drop-down list.
- Enter a detailed description of the problem in the field marked "b. Problem."
- You may choose to attach a file to further illustrate the problem. If so, click the "Browse…" button on the right-hand side of field marked "c. Problem Backup."
- If you are attaching a file to your CCR, make sure it is one of the following supported file types: .pdf, .doc, .html, .txt, .sec, .dgn, or .dwg.
- Type the details of your proposed solution in the field marked "d. Solution."
- You may choose to attach a file to further illustrate the solution. If so, click on the "Browse…" button on the right-hand side of the field marked "e. Solution Backup."
- Click on the "Submit CCR" button.

2

OKLAHOMA CITY FEDERAL BUILDING
OKLAHOMA CITY, OKLAHOMA

ARCHITECT: ROSS BARNEY + JANKOWSKI ARCHITECTS
PROJECT MANAGER: TIM THURY

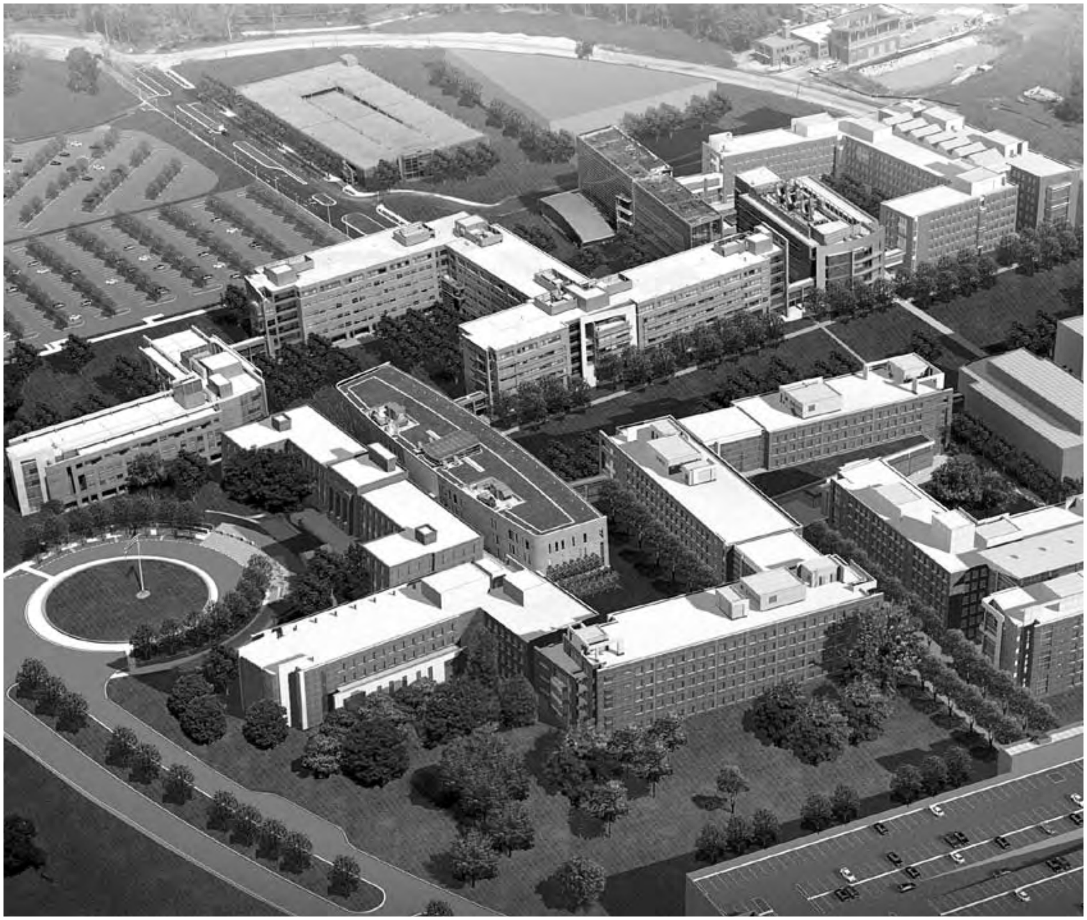
ARTIST: BRAD GOLDBERG
ARTWORK: *FOUNDATION*

Site Engineering and Landscape Design

Chapter 2 Site Engineering and Landscape Design

2.1 Goals and Objectives

Harmony among elements on site and between the site and its surroundings is the hallmark of a well-planned GSA project. The quality of the site design should be a direct extension of the building design and should make a positive contribution to the surrounding urban, suburban, or rural landscape, in terms of conservation, community design and improvement efforts, local economic development and planning, and environmentally responsible practices.



Food and Drug Administration Headquarters White Oak, Maryland

The FDA headquarters campus occupies the former 130-acre site of a Navy research center just north of Washington, DC.

2.2 GSA Programmatic Requirements

Chapter 1 has a complete discussion of the codes and standards adopted by GSA. This section highlights regulations and standards that apply to site design.

Coordination with Local Governments

GSA follows a "good neighbor" policy to collaborate with local officials and community stakeholders and implement their suggestions regarding design issues related to local zoning, official planning initiatives, economic development, and design guidelines wherever practicable. In order to have meaningful consideration and to effectively incorporate appropriate recommendations, relevant research and collaboration must occur well before completion of the design concepts. Unless there is an overriding reason and justification to the contrary, GSA respects local restrictions on setbacks, height, massing, signage, and site design requirements.

Social Security Administration Teleservice Center Auburn, Washington

On the building's east side, a landscaped swale serves both as a security barrier and as a "bioretention facility" to catch and treat 98 percent of the stormwater runoff from the hard-surfaced areas of the site. The plantings are indigenous, drought-tolerant, and watered by a low-volume drip-irrigation system.

In all cases, the number of parking spaces will be determined from the requirements of the program rather than zoning regulations.

Landscape provisions in local jurisdictions are a minimum requirement for the project.

Local regulations must be followed without exception in the design of systems that have a direct impact on off-site terrain or utility systems. These include storm water runoff, erosion control, sanitary sewers, storm sewers, water lines, gas lines, electrical and communications lines, emergency vehicle access, roads, and bridges.

NEPA and NHPA

Under the requirements of the National Environmental Policy Act (NEPA) either an environmental impact statement (EIS) or an environmental assessment (EA) will have been completed for each building project. The final environmental impact statement will contain a record of decision (ROD) that may impose restrictions on the design and construction of the project to mitigate the project's impact on the environment. These restrictions may affect the renovation of a historic building, new construction in a historic landscape or historic district, or archeological sites that limit construction or geotechnical testing. In addition, the EIS will describe wetlands, environmentally sensitive flora and fauna, and potential site contamination. The A/E must review and comply with the requirements of the final environmental impact statement and record of decision. Under Section 106 of the National Historic Preservation Act (NHPA) of 1966, additional coordination may be required to implement a memorandum of agreement (MOA) outlining specific design requirements and review processes.

2.3 Site Analysis

Successful site planning and site design depend on a thorough review and understanding of existing conditions, opportunities, and constraints of the site. A site inventory and analysis, including an on-site investigation, must be carried out before any design effort.

The site analysis includes a site survey and geotechnical investigation. In some cases the program may also include a requirement for archeological testing to determine the historical significance of the site. Coordinate geotechnical investigations to avoid damaging archeological resources. The requirements for the site analysis are described in Appendix A, Submission Requirements.

Wetland Delineation and Requirements

Determination of the potential for wetlands is part of site selection investigation and the NEPA process. Wetlands are to be delineated on the site survey. The A/E must follow the requirements of the ROD regarding wetlands.

Flood Plains

By Executive Order and GSA policy, buildings must not be built within the 100-year flood plain without an approved waiver. Buildings designated by agencies as "critical actions" must not be built within 500-year flood plains. Courthouses are designated as critical actions and the 500-year flood plain rule applies. For information on waivers and limitations for building within a flood plain, see GSA order, GSA ADM 1095.6: Consideration of Floodplains in Decision Making, and the *GSA PBS Floodplain Management Desk Guide* found at **www.gsa.gov/environmental**.

Waivers must be approved by the customer agency, the Public Buildings Service Assistant Commissioner for Portfolio Management, and the Office of Design and Construction.

If a floodplain waiver is approved, mechanical and electrical equipment rooms must be located 1,500 mm (5 ft.) above the level of the 100-year flood plain. Do not locate mechanical and electrical rooms in a basement or sub-basement.

Site Energy Analysis

The A/E must perform a site energy analysis during the preliminary concept stage. The site energy analysis will identify design strategies for the building's mass, fenestration, orientation, and features that contribute to meeting the energy goals identified in Chapter 1. Requirements of the site energy analysis are described in Chapter 5 as part of the building energy analysis.

Radon Testing

Soil must be tested for the presence of radon in EPA Zone 1 (high potential) locations. Soil must be tested in EPA Zone 2 locations where occupancy is expected below grade. Refer to **http://www.epa.gov/radon/zonemap.html** for radon zone determinations.

Brownfield

Projects constructed on "brownfield" sites where occupancy below grade is planned must test the soil for volatile contaminants.

2.4 Site Planning

Site planning must be integrated with the design of the building and respect the surrounding context. For more information on site planning related to building design, see Chapter 3, Architectural and Interior Design.

Preserve existing natural features on the site and use them as a starting point for the overall site design. To the maximum extent possible preserve existing vegetation, particularly mature healthy trees and plant specimens. Protect and integrate existing vegetation and natural terrain into the site design.

Site design must contribute to energy conservation and sustainability. Proper solar orientation of the building and well-placed plant material will improve thermal performance in the winter and reduce heat gain during the summer.

Building separation and requirements for rated exterior walls and openings for protection from exposure to adjacent buildings or hazards must comply with the requirements of the International Building Code (IBC).

Land Port of Entry
Warroads, Minnesota

A continuous canopy links three buildings and shelters inspection plazas—allowing protection from the harsh northern climate.

2.5 Physical Security

Federal facilities must be safe and secure, accessible, welcoming, and effective workplaces. Site and landscape design must address building and personal security while enhancing the pedestrian experience and fully engaging the surrounding context. The design must comply with the ISC Physical Security Criteria for Federal Facilities. The *GSA Site Security Design Guide* (2008) describes design methodologies to address these requirements. Effective site engineering and landscape design can enhance the security of a facility. Security considerations must be an integral part of all site planning, perimeter definition, lighting, and landscape decisions.

Grading of the site near perimeter barriers, vehicle inspection areas, guard booths, and other physical security features must mitigate the impact of water, ice, and snow on pedestrian and vehicles access points including the operation of gates and active vehicle arrest devices. Grading also must support the surveillance of the site by closed-circuit TV cameras and roving patrols.

Design of perimeter barriers such as fences must provide for crossing streams and other waterways with barriers in the watercourse to prevent surreptitious breach by unauthorized persons. Provide concrete culverts with grilles consisting of 16 mm (5⁄8 in.) steel bars protected from corrosion, spaced at not less than 150 mm (6 in.) between bars, and embedded in concrete not less than 100 mm (4 in.). Provide access to grilles for inspection and cleaning.

Manholes must be secured from unauthorized access using tamper-proof bolts.

Where fences, walls, cable systems, and other perimeter barrier designs are used, the design must accommodate mowing and maintenance of landscaping. Do not place trees near fences or walls where overhanging branches would permit surreptitious entry.

Where in-ground vehicle arrest devices are used, the A/E must provide adequate drainage of the pits. Where feasible, use uphill approaches to vehicle gates and barriers.

Where snow and ice are to be expected, gates and other operable devices must operate when adverse conditions occur and must allow for removal of accumulated snow and ice without damage to the barriers and other devices.

Oklahoma City Federal Building
Oklahoma City, Oklahoma

The form and orientation of the building is a direct response to the environment. It is designed to save energy and give users a sense of the outdoors.

BEST PRACTICE

FLEXIBLE SECURITY

Designs should include the ability to increase security in response to a heightened threat, as well as reduce security when threat levels decrease.

BEST PRACTICE

PERIMETER DESIGN

The design may incorporate earth berms, low walls, terracing, water features, boulders, and other features as part of the perimeter barrier system. Refer to the *GSA Site Security Design Guide* for more information.

BEST PRACTICE

CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN (CPTED)

ISC Design Criteria recommends this well-known array of strategies for site design and crime prevention that follow the premise that proper design and effective use of the built environment can lead to both a reduction in the fear of crime and the incidence of crime, as well as an improvement in quality of life.

The application of CPTED techniques can help reduce or even prevent crime. Good strategic thinking on CPTED during site planning, (perimeter definition, sight lines, lighting, etc.) can reduce the need for some engineering solutions.

Design the landscape to conceal aboveground security, electrical, communications, signal panel boxes, and hydraulic control and pump enclosures from public view. Grading must provide positive drainage away from such devices. Coordinate landscaping with underground security utilities to avoid interference.

Approaches to the site and building must be well lit and easily direct the visitor to the entrance. Grade-level pedestrian approaches are preferred over elevated approaches that require steps and ramps, but they need to be coordinated with the overall approach to provide building security. The design of vehicular approaches must be coordinated with electronic security devices such as under-pavement loop sensors, traffic signals, card readers, and other devices requiring buried services.

Where vehicle screening takes place at the site perimeter, provide adequate vehicle queuing and screening lanes to prevent interference and congestion with other traffic.

Anthony J. Celebrezze Federal Building Plaza
Cleveland, Ohio

Safety and accessibility are balanced through the use of bollards and walls combined with the innovative use of plantings and lighting within the topography.

2.6 Grading

Site grading addresses the control of runoff, storm water management, and the manipulation of topography to improve a site, or address any existing topographic challenges. A good grading plan will balance cut and fill and minimize environmental impacts caused by excessive grading, particularly in campus settings.

No grading will be performed within delineated wetland boundaries unless specifically permitted in the NEPA ROD.

Design the slopes of planted areas to control runoff, and encourage percolation. Grading and landscaping must also be designed to permit easy maintenance of the grounds. The maximum slope for turf areas is 3:1 and the minimum slope is 1 percent. A 2 percent slope is desirable. Plant slopes of 2:1 with ground cover or use other landscape materials specifically designed to control erosion. Slopes greater than 2:1 are not permitted.

Terracing is an appropriate solution for sites with large grade differentials, as long as access for lawn mowers and maintenance equipment is provided.

Turf areas adjacent to buildings must slope away from the building at a two percent grade for a distance of at least three meters.

In order to provide positive drainage, paved areas adjacent to buildings must slope away from the building at a 2 percent grade to a curb line, inlet, or drainage way.

Whenever possible, grades and slopes should contribute to the concept of universal accessibility. Slopes of walkways and ramps along a site's accessible routes must meet the requirements of The Architectural Barriers Act Accessibility Standard (ABAAS).

Tree Preservation

On projects where existing trees are to be preserved, care must be taken during grading to avoid impact or damage to root systems. Existing trees or other plant materials to be preserved must be reflected in the grading plan. Because each species has different root patterns, and because local soil and water table conditions vary, an arborist must be consulted to recommend limits of grading for tree preservation. Snow fencing must be erected at the limits of grading to protect existing trees from damage and soil compaction by construction materials or equipment. Other measures such as root and crown pruning may be needed so that existing trees can adapt to the new site conditions.

**United States Courthouse
Springfield, Massachusetts**

Preservation of two historic trees—each predating the Revolutionary War—was key to the spiraling courthouse design.

2.7 Site Utilities

During site design, the location and coordination of utilities (water, sanitary sewer, electricity, gas, communications, etc.) must be coordinated with other site design features and finalized.

Coordination with Service Providers

The A/E is responsible for coordinating the utility design with local utility companies and/or other service providers. The A/E must be sure the utility systems have sufficient capacity and reliability to meet the building design requirements. GSA will negotiate rates and connection charges with the utility providers.

Utility Location

The A/E must ensure all that utility elements, such as electrical transformers, emergency generators, backflow preventers, and meters, are easily accessible by the utility companies. Integrate utility elements into the building and landscape design to minimize their visual impact.

Design site utility lines to avoid street trees, large trees, and signature planting areas. Locate utility lines so that future maintenance and repair will not damage trees and plantings. Storm drainage pipes should be located in unpaved areas wherever possible.

Water lines should be located in the unpaved area behind curb lines or under sidewalks. Minimize locating water lines under streets, drives, or other areas where access is severely limited. Do not place main waterlines under foundations or within the building footprint.

Locate sanitary sewer lines in unpaved areas where possible. Follow code requirements on separation of water and sanitary sewer lines.

Manholes must not be located in the main pedestrian walkways, plazas, or entry courts.

Site Mechanical and Electrical Distribution Systems

Chapter 5, Mechanical Engineering, describes the requirements for site mechanical distribution systems, and Chapter 6, Electrical Engineering, has the requirements for site electrical and communications distribution systems.

Water

Follow all regulations of the local water authority. The service connection between building and public water lines must be coordinated with the local water authority. The service connection must be placed in a secure enclosure to prevent unauthorized access and potential contamination. Requirements for water meters and backflow preventers are in the Plumbing Systems Section of Chapter 5.

The Building Automation System (BAS) must monitor all water meters and record water usage.

Consider loop-fed systems with multiple water connections on large buildings or campuses. Install-dual feed systems if required by code for the building occupancy.

The water supply system must be capable of supplying the required water flow for fire protection in accordance with NFPA 24. See Chapter 7, Fire Protection & Life Safety, for additional information.

Sanitary Sewer

Follow all regulations of the local sanitary sewer authority.

Separate storm drains from sanitary sewers within the property limits, even in cities where separate public systems are not yet available.

Provide cleanouts 5 feet from the building on all service lines. Service lines should enter the main at a manhole. Provide drop manholes if the service line does not enter at the invert.

In areas where no public sewers exist, use of septic tanks and leach fields is acceptable. Install the septic systems in accordance with local codes. Locate septic systems where they can be expanded to meet future needs of the discharge system; plan for a 50 percent larger system.

Storm Drainage

Design the storm water system for a 25-year storm, unless local criteria are more stringent. Use gravity flow for all storm drain systems.

Where possible, locate storm drainage pipes in unpaved areas; offset inlets from main trunk lines to prevent clogging.

Rainwater not collected for reuse from the building roof drainage system must be discharged into the storm drain. Small buildings in rural areas may use gutters, downspouts, and splash blocks.

Storm Water Runoff Requirements

The site design must manage storm water runoff. Storm water runoff after the site is developed must not exceed the predevelopment rate or volume.

The Energy Independence and Security Act of 2007 (Sec. 438) requires: “All development or redevelopment projects that exceed a 5,000 square feet footprint use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow.”

The A/E must conform to local and State requirements for storm water management. The A/E must obtain any required local approvals for the storm water management plan.

Do not use roof surfaces for storm water detention.

Sediment and Erosion Control Requirements

Site plans must meet local and State requirements for controlling sediment and erosion during construction. The A/E must obtain any required regulatory approvals of the sediment and erosion control plan.

If no local or State regulations govern sediment and erosion control, the A/E must design sediment and erosion control measures to be used during construction, that conform to the best management practices of EPA’s Storm Water Management for Construction Activities, *EPA Document No. EPA-832-R-92-005*, Chapter 3.

BEST PRACTICE

SUSTAINABLE DESIGN OPTIONS

Where appropriate, consider rainwater harvesting for irrigation or flushing toilets. Rainwater harvesting systems must comply with all local codes and standards.

Use permeable pavements and vegetative swales within surface parking lots and other large paved areas.

Consider the use of gray water for irrigation to enhance water conservation.

For low-impact development strategies for storm water management refer to **www.epa.gov/owow/nps/lid/lidlit.html**.

The International Stormwater Best Management Practices Database project website, **http://www.bmpdatabase.org**, also provides information on the use of a variety of biofiltration facilities such as designed vegetative, wet, or continuous inflow swales and flat filter strips.

2.8 Site Circulation Design

Site circulation includes roadways, emergency accesses, drives, building entries, parking, loading and service areas, sidewalks and pathways, and connections to transit services. Design site circulation to segregate pedestrian access, vehicular access (including parking), and service vehicle access. In addition, site circulation must provide the security requirements described in Section 2.5, Physical Security.

Urban Sites

Service Traffic

Service dock access may be from an alley, from a below-grade ramp, or from a site circulation drive. Provide sufficient space for large trucks to maneuver and service the facility, and screen the service drive as much as possible. Always separate the service drive from access to the parking garage. One-way design for service traffic is preferred to avoid the need for large turning areas. The service area of the facility must not interfere with public access roadways.

Loading Docks

Design the loading dock area to be nearly flat with a 1:50 slope for drainage. The minimum headroom in the loading berth and apron space is 4,600 mm (15 ft.). When a steeper slope is required in the apron area, the headroom must increase with a gradient allowance to permit trucks to traverse the grade change. If the approach to the loading dock is ramped, the design must permit easy snow removal.

Public Transportation

In keeping with Federal policy and directives to improve sustainability (e.g., Executive Order 13514), GSA encourages the use of public transportation by employees and visitors. Using public transportation reduces the impact of private auto use on the environment, promotes active lifestyles, and creates opportunity for interaction in the community. In cooperation with regional planners of the public transit system, designers must consider access to public transportation early in the design process to orient and design the site accordingly. Provide a covered, wind-sheltered seating area for each bus stop. Bus shelters must comply with ABAAS requirements for clear floor or ground space within the shelter and be connected by an accessible route to a boarding and alighting area complying with ABAAS (See ABAAS Figure 810.3).

Bus Shelters

Bus shelters should provide rain and wind protection and offer seating for awaiting passengers. They should be designed to be compatible with architectural and landscape design and must comply with ABAAS standards.

Pedestrian Circulation

The orientation of the building, site design, and landscape should encourage the use of public transit and control pedestrian traffic. Pedestrian walkways should concur with the desired line that a pedestrian would use when walking from a building entrance to transit stop or nearby amenity. ABAAS requires each pedestrian site arrival point to be connected by an accessible route to the accessible building entrance or entrances served. In addition, the accessible routes must serve all of the accessible entrances on the site.

Drop-Off

If feasible based on the building security analysis, provide a vehicular drop-off area located on the street nearest the main entrance. The area must comply with ABAAS requirements for passenger loading zones.

Child Care Centers

If the project includes a child care center, refer to the requirements for short-term parking and entrances given in Chapter 6 of the *GSA Child Care Center Design Guide* (PBS-P140).

Bicycle Racks

Bicycle racks promote alterative modes of transportation, healthy lifestyles, and interaction with the community. Locating bicycle racks and showers in a project will earn the project one LEED point toward U.S. Green Building Council (USGBC) certification, with one additional point possible for including these features as part of a comprehensive transportation management plan that reduces personal automobile use. Refer to Section 2.13 for more information about the location of bicycle racks near building entrances in visible and secure locations.

First Response and Emergency Access

Provide fire department vehicle access in accordance with the requirements of the IFC.

Fire Apparatus Access Roads

The A/E must design the emergency vehicle access in accordance with the specific requirements of the local fire department. At a minimum, the fire department must be consulted regarding the surface material of the access roadways, minimum width of fire lanes, minimum turning radius for the largest fire department apparatus, weight of the largest fire department apparatus, and minimum vertical clearance of the largest fire department apparatus.

Aerial Apparatus Access

For buildings or portions of buildings exceeding 9 meters (30 ft.) in height, from the lowest point of fire department vehicle access, provide access roads capable of accommodating fire department aerial apparatus. Overhead utility and power lines must not cross the access roadway.

Vehicular Drives, Parking Lots, and Service Areas

Entrance Drives

Follow local codes for entrance driveways within the right-of-way limits of the city, county, or State.

Surface Parking Lots

Parking stalls must be 2,700 mm (9 ft.) wide and 5,400 mm (18 ft., 6 in.) long, with two-way aisles of 7,300 mm (24 ft.). Where possible, use 90-degree parking. Provide accessible car and van parking spaces and associated access aisles in compliance with ABAAS. Maximum slopes for accessible parking spaces and access aisles must not exceed 1:48.

Design internal islands for landscape planting to occupy at least 10 percent of the total parking lot area. Provide curbs or vegetated swales around the parking lot perimeter and around landscape islands. Where appropriate, use landscaped or vegetated swales, instead of curbs, to allow snow-melt to percolate and to avoid damage to snow removal equipment.

The maximum combined gradient for parking lots should not exceed 5 percent.

2.9 Pavements and Curbs

BEST PRACTICE

SURFACE COLOR

In northern climates, consider the use of dark-colored walkways. Dark surfaces can significantly reduce or eliminate the need to use de-icing chemicals and provide safer surfaces for pedestrians and vehicles.

Design pavements and curbs using local design standards and materials. If no local standards are available, use the appropriate standards of the State highway or transportation department.

Materials must be suitable for the traffic volume and loads expected. They must be durable for the climate and the anticipated use conditions. In choosing materials, select those that will be easiest to maintain.

In northern climates, the design must encourage snowmelt, allow easy snow removal, and not damage snow removal equipment.

Do not use surface-applied precast concrete curbs or asphalt curbs.

Areas for truck maneuvering must be paved with concrete.

Pavement markings must comply with local standards.

Design walkways with durable materials suitable to the climate and conditions involved. Walkways must be stable, firm, and slip resistant and drain to avoid accumulations of water and ice. Walking surfaces for accessible routes must comply with ABAAS and have a running slope not steeper than 1:20. The cross-slope of these walking surfaces must not be steeper than 1:48.

Walkways in the public right-of-way must comply with the standards of the governing authority.

IRS Regional Offices
Kansas City, Missouri

The courtyard expands this facility's usable space to the outdoors, adding to the workplace amenities.

2.10 Sustainable Landscape Design

Landscape design must be part of the integrated design concept for the project. The design of the landscape must be coordinated with the architecture of the building, security and safety, energy conservation goals, circulation, wayfinding, and lighting.

Carefully consider how landscape design for the building affects the use and feel of adjacent public spaces, properties, and the overall aesthetic experience. Where appropriate, coordinate the design with local properties and authorities.

Landscape Maintenance and Building Operations

Site design influences the operations and maintenance of a facility. Low maintenance materials, noninvasive xeriscape, and carefully designed storm water systems can help reduce costs and effort.

Before initiating the site design, the A/E should discuss with the building manager methods used to maintain the landscaping, including paved and unpaved areas. If this information is not available, assume there are only limited maintenance capabilities.

The landscaping maintenance contract for a typical building has two work categories. Category I consists of labor-intensive maintenance of high-visibility areas with well-developed landscape designs. Category II is general maintenance for areas of simpler design such as parking lots, lawns, and outlying areas. Identify Category I and II maintenance areas on the site plan that accompanies the Final Concept Submittal. See Appendix A: Submission Requirements.

Conservation of existing site features and site vegetation can help minimize long-term maintenance requirements, if these materials are thriving and in good condition.

During site analysis and landscape design, identify and address existing conditions such as steep slopes, trees that drop fruit or nuts, and standing water that may require more labor-intensive maintenance.

Do not use turf on small islands in parking lots because it is too difficult to maintain. Trees, shrubs in low hedgerows, and low-maintenance ground covers are more suitable in these locations.

In locations with snowfall, design areas for piling snow removed from roads and parking areas. Design the snow storage areas to control the runoff and refreeze of melt water.

Plants must not obstruct access to fire service equipment such as sprinkler or standpipe fire department connections, fire pump test connections, and fire sprinkler post indicator valves.

Plants must not obstruct the field of vision for vehicles at critical intersections.

Plants must be set back from the building and located where they do not impede the maintenance of the building envelope. When planting adjacent to building openings, air intakes, entries, or operable windows, do not use allergy-causing plants or plants that require chemical treatment.

Landscape Elements

Outdoor Plazas and Courtyards

The A/E must consider human scale and comfort when designing outdoor public spaces. Design plazas and courtyards for employee and visitor use during both planned and passive activities. Both fixed and moveable seating may be appropriate to support these uses. Program requirements such as outdoor dining or meeting areas may be incorporated into these spaces, but landscape, lighting, and security features must always be an integral component of the design.

Fountains, Reflecting Pools, and Ponds

Water features can be a visual and an acoustic element; however, water features must not become a maintenance burden. Elements that have the potential to produce aerosolized drift into pedestrian areas must be designed with a disinfection system to prevent the growth of disease-causing microorganisms. Keep water consumption low, especially in dry climates with high evaporation rates. Consider the use of nonpotable water sources and the opportunity to recycle water through a fountain, pool, or pond. In colder climates provide for easy shut-off and drainage during the winter season. Fountains and reflecting pools with pumping systems are restricted to Category I areas of the site. Water features must not be placed over occupied spaces.

Art

The A/E must coordinate the site design with any existing exterior work of art or new work commissioned by GSA's Art in Architecture program. Such works of art may include sculpture, fountains, earthworks or other landscape work, real or implied furniture, and so on. The site design must permit routine maintenance of the artwork and not create safety hazards.

Rocks and Boulders

Lightweight and synthetic rocks or boulders must not be used as landscape elements.

United States Courthouse Fresno, California

Artist and landscape architect worked collaboratively to create a setting of rocks, trees, and other natural elements that celebrate the San Joaquin Valley.

2.11 Planting Practices

Use sustainable landscape design principles; select regional plant materials, minimize the need for chemical supplements, reduce or eliminate the use of potable water for irrigation, and use biobased landscaping materials including compost and mulch.

Sustainable landscape design considers the characteristics of the site, its soil, the selection of plants, and the intended effect and use of the developed area.

Use approved standards, prepared by the American Nursery and Landscape Association (ANSI Z60.1), for the selection of plant materials.

Use regional or native plants where appropriate. Plants must be hardy for the regional climate of the site. Avoid plants that require meticulous soil preparation, fertilization, and spraying. Do not use exotic or invasive species.

Plant selection must be made with their mature size and growth habit in mind to avoid overplanting that may potentially conflict with other plants, structures, or underground utility lines. Species whose root systems can damage water and sewer lines must not be planted near these utility lines.

Design a planting plan around existing trees and shrubs. Plants must be set back from the building and not be located where they may impede the maintenance of the building envelope. Plants must be set back from the building and placed to deter rodent harborage. Future growth must be considered.

Create zones or group plant materials if an irrigation system is used. Plant selection is a critical element in water conservation. Maximum water conservation depends on selecting appropriate plants that naturally grow together, are self-sustaining, and require minimal amounts of supplemental water.

For larger transplanted trees, the consulting arborist from the design team must provide instructions and guidance on the installation and management of the tree to ensure its survival and future growth. The arborist must also provide a specific maintenance plan for watering, mulching, fertilizing, pruning, and mechanical support of transplanted trees.

Where hydroseeding is proposed, specify hydraulic mulch with recycled paper binders.

Soils

Soils vary significantly from site to site and even within sites. Conduct a soil test, based on random samplings, to obtain the information needed for proper selection of plant materials and soil amendments. The design must include appropriate soil amendments to enhance the health and growing potential of the selected plant materials.

Irrigation for Landscaping

Reduce outdoor potable water consumption by a minimum of 50 percent over that consumed by conventional means.

Any irrigation system must use nonpotable water wherever feasible.

A properly designed irrigation system (if required) conserves water. Design the irrigation system to provide water to plants only when needed. Use rain sensors or soil moisture sensors to prevent unnecessary watering. Avoid overspray onto paved surfaces. Drip irrigation systems can be used. Use nonpotable water for the irrigation system when it is available.

Reliable performance must be a prime goal in the design of irrigation systems. Materials must be durable and relatively maintenance-free. Irrigation systems are most successful in the long run if local design practices are followed and local materials are used.

Install all major components in protected, accessible locations. Provide freeze sensors for systems in cold climates. Irrigation controllers and remote sensing stations must be placed in vandal-proof enclosures. Aboveground components, such as backflow preventers, must be placed in unobtrusive locations and protected from freezing.

Install quick coupling valves (two-piece body design) throughout the system so that hoses can be connected to the system. Locate drain valves to permit periodic draining of the system. Avoid mixing different head or nozzle types (such as a spray head and a bubbler) on the same station.

To properly calculate sewage fees, meter irrigation water separately from domestic water.

Provide automatic controls so watering can be scheduled at night or in the early morning to reduce water losses from evaporation. Use zone irrigation systems so that different areas can be watered at different times.

Any irrigation system must be controlled by a smart controller that uses evapotranspiration and weather data to adjust irrigation schedules and that complies with the minimum requirements of the Irrigation Association's Smart Water Application Technology Climatological Based Controllers. All such control systems must also incorporate an on-site rain or moisture sensor that automatically shuts the system off after a predetermined amount of rainfall or sensed moisture in the soil.

The irrigation system must be part of the commissioning plan and training must be specified for operations and maintenance personnel.

Allow for expansion of the irrigation system, both in area and in flow rate, so the system can be adjusted as plants mature.

Warranties/Guarantees

The A/E must specify a 1-year contractor maintenance period. Also specify a 1-year guarantee that trees and shrubs will be alive, free of defects and disease, and growing satisfactorily.

Specify that all plantings on green roofs be guaranteed to be alive, free of defects and disease, and growing satisfactorily for 1 year. The 1-year performance period must start from the date of building acceptance by GSA, or 1 year after installation of the landscaping, whichever is later.

2.12 Site Lighting

The technical requirements for site lighting are described in Chapter 6, Electrical Engineering.

Generally, unobtrusive lighting designs and luminaires placement are preferred. Where the primary intent of the lighting is aesthetic, consider using low-voltage systems.

Site luminaires should complement and be integrated with other site elements. Place luminaires to reduce direct glare and light pollution.

To avoid damaging plants and creating a fire hazard, high-intensity or heat-generating luminaires must not be located immediately adjacent to plant material.

Luminaires must be resistant to vandalism and easily replaceable from local sources.

United States Courthouse
Orlando, Florida

A raised, landscaped terrace in front of the facade provides both a secure perimeter and a shady canopy between the sidewalk and the building.

2.13 Site Furniture

Site furniture is included as part of the site design. The selection of site furniture must be compatible in size and color with the surrounding architecture and landscape design. Selected site furniture is submitted as part of the design development package.

Seating

Provide outdoor seating in appropriate locations such as bus stops and plazas. Use fixed seating in public areas. Movable seating may be used in interior courtyards where theft is not a concern.

Where appropriate, design perimeter walls and stair elements to be a comfortable height and depth for seating. Provide seating in both sunny and shaded areas.

Trash and Recycling Containers and Newspaper Stands

Locate trash containers at the building entrance, seating areas, and parking areas as a minimum. Provide recycling containers in addition to trash containers. Selection of trash containers and newspaper stands must be compatible with architecture and landscape design and should be located in compliance with ABAAS.

Bicycle Racks

Place bicycle racks in visible and secure locations that are convenient to the building entrance. The bicycle rack must allow bicycles to be securely locked to the rack. Bicycle racks must be compatible with the architecture and landscape design.

Materials

Materials for outdoor furniture must be durable and resistant to vandalism. Install devices that discourage skateboarders from using site furniture and design elements inappropriately. Consider the use of recycled-content materials, when appropriate.

Jacob K. Javits Federal Building
New York, New York

Rendering shows plaza design.

2.14 Site Signage

A well-designed site uses as few signs as possible. Signs should make the site wayfinding clear to the first-time user by identifying multiple site entrances, parking, and the main building entrance.

Generally, graphics and style of site signage should be consistent with signage used inside the building. Signs integrated with architectural elements can also be very effective. Signage must be consistent in font, style, and color as well as with any directional symbology used in site and building signage. Signage placement can be an important detail element of the building design whether prominently displayed and tooled into the exterior building wall materials or as a freestanding component near the entrance to the facility. Exterior signs identifying permanent rooms and spaces must comply with ABAAS (see ABAAS Section F216). See also Chapter 3, Architectural and Interior Design, Guidelines for Building Elements, Artwork and Graphics, and Exterior Closure, Cornerstone and Commemorative Plaques for applicable standards. Additional information about GSA graphic standards can be found at **www.gsa.gov/logo**.

Construction Signs

Construction signs are to be 3,600 mm by 1,800 mm (12 ft. by 6 ft.) and constructed of a durable, weather-resistant material, properly and securely framed and mounted. The sign will be blue with white lettering and mounted at least 1,200 mm (4 ft.) above the ground. The sign must include the official GSA logo no less than 400 mm (16 in.) square. The lettering, graphic style, and format should be compatible with the architectural character of the building.

New Construction Signs

Signs at new construction sites must include the name of the architect and general contractor and may contain an artist's rendering or photograph of the model of the building under construction. See Figure 2-1.

Repair and Alteration Projects

Signs at prospectus level repair and alteration project sites must include the name of the architect and/or engineers for the major systems work (e.g., structural, mechanical, electrical), in addition to the name of the general contractor.

Site Wayfinding

Minimize the number of wayfinding signs on the site. For complex sites with multiple buildings or other destinations, consider developing a wayfinding plan for review by the project manager and users.

Obtain approval of local authorities for entrance signs in the public rights-of-way.

Use variable message signs for high-volume areas where entrance patterns need to be altered.

Construction signs must provide the following information:

- Building for the People of the United States of America
- (Name of) Federal Building
- Constructed by (building contractor)
- U.S. General Services Administration–Public Buildings Service
- (President's name), President of the United States
- (Administrator's name), Administrator, GSA
- (Name), Commissioner, PBS
- (Regional Administrator's name), Region X Administrator

Figure 2-1 Construction Sign

2.15 Flagpoles

A ground-mounted flagpole, located preferably at the left of the entrance (facing the building), must be provided for new Federal buildings. If ground-mounted poles are not feasible, a roof-mounted pole is permissible; or, if roof mounting is not suitable, an outrigger pole may be used. Only one flagpole is needed for a complex of buildings on a common site. The flag must be illuminated.

The following are approved flagpole heights and the corresponding flag sizes.

Flagpole Height	Flag Dimensions
20 ft.	$3\frac{1}{2}$ by $6\frac{2}{3}$ ft.
30 ft.	5 by $9\frac{1}{2}$ ft.
40 ft.	5 by $9\frac{1}{2}$ ft.
50 ft.	$8\frac{2}{3}$ by 17 ft.
60 ft.	$8\frac{2}{3}$ by 17 ft.

Carl T. Curtis Midwest Regional Headquarters of the National Park Service Omaha, Nebraska

An exemplar in the use of sustainable materials, this lease construction building earned a LEED Gold rating on completion.

3

UNITED STATES COURTHOUSE
FRESNO, CALIFORNIA

ARCHITECTS: MOORE RUBLE YUDELL / GRUEN ASSOCIATES
PROJECT MANAGER: MARIA T. CIPRAZO

Architecture and Interior Design

Chapter 3 Architecture and Interior Design

3.1 Goals and Objectives

This chapter includes architectural planning and design objectives for creating a lasting architectural legacy that will serve the American people for many decades. The A/E must be committed to excellence in architectural design and project development. This includes an integrated approach that achieves the highest quality of aesthetics in meeting GSA requirements, and cost effective operation and maintenance throughout a building's useful life.

Integrated Design

To achieve the Guiding Principles of Federal Architecture and to create High Performance Sustainable Buildings, use a collaborative, integrated design process that:

- Sets specific goals for building orientation, energy, water, materials, and indoor environmental performance
- Involves all relevant parties working together from the beginning of a project
- Establishes and documents comprehensive design and performance goals at the beginning of a project and incorporates them throughout the building process, including program documents, construction documents, and material provided to the building owner and operator
- Considers all stages of the building's life cycle, including operations, maintenance and deconstruction

Performance Measures and Functional Objectives

The A/E must ensure the design supports quality based performance measures for customer satisfaction, energy consumption, and reduced operations and maintenance. The A/E must also identify all functional expectations and establish alternative features that support attainment of these expectations. To the maximum extent possible, the A/E must apply those architectural elements that optimize building performance and functional capabilities. Performance and functional issues raised during the project's design program and/or as addressed in Appendix Section A.2 must be specifically addressed in concept presentations.

Environmental Sensitivity

The natural setting of the site, its contours and vegetation, must be viewed as assets to be preserved and woven into the design as much as possible. In settings that include historic buildings, adjoin historic properties, or are located near historic properties that will be affected by GSA construction, external design review, including public participation, is required under the Section 106 of the National Historic Preservation Act and may also be required under the National Environmental Policy Act. Compliance reviews should be coordinated through the Regional Historic Preservation Officer early, so that comments can be effectively addressed during the course of design.

Urban Context

Facility design and orientation should be consistent with existing and planned development patterns and nearby uses. The building's exterior should be consistent with existing local design guidelines. Where appropriate, the project team should help to develop design guidelines for the project and neighboring undeveloped sites.

3.2 Codes, Standards, and Guidelines

References

A current list of references used in this chapter and all other chapters is provided in Appendix B. References cited for the Introduction and Chapter 1 apply also to this chapter.

GSA Programs

A complete list of GSA programs and their descriptions is provided in the Introduction. The A/E must integrate appropriate GSA programs, policies, and guidelines to ensure proper project development.

Codes and Standards

The codes and standards that apply to GSA projects are provided in Chapter 1, General Requirements. Energy performance and LEED requirements are also found in Chapter 1.

Zoning Regulations

The policy for compliance with local zoning regulations is stated in Chapter 1, however, the number of parking spaces to be provided is described in the prospectus and program requirements documents of the project. This number may be different from what is required by local zoning regulation. If there is a difference, the program parking requirements govern.

United States Courthouse
Seattle, Washington

A one-acre landscaped plaza marks the main entrance and provides an inviting transition between the urban environment and the judicial realm.

3.3 Site Design

The building security design must be integrated with site security. The *GSA Site Security Design Guide* should be used as a reference.

Building Entrances

GSA buildings should have one main entrance for staff, visitors, and the public. In large buildings a second entrance may be designated for employees only. Buildings may have additional doors used for egress or access to service areas. These doors should not be used as entrances. Original primary entrances at historic buildings should be retained as such. Closure of ceremonial entrances and redirecting public access to below grade and other secondary entrances for security or accessibility purposes is discouraged. Wherever possible, access for the disabled to historic buildings should be provided at, or nearby, original ceremonial entrances. For building entrances and unsecured areas of building lobbies, raised floor systems must not be used. See the Interagency Security Committee (ISC) design criteria for access controls and intrusion detection systems.

Courtyards and Plazas

The most important consideration in designing exterior plazas and public spaces is the future potential use of those spaces. Potential uses should include shared and alternate uses. The team should discuss with potential users how they would like to use the space in order to incorporate appropriate amenities, relate outdoor areas to inside uses (e.g., dining facilities), accommodate traffic to and from the building, and provide for regular programmed use of the spaces and special events, as appropriate.

Consideration should be given to designing different areas in public plazas and courtyards to allow for varying uses and intensities of public activity. Potential users of the space in addition to building tenants could include nearby properties and organizations, such as performing arts or vendors, artists, schools, and the greater community, which could all bring activity to the public space. The treatment of elements such as seating, shade, water, art, security features, landscape, circulation, and flexibility of the space are important to supporting a variety of uses. Plazas should be designed with sufficient infrastructure (electrical outlets, water, etc.) to support future flexibility and a wide range of uses. Egress should be designed to meet NFPA 101 for the maximum expected occupant load.

Retail Shops

Generally, retail shops should be located on the non-secure side of the lobby. Exceptions could exist where commercial establishments serve the building population only. Some buildings may have multiple levels of retail around an atrium. In that case, the security checkpoint should be located at the elevator lobby. Designers should coordinate opportunities for retail with the Retail Tenant Services Center of Expertise as well as the Center for Urban Development.

3.4 Facility Planning

Security Design

Criteria for site and building security are also described in detail in Chapter 2. Some of the planning concepts are stated here because of their importance to building planning, but architects should familiarize themselves with the ISC Physical Security Criteria for Federal Facilities before developing schematic design concepts. The ISC criteria can be obtained from the project manager.

General Layout

Future security problems can be prevented by planning a clear, simple circulation system that is easy for staff and visitors to understand. Avoid mazes of hallways and hidden corners. Exterior doors should be readily visible.

Planning for Future Security Provisions

All Federal buildings must be planned to allow for future controlled access, both to the entire building and to individual floors.

Elevators

See Building Planning, Conveying Systems section of this chapter. Elevator control panels must have lockout provisions for all floors (passenger and freight).

Mechanical and Electrical Spaces

Provide access to mechanical and electrical spaces from secure areas inside of the building.

Space Efficiencies

Space efficiency is defined as the minimum necessary space for the desired functions to be properly accommodated, with minimum 'waste' between usable area and gross area. The target for the usable to gross ratio in new building construction is 75 percent. (See the National Business Space Assignment Policy for the definition of usable and gross area.) In all building types, space efficiency must be balanced against effectively achieving space requirements and desired aesthetics.

The plan configuration, floorplate depth, planning module, and circulation patterns together determine the space efficiencies of a building. The historic character of a building can create major inefficiencies where the primary circulation is typically wider and thereby affects the amount of usable space available. However, a building's historic value or design aesthetics should not be compromised to achieve greater space efficiencies.

Plan Configuration describes the geometry of a typical floor within a building. A square or rectangular plan, with a single central core, will be inherently more efficient than a plan that is highly irregular, with distributed service cores. Building types other than office buildings, like courthouses and land ports of entry (LPOEs), will likely have lower usable to gross ratios based on numerous special requirements that are addressed in their design guides. When efficiency ratios fall, the floor plan is likely to have more irregularities which, in turn, will increase space utilizations per full-time equivalent (FTE) and restrict furniture and tenant space planning. Configuration of space is an important consideration when selecting a new building design or comparing one with another.

Primary circulation is the areas on a floor necessary for access to egress stairs, elevator lobbies, public toilets, refuse area, building lobbies, and entrances. (See the National Business Space Assignment Policy for the definition of circulation.) Secondary circulation refers to circulation inside the tenant's space and is not included in primary circulation. The efficiency of both primary and secondary circulation will be determined by core placement, depth, planning modules, and plan configuration. New office buildings must have clearly defined circulation patterns that achieve a maximum primary circulation factor of 1.3 percent. This factor may be slightly higher in renovated buildings but should remain the goal of the design team.

Planning Module

The planning module describes the internal dimensions for the placement of structural columns and window mullions. The planning module often determines the ease with which internal space is planned. The most common planning grid is based on a 5-foot module, which allows for highly efficient and flexible partitioning. When selecting new space, consider the planning module and bay size if there is a high demand for enclosed space. The minimum recommended bay size is 9,100 mm by 9,100 mm (30 ft. by 30 ft.). Workstations should be designed to align with the planning module and bay size dimensions. An open plan using flexible furniture typically results in higher efficiencies than increased use of floor to ceiling partitioning. Furniture workstations should be planned early in the design to align with the planning module and bay size dimensions.

Core and Shell

The building core and shell comprise the complete enveloping structure, the base building systems, and finished common areas. Where the building core and shell end is the beginning point for tenant improvements. GSA, much like commercial real estate, distinguishes between building core and shell, and tenant improvement areas.

Tenant Improvement

To ensure that tenant improvement allowances are applied consistently in all regions, PBS defines standard tenant improvements for owned space (see PBS Pricing Desk Guide for additional information). The existence of standard finishes does not mean that PBS covers these as part of building core and shell; they are still tenant improvements. A standard simply represents restrictions on what the tenant can elect to do within the tenant space.

Circulation

The primary circulation connects the building's exits and all public spaces. Secondary circulation refers to other circulation leading off of primary circulation, usually inside the tenant's space. The efficiency factor of both primary and secondary circulation types will be determined by core placement, depth, planning modules, and plan configuration. Federal buildings must have clear circulation systems. Utility system backbone pathways should be routed in circulation spines, providing service access to utilities without disrupting the building's tenants.

Access to the building exits must be maintained from public areas (e.g., elevator lobbies, corridors) without having to pass through locked tenant spaces.

Wayfinding

Wayfinding must connect programmatic elements and clearly organize the building both horizontally and vertically. Circulation patterns must be efficient and minimize travel distances. Wayfinding should be intuitive and not solely dependent upon signage. Avoid mazes of hallways and hidden corners.

Core Placement and Configuration

Core placement must address the depth of the occupiable space between the core and perimeter walls. The optimum depth of this space between core and window wall in an office building is approximately 30 feet or less for providing access to daylight. Choosing the most efficient depth is usually a compromise. More depth will reduce the level of natural light while it increases flexibility for the planning of large teams and is good for visual communications. The most efficient design approach is to vertically stack or align building core functions such as elevators, staircases, mechanical and electrical closets, restrooms, and any other similar function that serve all or part of the entire facility. Planning for cores must provide for 40-foot nominal distances to the exterior and between core elements for occupiable space both for systems functionality and code requirements. Not all service functions need to be placed at each core location. Occupant needs and the following maximum distances must govern how often each element is repeated. Locate building cores within the floor plate to maximize access to daylight and views by all occupants. Configuration describes the geometry of a typical floor within a building. Thus, a square or oblong plan, with a single central core will be inherently more efficient than a plan form that is highly irregular, with distributed service cores. Efficient floor plates typically have an 80-85 percent ratio of net to gross. Where the efficiency falls below these levels, the floor plan is likely to have more irregularities which, in turn, will impede space utilizations. Configuration of space is an important consideration when selecting a new building design or comparing one with another.

Vertical Transportation

All new and altered elevators and escalators must comply with ASME A17.1. All new and altered lifts must comply with ASME A18.1, Safety Standard for Platform Lifts and Stairway Chair Lifts. See Chapter 7, Fire Protection and Life Safety, for additional information regarding requirements for elevators, fire service access elevators, and occupant evacuation elevators.

The selection of type and quantity of conveying systems, such as elevators, escalators, and wheelchair lifts, must be made in conjunction with a thorough vertical transportation traffic analysis of the facility.

Vertical Transportation/Elevator Traffic Analysis

The elevator traffic analysis must be performed by an independent consultant to determine the type, quantity, capacity, and speed requirements of elevators. Separate calculations must be performed for each elevator classification.

The criteria by which the traffic analysis calculations should be judged are “average interval” and “handling capacity.”

Average interval is defined as the calculated time between departures of elevators from the main lobby during the morning up-peak period. Calculated intervals during the up-peak period should not exceed 30 seconds for a typical elevator bank.

Handling capacity is defined as the number of persons the elevator system must move in any given 5-minute

Richard Bolling Federal Building
Kansas City, Missouri

A modernization of this landmark building included redesigned elevator lobbies which improved visitor wayfinding.

period of up-peak traffic used to measure average interval. GSA buildings must always be designed for a 12 percent handling capacity, even if the building is designed as a multitenant facility.

Elevator cab sizes must be in accordance with the standards established by the National Elevator Industries, Inc. (NEII), which are available at **http://www.neii.org/neii-1/neii-1.cfm**. Elevator cabs must be designed to reflect the architectural character of the building design.

Elevators

If no separate freight or service elevator is provided, one passenger elevator must be designated as a service elevator with pads to protect the interior wall surfaces of the cab. The passenger elevator designated as a service elevator must not be considered as one of the elevators required by the traffic analysis.

A minimum ceiling height of 2,700 mm (9 ft.) is required in service elevator cabs. Freight elevators must have a ceiling height of not less than 3,700 mm (12 ft.).

In large or high-rise GSA buildings, the number of freight elevators provided should be determined by the elevator traffic analysis. The use of more than one freight elevator will provide better freight service for the tenants as well as provide redundancy for normal maintenance and during times when repair work is conducted.

Where equipment penthouses are provided, service elevators or freight elevators must provide access to that level. An elevator must service all maintenance floors.

Trap doors and hoist beams must be provided at the elevator machine rooms for traction elevators where the machine room is not served by a freight or service elevator for removal of equipment for service and repair.

Elevator Classifications

Passenger

Passenger elevators must be sized to qualify for the disabled. Capacities of 1,590 kg to 1,810 kg (3,500 to 4,000 pounds) must be used for passenger elevators.

Service

A passenger elevator designed to meet the ASME A17.1 Code requirements for “Carrying Freight on Passenger Elevators” is required. The minimum rated load must be based on the inside net platform area for passenger elevators. See Figure 8.2.1.2 ASME A17.1 – 2007. The car doors must be horizontal sliding type. The car platform must be designed to the applicable freight class loading.

Freight/Service

A passenger elevator designed to meet the ASME A17.1 Code requirements for “Carrying Freight on Passenger Elevators” qualifies for freight purposes.

Security

Security or specific purpose elevators are designed to transport designated groups of people such as judges, cabinet members, or prisoners. These will be custom designed to meet specific program requirements.

Shuttle

Typically a passenger elevator that services a limited number of landings, e.g., parking garage to main lobby.

Machine Roomless (MRL)

A machine-room-less elevator is an elevator with the drive machine, governor, and other related components located in the elevator hoistway. These elevators require specific Government approval. The elevator must have a metal belt and the control system must be located outside of public areas to facilitate safe maintenance procedures. The MRL must meet the following minimum requirements:

- Controls must be installed in a fire rated control room

- The remote control room must be no more than 10 feet from the hoistway
- No other equipment is allowed in control room (only equipment directly related to the elevator)
- Main line disconnect switches must be installed within 18 inches of the strike jamb of control room door
- The car position, movement, and direction must be able to be determined from the control room
- Provide HVAC in the control room so that the temperature does not go below 50 degrees or above 90 degrees
- Access to the governor must be provided from outside the hoistway
- The suspension means must be manufactured for elevator use only and be constructed from steel only

Escalators

Due to their high operation and maintenance costs, use escalators only where necessary. Their use must be justified by the vertical transportation analysis. Escalators may be installed as supplements to elevators when vertical transportation is required for a large unpredictable volume of public traffic. They should be used where the first floor is not large enough to contain the high public traffic so that the interval for elevators can be calculated with accuracy. Escalators should be located to be visible from the building entry and convenient to the areas they serve.

Wheelchair Lifts

Wheelchair lifts must comply with the current edition of ASME 18.1 Safety Standard for Platform Lifts and Stairway Chairlifts. Proper design of accessible routes in new construction should not require the use of wheelchair lifts. In repair and alteration projects, ramps are preferred to wheelchair lifts.

Toilets

The distance from workstations to toilets must not exceed 61m (200 ft.). To the greatest extent possible, toilet rooms should stack vertically and share common chase partitions to maximize plumbing, maintenance, and operations. Locate toilet rooms adjacent to lobbies, elevator cores, cafeterias, conference/training facilities, auditoriums, and other large assembly areas.

Electrical Closets

Electrical closets must be stacked vertically and located so that they are no more than 45 m (150 ft.) from any occupied space. Secondary closets off permanent corridors may be used for receptacle panelboards where the distance between the riser and the farthest workstation exceeds 45 m (150 ft.) and a separate riser is not warranted.

Telecommunication Closets

Communications rooms must be stacked vertically within the building. Rooms must be sized to contain adequate floor space for frames, racks, and working clearances for current need and future expansion. Agency requirements for separate, dedicated communication closets must be verified.

Provide a telecommunication closet for each 930 m^2 (10,000 sq. ft.) of office space or a minimum of one closet per floor. Closets must be located so that wiring runs do not exceed 90 m (300 ft.). Closets must tie into vertical telecommunication backbones. Telecommunication closets must meet the requirements of EIA/TIA Standard 569: Commercial Building Standard for Telecommunications Pathways and Spaces (and related bulletins).

3.5 Interior Design and Planning

High-quality, high-performance buildings for Federal agencies are the goal of GSA's design and construction process. Interior design plays a key role, and effective collaboration with the building architects, engineers, landscape architects, and the tenant agencies is essential to providing a high-quality workplace over the life of the facility. GSA supports an interior design program that creates superior workplace environments that meet the business goals of their tenant agencies and enhances employee health, satisfaction, and performance. The design should provide an effective workplace for Federal employees reflecting their culture, business strategy, and the nature of their work.

Public Spaces

These are areas accessible to the general public, such as entrances, lobbies, atria and monumental spaces, stairways, elevators and their lobbies, escalators and their lobbies, and the permanent corridors at each level. Public functions such as child care, conference facilities, training rooms, auditoria, exhibition halls, and dining areas should be located near the main lobby. Spaces accessible to the general public include entrances, lobbies, stairways, public elevator lobbies, and primary circulation corridors. For security reasons, public use spaces must be separated from access to other areas of the building during public events. Security design must allow access to spaces programmed for public use without compromising the secure access to the remainder of the building.

Entrance lobbies and atria are the focal point of the Federal building. They are the landmark to which all other spaces in the facility relate. They should be an extension of the exterior of the building and the point of transition to interior spaces. These spaces have high levels of visibility and public use and warrant the highest degree of visual detail and finish. Integrate the exterior and interior building design in these areas. Materials must relate and be of high quality. Choose durable, moisture-resistant materials since these areas are typically exposed to weather. The depth of vestibules should be no less than 7 feet to minimize air infiltration. The main entrance must be conveniently located for vehicular and pedestrian traffic and accessible to physically challenged individuals. Vestibules must be provided with an air lock for swing doors, but revolving doors do not need an air lock. The distance between inside and outside doors must comply with the Architectural Barriers Act Accessibility Standard (ABAAS).

Elevator and escalator lobbies should have adequate space to accommodate the movement of pedestrian traffic to other parts of the building. Public corridors should introduce as much natural light as possible through windows, transoms, or borrowed light. The distance between inside and outside doors must comply with ABAAS. Elevator and escalator lobbies should have adequate space to accommodate the movement of pedestrian traffic to other parts of the building.

In historic buildings, new materials in public spaces should be commensurate in quality with original finishes and compatible in form, detail, and scale with original design. Refer to *The Design Notebook for Federal Building Lobby Security* for illustrations of effective integration of security into new and existing Federal lobbies.

Al Held, Artist

**United States Courthouse
Orlando, Florida**

A dramatic 92-foot-high atrium conveys a sense of civic purpose. Six colorful, abstract art glass windows designed by Al Held are installed in this space.

Entrances and Vestibules

The main entrance must be conveniently located for vehicular and pedestrian traffic. The entrance should be clearly identifiable. Approaches that provide universal access are preferred over elevated approaches that require steps. Entrance designs must be coordinated with site and security requirements. These spaces have high levels of visibility and public use and warrant the highest degree of visual detail and finish. Building approaches must direct visitors to each entrance in both daytime and nighttime conditions. Clear and attractive graphics must be provided to assist visitors with directions. Landscape features must complement and enhance the building approaches and entrance.

Provide a vestibule at each building entrance that includes an air lock to conserve energy and complies with ABAAS. Integrate the exterior and interior building design in these areas with related moisture-resistant, high-quality, durable materials. The depth of vestibules should be designed to capitalize on minimized air infiltration, no less than 2,100 mm (7 ft.).

Accessible entrances to historic buildings should be provided at, or nearby, the original ceremonial entrances.

Lisa Scheer, Artist
Beacon

United States Courthouse
Brooklyn, New York

Twin cast-iron sculptures frame the entrance, clearly marking the front door and directing visitors to the courthouse.

Doors

Use glazed doors at building entrances and vestibules to facilitate orientation and safe movement. Coordinate the public entrance design with site and security requirements. Doors must be ABAAS compliant. Locking, where provided, must comply with NFPA 101.

Revolving doors are the most energy conserving types, and automatic sliding doors are preferred over automatic swinging doors. Swinging automatic doors should swing in the direction of traffic and offset to mitigate drafts. Use safety devices to prevent a person from being struck by a swinging door. Power-assisted doors may be used instead of automatic doors. Slope floor drainage toward the exterior of the doors.

Floors

All entrance areas require a means to prevent dirt and moisture from accumulating on the entrance lobby floor. Buildings must have permanent entry way systems (grilles, grates, etc.) to catch dirt and particulates from entering the building at high-volume entryways. Buildings located in areas with severe weather conditions will require more elaborate entry mat and drainage systems to prevent the tracking of melting snow and rain. Buildings located in more moderate climates require a natural or synthetic fiber floor mat. Noncarpeted floors must meet the slip-resistance guidelines delineated in ANSI/ASSE A1264.2-2006 Provision of Slip Resistance for Walking/Working Surfaces. Door thresholds must be ABAAS compliant.

Main Lobby and Atria

The main lobby and atria of a Federal building must project an image of dignity and prominence. The lobby should be clearly visible from the outside, both day and night, and present a welcoming image to the public.

Planning and Design

Decisions for security systems in Federal building lobbies must be made by either the Court Security Committee, or for multi-tenant buildings, the Facility Security Committee, (refer to *The Design Notebook for Federal Building Lobby Security)*. Federal lobbies serve as the collection point for all entering the building by accommodating high volumes of employee and visitor traffic. Areas such as auditoria, exhibition halls, and cafeterias should be located near the lobby.

The main lobby should accommodate visitors by providing information facilities, waiting areas, and access to vertical transportation.

Lobby Security

The building lobby must always be designed to permit subdivision into a secure and a nonsecure area. The two areas could potentially be divided by turnstiles, metal detectors, or other devices used to control access to secure areas. There must be space on the secure side for a control desk and an area where bags can be checked. Mechanical ductwork, piping, and main electrical conduit runs should not extend from one area to the other. In building entrance lobbies, vending machines, automatic tellers, bulletin boards, and other tenant support services should be located in ancillary space outside of entrance lobbies or consolidated in a retail tenant service core. Equipment that must be installed in lobbies should be of a low profile variety and consolidated with other equipment to minimize bulk. For building entrances and unsecured areas of building lobbies, raised floor systems must not be used.

Lobby Security Equipment

The A/E must incorporate nonprescription screening devices into the lobby entrance design. In historic building entrance lobbies, where feasible, security processing equipment should be located in an ancillary space. Equipment that must be installed in historic lobbies should be of a low profile variety, consolidated with other equipment to minimize bulk, and placed carefully to avoid altering the original spatial configuration of the lobby.

There must be space on the secure side for a control desk, bag check area, metal detector and turnstiles. Adequate queuing space must be included for the future non-secure side of the lobby. Raised floors must not be used in building lobbies. For further information refer to *The Design Notebook for Federal Building Lobby Security*.

Do not install vending machines, automatic tellers, or bulletin boards in building entrance lobbies.

In historic building entrance lobbies locate security processing equipment in an ancillary space if possible. Refer to the GSA design guide *Lobby Security in Historic Buildings* for detailed guidance and prototype designs for integrating security equipment, guard stations, and circulation control for secure and nonsecure areas into a variety of historic lobby configurations.

Multi-Level Lobby

When a multilevel lobby or atrium is used, monumental stairs, escalators, or both may also be used if justified by the amount of pedestrian traffic between the two entrance levels. Mechanical, electrical, and communication systems must be integrated into the lobby design. Fixture and outlet locations, and forms, sizes, finishes, colors, and textures of exposed mechanical and electrical elements must be coordinated with all other interior elements. It is desirable to conceal HVAC supplies and returns. Lighting should be part of the lobby architecture. Indirect and spot lighting should be considered. Incandescent fixtures must be limited to accent lighting.

Access Maintenance and Cleaning Access

Access for maintenance and cleaning of the interior and exterior wall and ceiling surfaces (glazing and cladding) of multilevel lobbies or atria must be addressed during design, as well as maintenance and cleaning of light fixtures and servicing smoke detectors (if provided). Portable lifts or other appropriate equipment can be used to access these elements where approved by the facility manager; scaffolding should be avoided. The flooring materials within this space must be able to accommodate the loads and use of this equipment. Maintenance professionals should be included in schematic and design development reviews to address these issues.

Mechanical, Electrical, and Communication Systems

Mechanical, electrical, and communication systems must be integrated into the lobby design. Fixture and outlet locations, and forms, sizes, finishes, colors, and textures of exposed mechanical and electrical elements must be coordinated with all other interior elements. Conceal HVAC supplies and returns.

See *GSA Technical Preservation Guidelines* for design solutions to preservation challenges involving fire safety, signage, lighting, HVAC, and other upgrades affecting historic interiors.

Elevator and Escalator Lobbies

Like entrance lobbies, elevator and escalator lobbies must be designed to efficiently accommodate the movement of pedestrian traffic to other parts of the building. Provide adequate space for this movement. The elevator and escalator lobbies should be close to the main lobby and be visible from the main entrance. Visual supervision and physical control of the lobbies for elevators and escalators must be a prime consideration for building security. If unusually large pieces of equipment or furniture such as mechanical equipment or conference tables must be transported to a specific floor via an elevator, verify that the item can be moved into and through the lobby space.

Public Corridors

A complementary palette of materials should be used to establish a hierarchy in the treatment of spaces and corridors as they lead visitors from the entrance lobby to the main corridors and finally to departmental corridors. Introduce as much natural light as possible into corridors, through windows, transoms, or other means.

3.6 Child Care Centers

See the *GSA Child Care Center Design Guide* (PBS-P140) and refer to ISC child care annex guide for specific requirements for child care center design. Child care centers will usually be operated by organizations outside the Federal Government. The A/E must consult with the Public Buildings Service (PBS), Child Care Division, before design concepts are finalized

Child Care Center
United States Courthouse
Central Islip, New York

A separate building with an outdoor play area, this child care center is located on the grounds of the courthouse.

3.7 Tenant Spaces

When designing and planning the tenant space, the following are standards unless GSA modifies the requirements:

- Maximize natural light in open spaces and avoid placing enclosed rooms along the windows
- Provide adequate speech privacy and consider sound masking if necessary to ensure appropriate acoustic properties
- Circulation patterns should be clearly recognizable, and wayfinding must be user friendly. Proceeding through the office should be pleasant and intuitive for the users, encouraging informal communication
- Provide efficient and adequate storage that best meets the needs of the tenant based on their specific requirements
- Provide centrally located resource centers for files and staff to maintain documents
- Provide adequate space for the recycling program
- Equip work settings to enable simultaneous voice, data, and video collaboration among distributed co-workers, local and remote
- Choose workplace components and furnishings that occupants can easily move themselves and reconfigure to accommodate change, without skilled labor or technical contract support

Workspace Requirements Development

GSA's pricing policy mandates developing a "comprehensive, professional requirements package for 'new, expansion, or replacement' office space" (PBS Pricing Guide, Section 3.2.10). Part of GSA's pre-design project planning includes developing customer requirements, a process called requirements development (RD). PBS workspace program offices are responsible for developing RD processes, tools, and guidance. The process consists of a "basic RD" that conducts a more detailed programming and organizational analysis. When RD has been accomplished for a client agency, the architect or designer-of-record for the workspace project must reference the RD documents and comply with their recommendations.

GSA's strategic RD process is an in-depth analysis of a customer's workspace requirements. This process uses analytical tools, methods, and technology to structure input from a broad range of client staff, and integrates experienced insights and recommendations about how the design of the workspace could support the type of work performed there. The resulting requirements report presents specific recommendations for delivering functional interior work space with the flexibility to adapt to future change. For quality assurance purposes, the workplace consultant must meet the designers-of-record and inform them on the findings to ensure the client's requirements are translated into the design process. The A/E must be invited to participate in client meetings during the RD process. Similarly, the workplace consultant must have the opportunity to review and comment throughout the development of tenant improvement drawings. This feedback must be reflected in the final documents.

Office Space

In designing office space, all aspects and decisions must provide long-term flexibility for future floor plan changes. Most of the buildings owned or managed by GSA are office buildings and at least partially use an open plan layout. The success of an open plan design depends on a good floor plan, acoustics, views, daylight, and well-designed systems furniture. The open plan approach is encouraged with limited height furniture partitions. Open plans have a higher degree of efficiency and flexibility, and provide easier distribution of natural light, heating, and cooling to the working areas. This approach can be adapted to a larger building depth and still present an open and airy atmosphere. It also encourages interaction between individuals and work groups. An open plan approach provides less acoustical control, less visual privacy, and less environmental control than closed offices. These drawbacks can be countered effectively by creating closed rooms for functions that are either particularly noisy or require special acoustical privacy. Examples are rooms housing copiers and conference rooms. The average net workstation size in a Federal building is 7 m^2 (75 sq. ft.), which excludes circulation and support spaces. This demonstrates that small workstations are in the majority. Good open plans allow for ample circulation and open space between groups of workstations. Grouping workstations around open, informal meeting areas can increase communication between workers. Glazed partitions fronting the open area add to a feeling of spaciousness and should be used extensively where appropriate. In laying out workstations, avoid long rows of cubicles. The planning grid described in this chapter can be adapted to function with layouts that are rotated or even curved. At a minimum, grids can be set at 90 degree angles with each other and have small open spaces in between. Where glazed partitions are used between workstations, desks must be oriented so that occupants do not face each other directly.

Acoustics in Open Office Areas

The ambient noise level can be reduced significantly by specifying sound-absorbent floor and ceiling finishes and using systems furniture with NIC ratings of 20 or higher. This does not mean that background sound masking should be specified for every open plan office. The actual need for speech privacy varies widely between different groups of occupants; often group privacy is more important than individual privacy. Many people are used to the voices of their coworkers and the noise level within their group but are disturbed by noise from adjacent groups. Groups of workstations should be oriented differently to allow this sense of territory to develop.

Ceiling Height

The general office space should have a ceiling height that provides long-term flexibility for future floor plan changes. In historic buildings, however, original ceilings in significant spaces should remain exposed to view. New suspended ceilings in standard office space within historic buildings should maintain the original ceiling height to the greatest extent possible, maintaining full clearance at windows and grouping systems, as necessary, to minimize the reduction of ceiling height. In office space containing vaulted ceilings, oversized windows, or similar features, consideration should be given to thoughtfully designed, exposed system solutions that maintain full ceiling clearance and allow ornamental surfaces to remain exposed to view. The clear ceiling height for office spaces is a minimum of 2,700 mm (9 ft.) for spaces that are larger than 14 m^2 (150 sq. ft.). The clear ceiling height of individual office rooms not exceeding an occupiable 14 m^2 (150 sq. ft.) is a minimum of 2,700 mm (9 ft.). The clear ceiling height of private toilets and small closets, which are ancillary to other office spaces, is a minimum of 2,300 mm (8 ft.). Enclosed offices should have the same ceiling height as adjacent open office spaces to allow future reconfiguration flexibility. The clear ceiling height for office space is a minimum of 2,700 mm (9 ft.) for spaces that are larger than an occupiable 14 m^2 (150 sq. ft.). The clear ceiling height of individual office rooms not exceeding an occupiable 14 m^2 (150 sq. ft.) is a minimum of 240 mm (8 ft.). The clear ceiling height of private toilets and small closets, which are ancillary to other office spaces, is a minimum of 2,300 mm (7 ft. 6 in.).

Automated Data Processing (ADP)

ADP areas are associated with mainframe computer equipment and include dedicated rooms for server devices and any special HVAC components to temper the space where equipment is located. They need temperature and humidity control, acoustical isolation and absorption, security provisions, and usually require an uninterruptible power supply (UPS).

ADP spaces require access flooring over a plenum space, even if access floors are not used elsewhere in the building. The access flooring of ADP areas must be level with adjacent related spaces and must always be level with the landings of elevators that serve the ADP facility. Ramps must be used only where it is impossible to adjust the level of the structural floor. Where ADP areas occupy 33 percent or more of a floor, design the entire floor, including internal corridors, with raised access flooring to accommodate ADP facility expansion. The floor levels of access flooring should be constant throughout the floor. Designers must consider the need for access floor systems in ADP areas to carry larger loads due to special equipment like UPS systems.

Training and Major Conference Rooms

Individual training and conference rooms may be located within the building to best suit the tenant. If such spaces are grouped to form a large training or conference facility, they should be located near the ground floor to avoid excessive loading of vertical transportation and to provide immediate egress for large groups of people. Rooms designed for video teleconferencing or training should have a minimum clear ceiling height of 3,000 mm (10 ft.). The design should address how unusually large pieces of prefabricated millwork, furniture, such as conference tables, or equipment will be transported into place.

3.8 Building Support Spaces

Toilet Rooms

Toilet counts must be sized to meet occupant loads for the floor. Counts for large assembly functions must be sized to accommodate short-term, high-volume demands. Toilet fixture counts in repair and alteration and/or modernization projects must be sized to meet revised occupant loads. Sight lines into toilet rooms must be completely screened without the use of double door entrance vestibules. Unisex and family restrooms are excluded from this requirement. GSA's toilet requirements differ from model building codes. GSA fixture counts shown in Table 3-1 supersede building code requirements.

Table 3-1

Number of Toilet Fixtures

Number of Persons	Men			Women	
per Toilet Room	WC	Ur	Lav	WC	Lav
1 to 8	1	1	1	2	1
9 to 24	2	1	1	3	2
25 to 36	2	1	2	3	2
37 to 56	3	2	2	5	3
57 to 75	4	2	2	6	4
76 to 96	4	2	3	6	5
97 to 119	5	2	3	7	5
120 to 134	6	3	4	9	5
Above 135	1/20	1/40	1/30	3/40	1/24

Locker Rooms

Locker rooms are finished spaces. Wet areas (toilet rooms and showers) must be separated from dry areas. Sight lines into locker rooms must be completely screened without the use of double door entrance vestibules. Locker rooms must be provided and located adjacent to fitness centers.

Fitness Centers

Fitness centers must be structurally capable of supporting the loads of the equipment they may contain. HVAC must be adequate to serve the space use. Finishes will be cleanable, and glass must be tempered safety type.

Custodial Spaces

Custodial spaces are devoted to the operation and maintenance of the building and include maintenance storage rooms, stockrooms, and janitor's closets. Locations and configurations of all custodial spaces must be coordinated and approved by the operations and building management staff.

Storage Rooms and/or Stockrooms

Storage rooms must be configured with an efficient layout to accommodate the specified contents and/or functions. Access to and from the room and internal room circulation must be sized to accommodate the delivery and removal of contents.

Janitor's Closets

Janitor's closets must be centrally located on each floor adjacent to the toilet rooms. Janitor closets must have direct access from the corridor; they must not be accessed through the toilet rooms. The closet must accommodate all the maintenance equipment, cleaning gear, and supplies required to serve the adjacent work areas. At a minimum, the closet must have a 600 mm (24 in.) square mop basin, a wall-mounted mop rack, and 900 mm (3 ft.) of 250 mm (10 in.) wide wall shelving; the floor area should be a minimum of 1.7 m^2 (18 sq. ft.).

Loading Docks

Loading dock areas must be separated and visually screened from the main public building entrance(s). Loading docks must have a direct route to freight elevators and be sized to accommodate the transport of supplies, equipment replacement parts, and building goods. Service circulation must be separated from public areas such as lobbies, corridors, and elevators. Loading dock stairs must be located on the driver's left when backing into the dock. The grade of the apron must slope away from the loading dock and it should not to exceed an 8.3 percent slope. At least one loading berth must be equipped with a dock leveler. The dock must be protected with edge guards and dock bumpers. Open loading docks must be covered at least 1,200 mm (4 ft.) beyond the edge of the loading dock platform over the loading berth. In regions where energy conservation is mandated, dock seals must be used at each loading dock platform or when possible the entire load dock bay should be enclosed. Separate or dedicated loading docks should be considered for food service areas. A ramp must be provided from the loading dock down to the truck parking area to facilitate deliveries from small trucks and vans. This ramp must have a maximum 8.3 percent slope and comply with ABAAS. A dock manager's room must have visual control of the entire dock area as well as and the building entrance and exit. Loading docks must not be used as emergency egress paths from the building.

Loading Berths

Provide at least one off-street berth for loading and unloading. Loading berths must be located adjacent to the loading dock areas. Unless otherwise specified by the program and/or local zoning regulations, a single berth must be a minimum of 4,600 mm (15 ft.) wide and sized for the longest vehicle serving the building as determined by the facility manager. Additional loading berths do not need to be wider than 3,600 mm (12 ft.) if they are contiguous with another loading berth. An apron space must be provided in front of the loading berth for vehicle maneuvering equal to the length of the berth plus 600 mm (2 ft.). The apron must be relatively flat and have positive drainage with a minimum slope of 2 percent. The minimum headroom in the loading berth and apron space is 4,600 mm (15 ft.). If programming forces a steeper slope in the apron area, the headroom should increase with a gradient allowance to allow trucks to traverse the grade change. A ramp should be provided from the loading dock down to the truck parking area to facilitate deliveries from small trucks and vans. This ramp should have a maximum slope of 12:1 and comply with ABAAS, ensuring that it may be easily maneuverable for deliveries on carts and dollies. If the approach to the loading dock is ramped, the design should permit easy snow removal.

Staging Area

An internal staging area must be provided adjacent to the loading dock. The staging area must not interfere with emergency egress from the building.

Recycling and Trash Rooms

Trash rooms must be adjacent to loading docks or service entrances. Trash rooms must be sized to accommodate the trash handling equipment required and provide storage for trash and recycling generated during a three-day occupancy of the building. Space must be allowed for sorting and recycling of paper, bottles and cans, metals, and other materials. Facilities that use trash containers that are picked up by vendors must have at least one loading berth for the trash container.

Recycling Holding Space

Recycling space must be provided on each floor or within each tenant space as well as at the loading dock, and must be sized to contain at least three days of recycled materials.

Building Engineer's Space

Provide space for the building engineer even if not included in the building program. Most GSA buildings require such a space, which houses the consoles for the building automation system (BAS). This space should normally be located near the loading dock or main mechanical spaces.

Security Control Center

All Level IV (medium) and V (high) Federal facilities require an on-site security control center.

All GSA buildings with a local security force must have a control center. If the building will not have a local security force, this function can be combined with the building engineer's office or the fire control center. The security control center must be located adjacent to the main lobby. Approximately 21 m^2 (225 sq. ft.) should be allocated for this room which is intended to house the command station for the security guards and their equipment for current as well as future building needs. There should be an expectation in the planning of the building that a security command center and inspection station may be needed in the future, if it is not required at time of building design.

Refer to the GSA design guide *Lobby Security in Historic Buildings* for detailed guidance and prototypical designs.

Mail Rooms

Where mail sorting is conducted in the GSA building rather than in a separate federally controlled facility with screening capabilities, the mail sorting room must be located near the loading dock and segregated from other building spaces and vital services in the same way as the loading dock. (See the ISC criteria and Chapter 5, Mechanical Engineering, Section: Mail Sorting Rooms.)

Oklahoma City Federal Building
Oklahoma City, Oklahoma

The public lobby is separated from the adjacent offices by three-story, one-foot-thick, cast-in-place concrete walls.

Fire Command Center

See Chapter 7, Fire Protection and Life Safety, for the requirements for the fire command center.

Indoor Firing Ranges

Indoor firing ranges must be designed in accordance with the Guidance Document—Indoor Firing Range—Design and Operations Criteria. This document is available from the PBS Environmental Division.

3.9 Systems Support Spaces

Mechanical and Electrical Rooms

These spaces include, but are not limited to, mechanical and electrical equipment rooms, enclosed cooling towers, fuel rooms, elevator machine rooms and penthouses, wire closets, telephone frame rooms, transformer vaults, incinerator rooms, and shafts and stacks. Mechanical and electrical equipment rooms must be designed with adequate aisle space and clearances around equipment to accommodate maintenance and replacement. Hoists, rails, and fasteners for chains should be provided to facilitate removal of heavy equipment. The working environment in equipment rooms should be reasonably comfortable. Doors and corridors to the building exterior must be of adequate size to permit replacement of equipment. This path (may include knock-out panels, hoists, and provisions for cranes) is necessary and must be demonstrated for equipment replacement. When floor hatches are used to transport equipment from one level to another, overhead clearances should be provided to allow the equipment to be hoisted over the guardrail. If this is not feasible, an active fall protection system must be provided to protect workers during removal of the guardrail and floor hatch.

Access to the equipment rooms and penthouses must be at the same level as the freight elevator stop. Equipment that is over 6 feet above the floor must be provided with stairs and guarded work platforms. If guarded work platforms are not feasible, an active fall protection system must be provided to protect workers during maintenance and repair tasks.

Within the equipment rooms and penthouses, stairs are the preferred access to equipment spaces and required when access is more frequent than once per week. Stairs must be standard (angle of rise between 30 and 50 degrees). If ladders must be used they must be of the caged safety ladder type. Ship's ladders and alternating tread devices are not permitted as a means of access to mechanical equipment. In all cases, guarded work platforms must also be provided. All preventive and repair maintenance tasks must be considered in providing work platforms and determining their size. This requirement applies to both interior and exterior building equipment.

In some buildings special fire protection measures may be required. All equipment spaces must be designed to control noise transmission to adjacent spaces. Floating isolation floors are recommended for all major mechanical rooms. See the section in this chapter on acoustics for noise isolation criteria.

A minimum of 4 percent of the typical floor's gross floor area must be provided on each floor for air-handling equipment. A minimum of 1 percent of the building's gross area must be provided for the central heating and cooling plant (location to be agreed upon during preparation of concept submission). Mechanical equipment room must not be less than 3,700 mm (12 ft.) clear in height. All mechanical equipment rooms must be accessible via a freight elevator at that level for the purpose of operations and maintenance, and replacement of equipment. The freight elevator must be of a size to accommodate the largest component of the equipment. Ship's ladders and alternating tread devices are not permitted as a means of access to mechanical equipment.

Main electrical switchgear must not be below toilets or janitor closets or at an elevation that requires sump pumps for drainage. If electrical switchgear is housed in the basement, provisions must be made to prevent water from flooding the electrical room in the event of a pipe breaking. Automatic sprinkler piping must not be installed directly over switchgear equipment.

Mechanical rooms as a rule must open from nonoccupied spaces such as corridors. If mechanical rooms must open from occupied spaces because of configuration constraints, consider incorporating a vestibule with partitions that extend to structure and sound-gasketed doors at each side for acoustic and vibration separation. The architect must coordinate with the mechanical engineer to place mechanical equipment with easy access for maintenance and replacement. Design of equipment placement must allow maintenance of motors and replacement of filters from the ground. When there is no practical alternative to overhead placement, filters must be able to be safely replaced by one person from a standard stepladder.

Communications Equipment Rooms

Rooms must be stacked vertically within the building, with adequate floor space for frames, racks, and working clearances for current need and future expansion. In addition to the criteria stated for general mechanical and electrical equipment rooms, rooms for communications equipment must comply with EIA/TIA Standard 569: Commercial Building Standard For Telecommunications Pathways And Spaces (and related bulletins).

Agency requirements for separate, dedicated communication closets must be verified.

Equipment rooms must be sized to accommodate the equipment planned for the room. At a minimum, the room should have 0.7 m^2 (0.75 sq. ft.) of equipment room space for every 9.3 m^2 (100 sq. ft.) of occupiable space. The equipment room should be no smaller than 14 m^2 (150 sq. ft.). Federal Acquisition Service (FAS) should determine if tenants will share equipment rooms or if separate equipment rooms are required for specific tenants. Equipment rooms must be connected to the communications entrance facilities and the backbone pathway. The equipment room will have 24-hour HVAC service and be protected from contaminants.

Uninterruptible Power Systems and Battery Rooms

The UPS modules and associated batteries must be installed in separate, adjacent rooms. See the UPS and battery manufacturers' installation instructions for weights, dimensions, efficiency, and required clearances. Allow space for storage of safety equipment, such as goggles and gloves. Special attention must be given to floor loading for the battery room, entrance door dimensions for installation of the UPS, and ceiling height for clearance of the appropriate HVAC systems and exhaust systems.

Electrical Rooms

Electrical closets must be stacked vertically within the building. Closets must be designed with adequate wall space and clearances for current and future requirements, should have a minimum size of 1,800 mm by 3,000 mm (6 ft. by 10 ft.) and must be at least 600 mm (24 in.) deep by 2,600 mm (8 ft. 6 in.) wide. These are satellite closets for electrical panelboards. They should not contain extraneous floor area, which may be an invitation to store items that do not belong in electrical closets.

Vertical Shafts

Shafts for pipes, ducts, flues, and other services must be straight vertical runs located adjacent to other core elements and sized to accommodate future expansion. Consider sound isolation when planning location of shafts. Provide sound transmission isolation in accordance with the acoustical section of this chapter. Shafts must be closed at top and bottom, as well as at the entrance to the mechanical room, for sound isolation.

Shafts containing critical utilities such as power and communications must be run remotely from the building exterior, entrance lobbies, mail rooms, and loading docks or encased in blast-mitigating construction. Vertical shafts for running pipes, ducts, and flues must be located adjacent to other core elements to the maximum extent possible. Be aware of the requirement to locate fire alarm vertical risers remotely.

3.10 Specialty Areas

Food Service Areas

Space allocations for food service facilities are established in GSA handbook, *Concession Management Desk Guide* (PMFC-93).

In most cases, food service areas perform better when not isolated within a facility. Consider making food service directly accessible to the public and integrated with the site design. Mitigate security concerns by placing food service within freestanding structures or by providing hardened partitions. The entrances to the dining area should be visible from the main circulation paths, but should not impede lobby traffic. They should be located to take advantage of natural light and outdoor eating areas whenever possible.

Food service areas should be laid out to minimize waiting times for customers. Scramble service is recommended.

Outdoor Eating Areas

To the extent possible, outdoor eating areas should be encouraged. When incorporating outdoor eating areas, the security of the building or facility must be considered. Special consideration should be given to capture those opportunities to engage the building's exterior/landscaping with the community in which it is placed. Outdoor eating areas should be incorporated into public courtyard and plaza design by providing adequate amenities and a comfortable environment. Outdoor eating areas should provide seating, shading elements, landscape, and trash and recycling containers to maintain a clean, organized, and inviting public space for employees and visitors. If located along the perimeter of the building, the eating area must follow all applicable site security guidelines.

Laboratories

The construction of new laboratories in existing office buildings is strongly discouraged. See Chapter 7, Fire Protection and Life Safety, for additional requirements.

Outleased Spaces

This term defines building space leased to businesses as commercial stores. Outleased spaces and the connection between them and the remainder of the building should be designed so they can function as Government office space in the future. Consideration should also be given to those building without programmed outleased space to allow for this flexibility in the future.

Structured Parking Garages

For planning of on-grade parking, refer to Chapter 2, Site Engineering and Landscape Design.

Parking must be based on a transportation management plan and aligned with the numbers and types of vehicle parking spaces stipulated in the prospectus. When locating entrances, exits, and ramps consider internal and external traffic flow, queuing during peak periods, and required security features. Provide for stacking and queuing for peak hours. The following criteria apply to structured parking facilities and are minimum requirements. Dimensions apply to passenger cars and need to be modified for other types of vehicles.

Parking Layout

To the extent possible, parking spaces should be arranged around the perimeter of the parking deck for maximum efficiency. Two-way drive aisles should be used with 90-degree vehicle parking stalls on each side.

Drive Aisles

Two-way aisles must have a minimum width of 7,000 mm (23 ft.). One-way aisles and aisles with stalls on only one side are less efficient and should be avoided.

Vehicle Stalls

Stalls must be a minimum size of 2,600 mm (8 ft. 6 in.) wide and 5,500 mm (18 ft.) long. Special consideration must not be given to compact vehicles. Structural elements must not intrude upon the required stall dimension. Columns must not be located within 610 mm (2 ft.) of the required aisle except where the aisle has no stalls perpendicular to it. Each stall must have access to an aisle. Stacked parking is not permitted.

Accessible Parking

Accessible parking spaces must comply with ABAAS. Accessible routes will not be located behind parking spaces.

Ramps

Drive ramps must not exceed 8.3 percent slope. Sloped parking garages must not exceed 5 percent. There must be gradual transitions between the slope of ramps. The entire length of entrance and exit ramps must be covered to protect them from snow and ice.

Provide moisture protection and drainage of the parking deck. Snow melting systems should also be considered, including the potential impact on the energy target.

Stairs and Elevator Lobbies

To enhance security, stairs and elevator lobbies serving the structured parking may be glazed and located so they can be observed from a public street.

Walkways

Pedestrian walkways should provide a link to all areas that might be used by employees and visitors. Circulation from building entrances to parking structures, outdoor eating areas, off-site child-care facilities and neighborhood amenities should have designated pedestrian walkways that are protected from traffic. Provide curbs, bollards, low walls, landscaping, or other barriers to prevent vehicles from encroaching upon pedestrian walkways. Provide security measures such as painted crosswalks and signage to identify pedestrian crossings of vehicular traffic lanes.

Garage Door Opening

Garage door openings must be a minimum of 3,600 mm (12 ft.) wide with a minimum height of 2,400 mm (8 ft.). A headache bar must be provided in front of each opening; and mounted 100 mm (4 in.) lower than the height of the clear opening. Use motor operated overhead doors or grilles when required for security purposes. The control devices must be suited for high-frequency operation, open and close quickly, and have a sensor edge to detect an object beneath so as to reverse operation. Openings must be monitored by security cameras.

Protection of Garage and Vehicle Service Entrances

All garage or service area entrances for Government-controlled or employee-permitted vehicles that are not otherwise protected by site perimeter barriers must be protected by devices capable of arresting a vehicle of the designated threat size at the designated speed. This criterion may be adjusted if the access circumstances prohibit a vehicle from reaching the designated speed and weight as stated in the Risk Assessment. See Chapter 2, Site Engineering and Landscape Design, for Site Planning and Vehicular Control, Perimeter Protection Zone. The threat assessment of a facility often affects curbside or underground parking in urban areas. Mitigating associated risks requires creative design and planning, including parking restrictions, perimeter buffer zones, barriers, structural hardening, and other architectural and engineering solutions.

3.11 Daylight and View

Design interior spaces to provide daylighting and views for the occupants. Daylighting is the practice of harvesting natural light to supplement or replace a portion of the building's internal artificial lighting. Views of the exterior environment give building occupants visual comfort along with physiological and psychological benefits.

Daylighting design must mitigate the adverse effects of glare and solar heat gain.

United States Courthouse
Orlando, Florida

Outdoor terraces allow judges access to the outdoors while allowing daylight to filter into courtrooms.

Daylight Design Criteria

Daylighting design requires an integrated design approach involving the A/E, the occupants, the lighting designer, the mechanical engineer, interior designers, and operation and maintenance staff. Automatic controls for lighting in daylight zones must reduce lighting power in response to available daylight without noticeable changes to the occupant. Well-designed lighting provides a comfortable and healthy visual environment and supports the activities of the occupants. Even when excellent daylighting components or technologies are selected, poor integration can lead to unreliable building performance and uncomfortable work environments. Critical design elements include building orientation, fenestration size, lighting and control systems optimization, commissioning, and proper maintenance.

Daylight Design Concept and Integration Process

The daylight design process includes the following steps:

- Concept design basis
- Building orientation and form
- Daylighting the perimeter
- Daylighting the core
- Windows and glazing identification and selection
- Shading, daylight controls, and visual comfort
- Utilization of a daylight design software
- Mechanical coordination
- Auxiliary lighting integration
- Commissioning

3.12 Lighting

Lighting is a critical and energy-intensive component of office building design. Good lighting design is a careful integration of daylight and artificial lighting to enhance the appearance of the space, save energy, and support the performance of the occupants. Lighting design uses a combination of ambient and task lighting to provide light levels that support occupant productivity. Brightness and glare must be balanced from both natural and artificial lighting sources to reduce high contrast and prevent eyestrain. Use appropriate controls to balance daylighting, occupant needs, and energy efficiency.

See Chapter 6 for lighting standards.

U.S. Courthouse Annex
Wheeling, West Virginia

Elevator lobbies on the upper floors open on to tall windows that provide daylight and views.

Artificial Lighting

Artificial lighting is a combination of direct and indirect sources provided by ambient and task lighting fixtures and should complement, not duplicate, natural lighting. Separating lighting into several categories, or layers, increases visual comfort, provides user flexibility, and creates visual interest. These include architectural and local ambient lighting, task lighting, and accent lighting.

Ambient Lighting

In office space over 9 feet-6 inches high, use suspended fluorescent pendants that are 80 percent indirect and 20 percent direct. For specific tasks, other combinations of direct and indirect lighting may be considered. Office space that is less than 9 feet-6 inches may use lay-in lighting units in a suspended ceiling using perforated baffles to create a direct/indirect distribution similar to pendant fixtures. Chapter 6 describes the required minimum lighting levels. Coordinate ambient light with daylighting and the reflectance levels of furniture, walls, ceilings, and floors.

Task Lighting

The tenant will provide task lighting.

Accent Lighting

Accent lighting balances contrast on window walls, and enhances the workspace by highlighting special areas, artwork, or architectural features. Synchronize color and light levels as described in the *IESNA Lighting Handbook.*

3.13 Acoustics

The standards in this section establish adequate acoustic qualities in Federal buildings. Post-construction commissioning will confirm that the acoustical standards have been met.

General Criteria for Building Spaces

Four key concepts govern the quality of office acoustics. See Table 3-2 for design criteria.

1 Speech Privacy
The degree to which a conversation cannot be overheard in an adjacent space.

2 Background Sound
Continuous background sound may have to be supplemented with additional electronically generated sound to provide for masking of speech while private conversation is being conducted. The A/E will differentiate between enclosed and open office environments to meet these objectives.

3 Equipment Vibration and Reverberation
Office equipment noise levels must meet the standards at the workstations. Reverberation and echoes must be controlled in courtrooms, auditoriums, and conference, team, and training room spaces that may require professional acoustical engineers to meet the standards. Sound transmission through building frames must be inhibited.

4 Exterior Noise
Facilities located near airports, highways, rail corridors, or other sources of significant environmental noise levels must have building envelope assemblies controlling noise intrusions to the required standards.

Closed Offices versus Open Plan

For work that does not require acoustic and/or visual privacy, an open plan environment with low or no partitions between workstations is permitted. For work that requires a balance between ongoing, active collaboration, easy workgroup reconfiguration, flexible settings, and minimized unwanted acoustic distraction, an open plan setting with a well-engineered acoustical design is recommended.

Key components of such engineered open plan designs are highly absorptive ceilings, suitable height partition panels that both absorb and block sound, suitable levels of background sound (typically provided by electronic sound masking systems), and ready access to acoustically private (closed-office) meeting spaces.

Closed offices must be provided for workers who routinely require extended periods of concentration, in-office meetings, and/or confidential conversation. Meeting spaces and closed offices that require speech security must be designed in conjunction with a qualified acoustical consultant.

In enclosed offices, HVAC background sound may be an important component in achieving the required level of privacy because it helps to cover up or “mask” speech transmitted between adjacent spaces. In open plan areas, the background sound provided by contemporary HVAC equipment is often not uniform and/or does not have the tonal balance and loudness needed to mask speech transmitted between adjacent cubicles. For this reason, additional electronic background noise or sound masking is often deployed in these areas.

Mechanical and Plumbing Noise

All mechanical equipment must be vibration isolated from the building frame as required by Chapter 5. Ambient noise from mechanical equipment must not exceed noise criteria (NC) values described in the acoustical section of this chapter. Diffusers with an NC rating 5 points less than the noise criterion for the space being served must be used where occupied space occurs adjacent to, above, or below mechanical or electrical equipment or machine rooms, or adjacent to HVAC or elevator shafts. The intervening structure (partitions, shaft walls, doors, floor and ceiling assemblies, etc.) must be sufficient to control noise intrusion to no greater than the maximum NC or room criteria (RC) values. Where an elevator shaft or equipment room occurs adjacent to noise-sensitive spaces (NC/RC 35 or lower), the maximum intrusion level of elevator noise must be limited to 5 dB below the maximum NC/RC for the space in all octave bands. In the walls, ceilings, and floors enclosing noise-sensitive spaces (Table 3-2, column 1, RC/NC 35 or less), all water, wastewater, and drain piping must be vibration-isolated from the structure, finishes, and other piping. Install R-11 batt insulation in all wall spaces where such piping is located and install the piping at least 200 mm (1 in.) away from the gypsum wall board.

Noise Isolation, Room Acoustics, and Speech Privacy

Absorptive materials are required in speech-sensitive spaces to control reverberation and echoes. Table 3-2, columns 2 and 3, list spaces that require absorptive finishes. The first number in each column refers to the minimum level of the material's performance; the second refers to the minimum percentage of the ceiling or wall that must have finishes achieving this performance.

Floor and ceiling assemblies separating office spaces must achieve an NIC of not less than 50 (when furnished) and Field Impact Isolation Class (FIIC) of not less than 50. Table 3-2, column 4, lists the minimum noise isolation (NIC) for spaces requiring acoustically rated walls.

For constructions on suitable slab floors, when properly detailed and constructed, and with all connections caulked airtight with acoustical sealant, the following wall assemblies typically will satisfy the minimum specified NIC requirements, with the spaces furnished typically. These wall examples are not the only constructions that will satisfy the performance criteria; they are intended

**Oklahoma City Federal Building
Oklahoma City, Oklahoma**

Open workstations placed near the courtyard exterior share daylight with the interior spaces.

solely to provide guidance on projects that do not require a qualified acoustical consultant during the design phase.

- NIC 53 (teleconference room): Double stud wall, two layers of gypsum board each side, batt insulation in the stud cavities. Full height (slab to slab).

- NIC 48 (meeting rooms, training facilities): Staggered stud wall, two layers of gypsum board each side, batt insulation in the stud cavity. Full height (slab to slab).

- NIC 45 (private offices, confidential speech privacy): Single stud wall, two layers of gypsum board each side, batt insulation in the stud cavity. Full height (slab to slab) or 6 inches above a hung gypsum board ceiling.

- NIC 40 (private offices, normal speech privacy): Single stud wall, two layers of gypsum board one side, one layer of gypsum board the other side, batt insulation in stud cavity. Slab to slab (preferred); minimum 6 inches above acoustical tile ceiling (minimum CAC 44).

- NIC 35 (private offices, normal speech privacy, sound masking): Single stud wall, single layer gypsum board each side, batt insulation in stud cavity. Minimum 6 inches above acoustical tile ceiling (minimum CAC 44).

- NIC 31 (private offices, normal speech privacy, low voice level, miscellaneous other spaces): Single stud wall, single layer of gypsum board each side, batt insulation in the stud cavity. Terminates at underside of acoustical tile ceiling (minimum CAC 35).

Acoustical performance will be verified during the commissioning of the building. The commission requirements are further defined in the *GSA Building Commissioning Guide.*

Parameters Used in Acoustical Design

The following parameters are used to specify acoustical standards for GSA buildings:

Background noise The loudness of noise is quantified by NC, balanced NC-B, and RC contours.

Environmental noise The continuous noise outside a building. The day-night average noise level (DNL) is a descriptor established by the U.S. Environmental Protection Agency to describe the average day-night sound level. Lower values are quieter.

Noise isolation The amount of noise transmitted through the perimeter boundary elements of a space. Sound transmission class (STC) quantifies the sound insulating performance of building elements such as walls, windows, and doors when tested in a laboratory in accordance with ASTM E90. NIC quantifies the field-tested sound isolation between two enclosed spaces separated by a partition when tested in accordance with ASTM E336. FIIC quantifies the field-tested impact sound insulating properties of a floor/ceiling assembly when tested in accordance with ASTM E1007.

Reverberation time The time required for sound to decay 60 decibels in the 500 Hz band in an enclosed space. Reverberation time becomes longer as the sound absorption is reduced and/or the room volume increases.

Sound absorption The amount of sound absorbed by a surface finish. Sound absorption average (SAA) quantifies the efficiency of a material in absorbing sound energy when tested in accordance with ASTM C423.

Table 3-2

Acoustics	1	2	3	4	5
Space	Maximum Mechanical Noise (RC/NC)	Minimum Absorption: Ceiling (SAA/NRC)	Minimum Absorption: Wall (SAA/NRC)[1]	Minimum Noise Isolation (NIC)	Optimum Reverberation (RT60)
Teleconference facility	20	0.8/ 50%	0.8/ 25%	53	0.5
Meeting rooms, Training facilities	25	0.8/ 50%	0.8/ 25%	48[2]	0.6
Private offices, confidential speech privacy	30	n/a	0.8/ 25%	45	n/a
Private offices, normal speech privacy	35	n/a	0.8/ 25%	40	n/a
Plan offices, normal speech privacy, sound masking	35[3]	n/a	0.8/ 25%	35	n/a
Private offices, normal speech, low voice level	35	n/a	0.8/ 25%	31	n/a
Open plan offices, normal speech privacy, sound masking	40[4]	0.9/ 100%	0.8/ 25%	n/a	n/a
Open plan offices, No speech privacy	40	0.8/ 100%	n/a	n/a	n/a
Child care center	35	0.8/ 80%	0.8/ 25%	31	0.5

[1] Absorption should be placed on two adjacent walls.
[2] Operable walls and partitions must achieved the required NIC rating for the spaces that they are separating.
[3] Steady state background noise provided by electronic sound masking system: 40-42dBA.
[4] Steady state background noise provided by electronic sound masking system: 45-48dBA.

3.14 Exterior Building Elements

This section establishes design guidelines for exterior elements of the building. These may be individual materials, assemblies of materials, equipment, or assemblies of materials and equipment.

The A/E is responsible for specifying construction materials and systems appropriate to the final design that are lasting, provide enduring quality, and are maintainable.

Selection of construction materials with these factors is vital to building performance.

Building Enclosure

The building enclosure is an environmental separator for thermal, moisture, air, acoustic, and daylighting properties, and also provides structural protection for blast, seismic, wind, and other hazards.

Since the building enclosure has a major impact on energy conservation and on blast mitigation, the A/E must coordinate all systems selection and design with the requirements in Chapter 4, Structural Engineering, for blast mitigation and Chapter 5, Mechanical Engineering, for building energy analysis.

Exterior wall assemblies must be designed to work in concert with HVAC systems to optimize energy performance. Envelope load criteria are described in ASHRAE 90.1.

Moisture Control

Design of the above-grade building enclosure must be demonstrated early in the design development. ASHRAE 160, *Criteria for Moisture Control Design Analysis in Buildings* is an acceptable basis of design. Demonstration of the transient hygrothermal behavior of the various multi-layer building components for all critical building enclosure systems must be confirmed through modeling.

Design against water penetration with clearly conceived redundant systems. The A/E is responsible for the integrity of the overall moisture control system.

Construction documents must clearly depict all drainage and air passages. Detail in three dimensions where practical, indicating critical corner terminations, interface of all differing systems, proper sealant methodologies, etc.

Future Maintenance

The use of different exterior materials, window designs, sun control devices, and other design elements contribute to the design articulation of a building. Each of these components, their use, and how they are combined on a building must be reviewed for future maintenance needs including replacement, repair, cleaning, weathering, and damage from bird roosts.

Consider the use of steeply sloped surfaces, limited use of horizontal surfaces at window sills, sun control devices or other design features or design approaches to minimize bird roosts.

Below Grade Systems

Ground Water Control

The drainage mat and soil filter should relieve hydrostatic pressure on substructure walls and allow water drainage to the level of the drain. Drainage system piping may be clay tile or rigid PVC. Pipes should not slope less than 1:200. Subsurface drainage should discharge into the storm drain, by gravity if possible. Cleanouts must be provided at grade to facilitate washing out the system.

United States Courthouse
Fresno, California

A system of distinctive precast concrete wall panels form an irregular pattern of folds, extrusions and corrugations across the building's buff-colored surface.

Waterproofing

Membrane waterproofing should follow the recommendations of the National Roofing Contractors Association (NRCA) in *The NRCA Waterproofing Manual*. Membrane waterproofing must be fully bonded and seamless.

Membrane Protection

Below-grade waterproofing must be applied to the positive pressure side and must be covered by a protection mat to shield the waterproofing membrane from deleterious effects of construction activities, ultraviolet radiation, or aggressive vegetation.

Waterstops

Waterstops must be used at construction joints in below-grade walls, footings and other elements where a water-proof system is required. Wherever possible use level changes to create a redundancy with the substrate in the event the water barrier fails.

Underslab Insulation

Provide insulation under concrete slabs on grade where a perma-frost condition exists, where slabs are heated, and where they support refrigerated structures.

Substructure

If soil radon or contaminant levels are a concern, a substructure depressurization system must be provided. If a passive system is designed, it must have the capability to accommodate future active depressurization. See Chapter 5, Mechanical Engineering, for additional requirements.

Wall Systems

Connections and Fasteners Exposed to Weather

Products constructed of carbon steel are not permitted in exterior construction, which includes exterior walls, soffits, or roofs, except where protected by a galvanic zinc coating of at least 460 grams per m^2 (1.5 ounces per sq. ft.) of surface or other equivalent protection.

Materials with Organic Content

In hot-humid and mixed-humid climates, do not use vinyl wall coverings as the interior finish of exterior walls. On mass storage walls where water may penetrate the wall, avoid interior finishes made from paper-faced gypsum sheathing or other highly processed organic materials that may promote mold growth.

Air/Moisture Barrier System

An air/moisture barrier is required of all new construction and should be employed wherever possible during remediation of existing exterior envelopes. The air barrier system is:

- a continuous element or combination of elements designed to control the movement of air across an exterior enclosure system
- continuous in three-dimensions from roof-to-wall-to-foundation
- consisting of materials and components that are, either individually or collectively, sufficient in stiffness and rigidity to resist air pressure differentials across the exterior wall assembly without permanent deformation or failure
- durable and structurally rigid to withstand the construction process

The interior and exterior air pressures across an air barrier system that need to be examined include, but are not limited to, pressures caused by wind, stack effect, and mechanical systems. Air barriers may be located at different locations within a wall system, and the placement of the air barrier needs to be indicated by the designer on the drawings. The designer must carefully consider placement of the air barrier when the air barrier material(s) will act both as an air barrier and as a vapor retarder to determine if drying of the system will be inhibited by the location of this material within the assembly. Portions of the air barrier may require regular maintenance and an allowance should be made within the design to accommodate this maintenance.

Requirements

A continuous plane of air tightness, herein called the air barrier system, must be installed as part of the building enclosure (both above- and below-grade) to effectively separate all conditioned air from outdoor and polluted spaces.

The air barrier system must be shown on the drawings as continuous through all section drawings of the enclosure. The air barrier materials and components of each assembly must be clearly identified and labeled as “Air barrier” on construction documents, and detailed at all penetrations, joints, and transitions. The pressure boundary of the air barrier system(s) and the zone(s) to be tested must also be shown on the drawings.

The air barrier material of each assembly must be joined and sealed to the air barrier material of adjacent assemblies with sufficient flexibility to allow for the relative differential movement and with sufficient strength to resist expected peak air pressure differences.

The air barrier systems and the materials or assemblies used must meet either Items 1 and 3 or 2 and 3:

1 The air permeance of materials comprising part of the air barrier system must not exceed 0.004 cfm/ft^2 at 0.3 in. wg (0.02 L/s.m^2 at 75 Pa) when tested in accordance with ASTM E 2178 Standard Test Method for Air Permeance of Building Materials.

2 The air leakage rate of opaque assemblies that comprise the air barrier system must not exceed 0.04 cfm/ft^2 at 0.3 in. wg (0.2 L/s.m^2 at 75 Pa) when tested in accordance with ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies or, for assemblies whose structural integrity is otherwise determined, ASTM E283 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

3 The whole building must not have an air leakage rate of more than 0.4 cfm/ft^2 (2.0 L/s/m^2) at a pressure differential of 0.3 in. w.g.(75 Pa). The test method used should be developed for each specific project by the Testing Agency and General Contractor, and approved by the Government (or representative). Existing methods such as ASTM E779, Determining Airtightness of Buildings Air Leakage Rate by Single Zone Air Pressurization; ASTM E-1827, Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door; or CGSB 149.15, Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building’s Air Handling Systems, modified as necessary, should be used whenever possible.

Penetrations of the air barrier system must be sealed to the air barrier system in an airtight manner. These penetrations include, but are not limited to: lighting fixtures, wiring, conduit, gas lines, cable services, windows, doors, ducts, fire protection standpipe connections, and plumbing pipes.

The air barrier system (and all materials and components comprising it) must last the anticipated service life of the enclosure or allow for easy maintenance, repair, and/or replacement.

Any louvers installed within elevator shafts must have a motorized damper set to the closed position, be connected to the fire alarm system to open on call, and fail in the open position.

All ventilation and make-up air intakes and exhausts, atrium smoke exhausts and intakes, etc. must have motorized dampers that are set to close when not active.

Parking garages (attached to or under buildings), other structures connected to the building, including those connected via tunnels, walkways, service conduits, etc., and any storage with contents that can negatively affect indoor air quality must be separated from all other conditioned spaces by an air barrier system. Access to such spaces must be provided by doors in air-tight vestibules or airtight hatches at building access points.

Boiler rooms not using sealed combustion equipment must be separated from the rest of the building space by an air barrier system and provided with make-up air for combustion.

Stairwells, shafts, chutes, and elevator lobbies must be provided with full height sealed walls and doors that meet air leakage criteria for exterior doors and components, complete with necessary gaskets and weather stripping.

Additional equipment and other items required for testing the building's airtightness are to be installed by the contractor as specified by the testing agency. This may include: indoor-to-outdoor pressure taps at various locations across the air barrier system, air flow and pressure measuring stations in air conveyance and handling systems, and tight-sealing dampers on all ducts carrying air across the air barrier.

Masonry and Concrete Materials

Brick masonry design must follow the recommendations of the Brick Institute of America contained in the publication, *Technical Notes on Brick Construction.*

Concrete masonry design must follow the recommendations of the National Concrete Masonry Association contained in the publication, *TEK Manual for Concrete Masonry Design and Construction.*

Architectural precast concrete design must follow the recommendations of the Precast Concrete Institute (PCI) contained in PCI publication, *Architectural Precast Concrete, Current Edition.*

Exterior limestone design must follow the guidelines of the handbook published by the Indiana Limestone Institute of America.

Marble and Marble veneer design must follow the recommendations in *Exterior Marble Used in Curtain or Panel Walls,* published by the Marble Institute of America. Extreme care should be used in the design and selection of thin marble veneers to prevent thermal hysteresis.

Fenestration Systems

Structural Integrity

Wind loads must be determined in accordance with the applicable edition of ASCE 7. However, large complex structures, especially those located in hurricane-prone regions that in the opinion of wind-engineering professionals would benefit from a more reliable performance prediction, should be wind tunnel tested as early as practical in the design process.

Thermal Performance

The facility must have windows based on climate and energy conservation that comply with security requirements. The design of the fenestration, size, glazing properties, and shading must be closely coordinated with the design of the mechanical systems to maximize performance. See Chapter 5, Mechanical Engineering, for further requirements.

Condensation Resistance Windows

Condensation resistance windows must have a condensation resistance factor (CRF) appropriate to prevent condensation from forming on the interior surfaces of the windows. The CRF can be determined by testing in accordance with AAMA 1502.7, Voluntary Test Method for Condensation Resistance of Windows, Doors, and Glazed Wall Sections. Aluminum windows must meet the requirements of AAMA 101/I.S.2/A440-05. Only optimal performance classes may be used.

Aluminum Windows

Aluminum windows must meet the requirements of ANSI/AAMA Standard 101- 85. Only optimal performance classes may be used. Metal windows other than aluminum must meet the requirements of the National Association of Architectural Metal Manufacturers Standard SW-1 for the performance class required. Wood windows should meet the requirements of ANSI/NWMA Standard I.S. 2-87, Grade 60.

Window Frames

Aluminum frames must have thermal breaks where there are more than 1,670 heating degree days °C (3,000 heating degree days °F). Window mullions, as much as possible, should be located on the floor-planning grid to permit the abutment of interior partitions.

Metal windows other than aluminum must meet the requirements of Steel Window Institute's (SWI) *Specifier's Guide to Steel Windows* for the performance class required.

Wood windows must meet the requirements of ANSI/NWMA Standard I.S. 2-87, Grade 60. Wood windows must meet the requirements of AAMA/WDMA 101/I.S.2/NAFS. AW Architectural Class.

Replacement of windows in historic structures should exactly match original frame and muntin profiles. First consideration should be given to rehabilitating the existing windows. Retrofitting existing monolithic glass in a nonweeped wood sash with insulating glass units is prohibited.

Operable Windows

Although fixed windows are customary in large, environmentally controlled GSA buildings, in certain circumstances operable windows may be appropriate. Operable windows should be considered in all new buildings. The facility may have operable windows, where appropriate, to support facility survivability and window washing. Consider using operable windows that pivot and can be washed from inside the building. The exterior of an operable window should pivot so it may be cleaned from inside the building.

Glare

Consideration of glare control plus heating and cooling loads must be factored into decisions on number and placement of windows.

Glazing

The choice of single, double, or triple glazed windows should be based on climate and energy conservation and security requirements. Use thermally broken frames when double and triple glazing units are specified. Highly reflective glass that produces mirror images should be used with care to avoid creating glare in surrounding streets and buildings. Note: Clear glazing is also available to meet a fire protection rating.

The use of wire glass should be avoided unless required to meet a fire protection rating.

Entrance Doors

Entrance doors may be aluminum and/or glass of heavy duty construction. Glazed exterior doors and frames must be steel and meet the requirements of SDI Grade III with a G-90 galvanic zinc coating. Vestibules are desired to control air infiltration. Sliding automatic doors are preferred over swinging type. Motion detectors and push plates are preferred over mats as actuating devices.

All public entrances provided in accordance with Paragraph F206.4.1 (Public Entrances) of the ABAAS must have at least one entrance door complying with Section 404.3 (Automatic and Power-Assisted Doors and Gates). Where a public entrance has a vestibule with exterior and interior entrance doors, at least one exterior door and at least one interior door must comply with Section 404.3.

Loading Dock Doors

Overhead coiling doors are preferred for loading docks. At least one personnel door should be provided in addition to the overhead doors.

Hardware for Exterior Doors

Hinges, hingepins, and hasps must be secured against unauthorized removal by using spot welds or peened mounting bolts. All exterior doors must have automatic closers. The exterior side of the door must have a lock guard or astragal to prevent jimmying of the latch hardware. Doors used for egress should not have any operable exterior hardware. See Chapter 7, Fire Protection and Life Safety, and Chapter 8, Design Standards for U.S. Court Facilities, for additional information.

Roof Systems

Roofing Design

Roofing design must follow the recommendations of the National Roofing Contractors Association as contained in NRCA publication, *NRCA Roofing and Waterproofing Manual.* The design of metal flashing, trim, and roofing must follow the recommendations of the Sheet Metal and Air Conditioning Contractors' National Association publication, *Architectural Sheet Metal Manual.*

Four guiding principles for low slope roofing include:

- Insulations or insulating assemblies that are highly resistant to water and physical damage
- Assemblies that position the roof membrane directly over a permanent or semi-permanent substrate
- Designs that prohibit or highly discourage the entrapment of water within the roof assembly
- Membrane and insulation designs capable of in-place reuse or recycle in future roof iterations

A vegetative roof must be constructed utilizing only an Inverted Membrane Roof Assembly (IRMA). The waterproofing membrane must be fully bonded to the substrate, seamless with an overburden consisting of a protection course, root barrier, drainage layer, insulation, moisture-retention layer, reservoir layer, filter fabric layer, and engineered soil-based growth medium with plantings. If trayed systems are employed, they must be installed above the insulation layer and be designed to resist wind uplift via tie down or some other methodology.

Re-Roofing

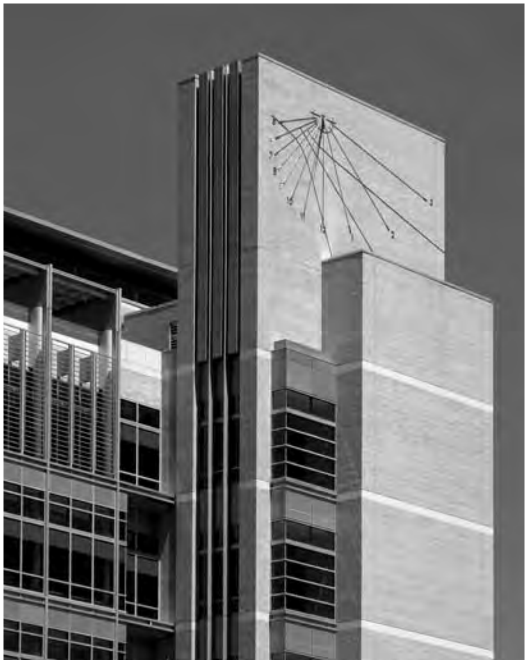
Where existing roofing is to be replaced, it should be completely removed and the substrate prepared for new roofing. The new roofing system should not be of greater weight than the old roofing system, unless a structural analysis shows that the framing system can carry the additional weight. Do not overlay new roofing membrane systems over existing roof membranes. Installing new roofing systems over an existing roof will place additional load on the building structural system and may trap moisture remaining in the original roof. This trapped moisture can facilitate the premature deterioration of the building materials.

Access to the Roof

An interior permanent stair must be provided to permit access to roof-mounted equipment. Permanent access to all roof levels must be provided to facilitate reoccurring inspection and maintenance.

Alfred A. Arraj
United States Courthouse
Denver, Colorado

Photovoltaic panels containing solar cells are installed on the top of the building's tower.



Roof Drainage

Roof drains or scuppers are the only low points permitted. For low slope roofing provide slope to the structural deck wherever possible. For other than IRMA assemblies provide a minimum slope to drains of 1:50 on roofing surfaces.

Insulation

Roof insulation should use multiple layers to maximize thermal breaks in the roof system.

Roof Mounted Equipment

Roof mounted equipment must be kept to a minimum and must be housed in penthouses or screened by walls. Penthouses and screen walls should be integrated into the building design and constructed of materials used elsewhere in the building exterior. Some roof-mounted equipment, such as antennae, lightning rods, flagpoles, etc., do not have to be screened, but these elements must be integrated into the building design. Roof-mounted equipment should be elevated as recommended in the *NRCA Roofing and Waterproofing Manual* and set back from the roof edge to minimize visibility. Critical roof-mounted equipment should be installed in such a way to permit roof system replacement or maintenance without disruption of equipment performance.

Penetrations through the roof to support equipment are extremely vulnerable to leaks. Flashing details must be studied for appropriate continuation of the waterproof barrier. Do not use pitch pockets as part of the roof design.

BEST PRACTICE

ROOF PENETRATIONS

The roof structure should consider the future addition of multiple antennae. An integrated anchoring system such as light c-channel should be installed on parapets to eliminate subsequent multiple and varied attachment methods. Cable trays leading to a roof penetration to a utility room or chase should also be considered. The intent is to eliminate or reduce haphazard antenna installations, cable routing that presents a trip hazard and interferes with building maintenance, and multiple roof penetrations.

No building element may be supported by the roofing system except walkways. Provide walkways on the roof along routes to and around equipment for maintenance.

When installing roof top photovoltaic systems, consult with the local building and fire departments for additional access and safety requirements.

Exterior Soffits

Design exterior soffits to resist displacement and rupture by wind uplift. Design soffits for access to void space where operating equipment is located or maintenance must be performed. Soffits can be considered totally exposed to weather and should therefore be designed to be moisture resistant. Provide expansion and contraction control joints at the edges and within the soffit. Spacing and configuration of control joints should be in accordance with the recommendations of the manufacturer of the soffit material.

Operating equipment or distribution systems that may be affected by weather should not be located inside soffits. Where it is necessary to insulate the floors over soffits, the insulation should be attached to the underside of the floor construction so that the soffit void may be ventilated to prevent condensation.

Skylights and Sloped Glazing

Skylights are defined as prefabricated assemblies shipped ready for installation, while sloped glazing is defined as field-assembled. Skylight design must follow the guidelines of AAMA Standard 1600. For the design of sloped glazing, two AAMA publications are available: *Glass Design for Sloped Glazing* and *Structural Design Guidelines for Aluminum Framed Skylights.*

Skylights and sloped glazing should use low emissivity glass. Placement should be calculated to prevent glare or overheating in the building interior. Condensation gutters and a path for the condensation away from the framing should be designed.

Consideration must be given to cleaning of all sloped glazing and skylights, including access and equipment required for both exterior and interior faces.

Skylights must be guarded for fall protection or meet OSHA structural requirements.

Edge Protection

Flat roofs designed for access must include a parapet or perimeter railing at least 42 inches in height.

Where parapets and railings are not feasible, personal fall protection anchorage points must be provided. Equipment should be located away from roof edges and oriented with access panels inboard of the roof edge.

Quality Assurance

Mockups

Many unique contemporary building solutions require full scale, laboratory, and on-site mockups of critical portions of the building facade. The testing of the laboratory mockup almost always assists in determining the final design solution. Mockups should be constructed by same team that will construct the facade.

Air Barrier Testing

For new construction, demonstrate performance of the air barrier system for the building enclosure by the following:

- Test the completed building and demonstrate that the air leakage rate of the building enclosure does not exceed 0.4 cfm/ft^2 (2.0 L/s/m^2) at a pressure differential of 0.3 in. w.g.(75 Pa). The test methodology used should be selected and tailored for each specific project by the testing agency, and approved by the Government.

Acceptable test methods include:

ASTM E779, Determining Airtightness of Buildings Air Leakage Rate by Single Zone Air Pressurization

ASTM E-1827, Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door

CGSB 149.15, Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems

Tests can be conducted using either pressurization or depressurization: conducting both provides diagnostic information. The building must not be tested until verifying that the continuous air barrier system has been installed as per the design in accordance with installation instructions.

Sun Control Devices

To reduce solar gain, provide exterior sunscreens in addition to interior daylight control devices. Steeply angled fins or large-scale scrims are preferred to flat horizontal fins.

Where sun control devices are used, operable and fixed sun control devices must be used, which allow for ease of maintenance, repair, and replacement. Window washing systems used for the facility must also be compatible with any sunscreens or sun control devices.

Daylight shading controls must be programmable and calibrated with a daylight sensor to control direct sun penetration and minimize energy consumption.

Projecting exterior sunscreens may be used in addition to interior daylight control devices where they are beneficial for building operation and energy conservation.

Sunscreens and sun control devices must be compatible with the window washing system.

Window Cleaning

The facility must have provisions for cleaning the interior and exterior surfaces of all windows, skylights, and other glazed openings. The A/E must demonstrate that cleaning and maintenance of interior glazing surfaces and equipment (lighting, smoke detectors, and other systems that are mounted within atrium spaces) can be achieved without extraordinary means and methods. Submit this information with the construction documents.

The design of the building must include provisions for cleaning the interior and exterior surfaces of all windows. Consider the selection of self-cleaning (e.g., TiO_2) glass to reduce the need for exterior window washing. A cost benefit analysis is required for this option.

Providing Access to Elevated Locations

Suspended scaffolding and boatswain's chairs are typically used for window washing, building inspection, and maintenance. The most common configurations include:

- Attachment to davits
- Attachment to cantilevered outriggers
- The use of temporary structural attachments (parapet clamps, cornice hooks, roof hooks, and similar systems)
- Permanent engineered systems

The provision of stanchions with moveable davits is the preferred design. Davits eliminate the need to transport cantilever systems and the necessary counterweights to the roof, reducing the risk of roof damage. Stanchions must be spaced to accommodate expected scaffold lengths. Pitch pockets for waterproofing purposes are not allowed.

If temporary structural attachments are anticipated, the structure must be designed to support the work platform load, including OSHA safety factors.

In some cases, GSA may decide to install engineered systems for window washing and access to elevated locations that must be incorporated into the building design. If the design is for buildings three stories or 12,200 mm (40 ft.) and higher, it must conform to OSHA Standard 29 CFR 1910.66, Subpart F–Powered Platforms, Man Lifts, and Vehicle-Mounted Work Platforms, ANSI Standard A120.1, Safety Requirements for Powered Platforms for Building Maintenance, and ANSI/IWCA I-14.1-2001, Window Cleaning Safety.

While engineered systems are convenient to use, the building owner, public or private, has the responsibility to maintain and certify the equipment, including the scaffold. Elaborate systems such as multipoint suspension scaffolds that use tracks and rollers can require multiple roof penetrations and impede general maintenance access on and about the roof.

Regardless of the system selected, secondary tieback anchors must be provided in the vicinity of anticipated suspended scaffold operations. Anchors must be designed to support a 5,000-pound load in any direction. Where feasible, anchors must be located to facilitate routine inspection and load testing.

Facade tiebacks must be provided on buildings over 75 feet high. Facade tiebacks prevent wind-induced scaffold kickout and uplift. Integrated systems such as channels eliminate the need for contractors to drill into the facade or improvise attachments.

Window-washing systems that are widely used in the region of the project must be considered and the preferred system and equipment be identified during design. In large and/or highrise buildings, such glass surfaces as atrium walls and skylights, sloped glazing, pavilion structures, and windows at intermediate design surfaces must be addressed.

3.15 Interior Facility Elements

For finishes refer to Section 3.16, Interior Finishes.

Partitions

Partitions should be selected for use based on the type of space and the anticipated activity within that space. For subdividing within tenant areas, preference should be given to the use of prefinished, demountable partitions that can be easily relocated with a minimum of time and waste. The following should be evaluated: the volume of people; their activities; the type, size, weight, and function of equipment (mail carts, forklifts, etc.) that will be used in the space; and any free-standing, moveable or wall-mounted equipment that will impose lateral loads (built-ins, wall-mounted televisions, etc.).

Each potential wall system must be evaluated for structure, backing, finish, and protection factors. GSA prefers partition systems that are simple to construct, made from readily available materials, economical, and easily moved and reassembled by common laborers.

Metal stud systems must meet the requirements ASTM C754. The application and finishing of gypsum board should follow standard ASTM C840. Adequate tolerances should be designed where the top of a partition abuts the underside of the building structure; allow for deflection and long-term creep.

Partitions used at the perimeter of a humidified space must include a vapor barrier. In computer rooms the need for air plenum dividers below the floors must be checked.

Interior Doors

Interior doors in tenant spaces should be flush, solid-core wood doors. Steel doorframes should meet the requirements of SDI Recommended Erection Instructions for Steel Frames. Provide matching-edge veneers for transparent-finished wood doors. Avoid the use of wood doorframes except to match wood doors in specially designed areas.

Ceiling Suspension Systems

The design of suspension systems for acoustical ceilings must meet the requirements of ASTM C.635 for heavy-duty systems and ASTM C.636.

Facility Specialties

Waste Removal Equipment

Waste is normally removed from GSA buildings by contract maintenance firms. The firm will usually collect the waste from receptacles in the occupied spaces into carts, which will be taken to larger containers at the waste pickup station. The firm will usually provide the containers as part of its contract.

The minimum architectural requirements for waste removal are: access for waste handling equipment from the occupied areas of the building to the pick-up station; housing for the on-site containers; and maneuvering space for the collection vehicles. In calculating numbers of containers, assume separate containers for recyclable materials (paper, bottles and cans, metals, and other materials). Waste handling stations must be completely screened by walls and doors or gates constructed of materials complementary to those of the building.

Toilet Partitions and Accessories

Toilet partitions must be ceiling hung. They should be metal or similarly durable construction. A large, continuous mirror must be provided on at least one wall of each toilet room.

The following toilet room accessories must be reviewed and coordinated with the operations and building management staff. Verify and get approval from the building management for the selection and placement of the following commercial grade products:

- Toilet paper dispensers
- Toilet seat cover dispensers
- Paper towel dispensers and/or hand dryers
- Soap dispensers
- Waste receptacles
- Feminine hygiene product dispensers and disposal receptacles (only for women's, unisex, and family restrooms)
- Baby changing stations (only in toilet rooms that serve the public and family restrooms)
- Mirrors
- Grab bars
- Clothing hooks

Locker Rooms

Gypsum wallboard must not be used as a substrate for any shower room surface. Cover floors with hard surfaces that can be disinfected. Lockers should be raised off of the floor for cleaning. Locker rooms will have the following elements:

- Lockers with integrated combination locks or padlocks (by employees)
- Benches
- Separate wet and dry locker room functions
- Toilet room fixture counts coordinated with occupant load
- Floor drains
- Shower stall curtains
- Shower room accessories: Soap dish, shampoo/soap niche ledge, shower curtains, benches
- Hair dryers (hand dryers mounted high)
- Individual stalls
- Full-length mirrors (for dressing)

Drinking Fountains

At least one water fountain should be provided on every floor near toilet rooms and near auditoria. One drinking fountain per location, and 50 percent of all fountains in the facility, must be accessible to disabled persons per ABAAS. Retain original fountains in historic buildings, retrofitting hardware and remounting, when possible, to provide access for the disabled. Where modifying historic fountains is not practical (e.g., fountain mounted in stone or other ornamental wall), supplement with new fountains of similar materials and detailing to original fountains.

3.16 Interior Finishes

Building Design Standards

The A/E must establish Building Design Standards when designing the building for the purpose of creating guidelines for all future interventions and alterations. This will ensure a cohesive, consistent, and streamlined approach for the building's long-term design. When selecting any finishes for projects in federally owned space, refer to the Building Design Standard established for that particular building as listed in the Asset Business Plan.

Minimum Standards for Finishes

GSA provides a tenant improvement allowance for finishes and features within its rental charge. The tenant may accept the finishes established as part of the allowance or choose to upgrade at their expense, if they comply with the Building Design Standards previously established by the building designer. Codes, Executive Orders, and LEED requirements may have a bearing on the type of finishes in an area and must be consulted. For fire safety requirements, see Chapter 7, Fire Protection and Life Safety, Interior Finishes.

Designers must specify, where practical, finishes that contain recycled, renewable, and/or reusable materials and that eliminate or minimize the release of harmful substances during installation and use. Finishes must be specified based on the value they provide over their useful life; considerations include maintenance and disposal costs in addition to first cost.

Carpet

All GSA carpet selections must meet the NSF/ANSI 140 Standard, USDA Biobased carpet recommendations, and comply with the *GSA Carpet Specification Guide,* see Appendix D.

When selecting carpets, colors in the medium range are preferred and show the least amount of stain and soiling. Dark and light colors should be avoided, especially in high-trafficked areas. Carpet tile is preferred and must be used whenever there is access flooring, a cellular floor, or a ducted floor system. This will ensure ease of maintenance of the systems under the floor and also in carpet replacements. The amount of foot traffic should be considered when selecting carpet types and colors.

Resilient Floor

Resilient flooring materials include products such as linoleum, rubber, cork, and vinyl. All linoleum products must be made with ether recycled or renewable ingredients, linseed oil, cork dust, natural jute fiber, or wood powder salvaged from sawdust. Adhesives used to install resilient flooring must be 100 percent solvent-free and meet low-VOC requirements. Avoid surfaces that require extensive use of volatile cleaning and waxing compounds. Resilient flooring may be used in office spaces to support tenant requirements and promote improved indoor air quality, and in offices adjacent to utilitarian spaces such as loading docks.

Table 3-3

Materials Selection

Materials to Avoid	Materials to Use

Materials to Avoid

This list reflects the industry best practice of materials to avoid. The intent is to remove the worst known offending materials from a health standpoint, and to reduce and offset the environmental impacts associated with the construction process. The ideal is a future where all materials in the built environment are safe and replenishable and have no negative impact on human and ecosystem health. The precautionary principle guides the list of best practice materials decisions. The PHAROS protocol (**www.pharosproject.net**), developed by the Healthy Building Network, is a valuable framework for evaluating sustainable materials and a progressive tool for consumer benefit.

Additionally, projects are encouraged to eliminate all known persistent bio-accumulative toxins, carcinogens, and reproductive toxicants (source: the Living Building Challenge v 1.0, Draft Version 1.1, December 2006).

As a best practice, the A/E is strongly encouraged not to specify any products containing any of these materials or chemicals:

- No added formaldehyde
- Halogenated flame retardants (halogenated flame retardants include PBDE, TBBPA, HBCD, Deca-BDE, TCPP, TCEP, Dechlorane Plus, and other retardants with bromine or chlorine)
- PVC (an exception is made for PVC in wiring applications where it is mandated by code)
- Mercury (an exception is made for low-mercury fluorescent lighting)
- CFCs
- HCFCs
- Neoprene (chloroprene)
- Cadmium
- Chlorinated polyethylene and chlorosulfonated polyethylene (HDPE and LDPE are excluded)
- Wood treatments containing creosote, arsenic, or penta-chlorophenol
- Polyurethane
- Lead (an exception is made for solder and off-grid solar battery systems only)
- Phthalates

Materials to Use

Biobased and Rapidly Renewable Content in Construction Materials

The project material selection will prioritize biobased and rapidly renewable content in construction materials per Executive Orders 13423 and 13514. GSA is required to buy biobased content products as designated by the USDA BioPreferred Procurement Program. For other products, the A/E must specify biobased products made from rapidly renewable resources and certified sustainable wood products either through FSC (Forest Stewardship Council) or SFI (Sustainable Forestry Initiative) or from salvaged sources.

Recycled Content in Construction Materials

The project material selection must prioritize recycled content materials (postconsumer preferred) per Executive Order 13423. GSA is required to buy recycled-content products that meet or exceed the recycled content recommendations as designated by EPA through the Comprehensive Procurement Guidelines (CPG). Exceptions will be permitted only if written justification is provided when a product is not available competitively, not available within a reasonable period, does not meet appropriate performance standards, or is only available at an unreasonable price. For other products, the sum of postconsumer recycled content plus one-half of the preconsumer content must constitute at least 10 percent (based on cost) of the total value of the materials in the project.

**Wayne Lyman Morse
United States Courthouse
Eugene, Oregon**

Natural light pours in through glass walls, clerestories, and skylights, to animate the curving white walls of the public spaces.

Table 3-4

Finish Selections for Indoor Air Quality

Paints and Coatings

All interior paints and coatings used on the project must meet the following standards for volatile organic compound (VOC) off-gassing:

- Topcoat paints: Green Seal Standard GS-11, Paints, First Edition, May 20, 1993.
- All other architectural coatings, primers, and undercoats: South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, effective January 1, 2004.

Architectural paints, coatings, and primers applied to interior walls and ceilings	grams per liter
Flats	50 (g/L)
Nonflats	150 g/L
Anticorrosive and antirust paints applied to interior ferrous metal substrates	250 g/L
Clear wood finishes:	
Varnish	350 g/L
Lacquer	550 g/L
Floor coatings	100 g/L
Sealers:	
Waterproofing sealers	250 g/L
Sanding sealers	275 g/L
All other sealers	200 g/L
Shellacs:	
Clear	730 g/L
Pigmented	550 g/L
Stains	250 g/L

Use reprocessed latex paint in accordance with EPA's CPG and biobased paint on all painted surfaces where feasible. The A/E must require reprocessed latex paint be submitted and approved. Follow the manufacturer's recommendations for the application and maintenance of all paint products.

Adhesives and Sealants

All adhesives and sealants used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) must comply with the requirements of the following reference standards:

- Biobased adhesives and sealants in accordance with USDA's BioPreferred guidelines
- Adhesives, sealants, and sealant primers: SCAQMD Rule 1168 with a corresponding effective date of July 1, 2005, and rule amendment date of January 7, 2005.
- Aerosol adhesives: Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

Architectural Applications	VOC Limit (g/L Less Water)
Indoor carpet adhesives	50
Carpet pad adhesives	50
Wood flooring adhesives	100
Rubber floor adhesives	60
Subfloor adhesives	50
Ceramic tile adhesives	65
VCT and asphalt adhesives	50
Drywall and panel adhesives	50
Cove base adhesives	50
Multipurpose construction adhesives	70
Structural glazing adhesives	100
Specialty Applications	
PVC welding	510
CPVC welding	490
ABS welding	325
Plastic cement welding	250
Adhesive primer for plastic	550
Contact adhesive	80
Special-purpose contact adhesive	250
Structural wood member adhesive	140
Sheet applied rubber lining operations	850
Top and trim adhesive	250

Substrate-Specific Applications	VOC Limit (g/L Less Water)
Metal to metal	30
Plastic foams	50
Porous material (except wood)	50
Wood	30
Fiberglass	80
Sealant Primers	
Architectural nonporous	250
Architectural porous	775
Other	750
Sealants	
Architectural	250
Nonmembrane roof	300
Roadway	250
Single-ply roof membrane	450
Other	420
Aerosol Adhesives	
General-purpose mist spray	65% VOCs by weight
General-purpose web spray	55% VOCs by weight
Special-purpose aerosol adhesives (all types)	70% VOCs by weight

Floor Perimeter Base

Where specified, floor perimeters must use a wall base made of materials that provide long-term durability for the use intended. Preferred base includes a low-emitting, natural, and recyclable material such as, wood, stone, terrazzo, ceramic tile, and recycled vinyl or rubber.

Wall Covering

Use wall covering that will maintain an acceptable appearance in the location used for a minimum of 10 years. Wall coverings must be those that use nontoxic, permeable, PVC free, bio-based, renewable or recyclable, materials with low-VOC (volatile organic compound) or VOC-free adhesives weighing not less than 13 ounces per square yard or equivalent. Examples of these materials include, but are not limited to, recycled cotton, sustainably harvested wood, jute, sisal, wool, polyester, polyethylene, and vinyl. Other wall covering examples include, but are not limited to, stone and other hard surface elements that meet code requirements, GSA specs, and Building Design Standards. In the event the Government chooses to install a high-performance paint coating in lieu of a wall covering, the minimum standard is low-VOC Green Seal Standard GS-11.

Window Covering

Provide adjustable window coverings at all windows that are appropriate to the elevation, sun exposure and daylighting, and operable window strategies. Provide controls for coverings on clerestory and atria windows. As applicable to support building performance, provide automated blinds that respond to sun angle and internal temperatures. Blinds and sun-filtering shades are preferred over draperies, which have limited adjustments and are difficult to clean and maintain.

Interior Doors

The finish for doors in general office spaces should be limited to a paint grade finish, wood, wood veneer, glass, or glass front. Glass doors may be used at entrances to tenant suites. Refer to the Building Design Standards.

Architectural Woodwork

For all new installations of wood products, use independently certified forest products. For information on certification and certified wood products, refer to the Forest Certification Resource Center (**www.certifiedwood.org**), the Forest Stewardship Council United States (**www.fscus.org**), or the Sustainable Forestry Initiative (**www.aboutsfi.org**).

Wood products used must not contain wood from endangered wood species, as listed by the Convention on International Trade in Endangered Species. The list of species can be found at the following website: **www.cites.org/eng/resources/species.html**.

Particle board, strawboard, and plywood materials must comply with Department of Housing and Urban Development (HUD) standards for formaldehyde emission controls. Plywood materials must not emit formaldehyde in excess of 0.2 parts per million (ppm), and particleboard materials must not emit formaldehyde in excess of 0.3 ppm. All materials composed of combustible substances, such as wood plywood and wood boards, must be treated with fire retardant chemicals by a pressure impregnation process or other method that treats the materials throughout as opposed to surface treatment.

U.S. Census Bureau Headquarters
Suitland, Maryland

Sustainability was a priority in the design of the headquarters, and paramount in the choice of materials.

Finishes for Public Space

Entrances and Vestibules

Select durable, moisture-resistant materials for entrances and vestibules.

The depth of vestibules should be no less than 2,100 mm (7 ft.) to minimize air infiltration. Provide means to prevent dirt and moisture from accumulating on the entrance lobby floor. Use walk off mats and grate systems at the building entry.

Corridors

Public corridors should be designed in such a way that each part of the building correlates with each other, keeping a holistic and consistent design approach. Wayfinding should be reflected in the material, colors, and placement of finishes. Corridors that carry significant foot traffic and provide major circulation pathways throughout the building must have materials selected that are extremely durable and require low maintenance. To improve acoustic control in corridors adjacent to work spaces, avoid specifying hard, reflective surfaces.

Doors along public corridors should be of a quality equivalent to that of other elements in these spaces and higher quality than those in the interior spaces. The finish on both sides of the door should match. At interior spaces with high levels of public use, provide glazed entry door systems along public corridors.

Stairways

For all open, internal, and circulation stairways use finishes that match or relate to the adjacent spaces. For stair treads, use noncombustible resilient materials with nonslip nosing on the treads. Wall surfaces in these areas should be drywall substrate with a simple, straightforward finish such as paint or wall covering. Absorptive materials are desirable in stairways for their acoustic effect. Stair runs should have painted gypsum board soffits where appropriate.

Doors between adjacent building areas and stairways should match other doors in the building areas. Doors should have the same finish on the interior and exterior.

In stairways used for utility purposes or only for emergency egress, unfinished or painted surfaces are appropriate. Always provide nonslip nosings on the treads. Utility and egress stair doors should be painted metal.

Elevators

Passenger elevators usually receive the highest amount of traffic in the facility. Their finishes should relate to the entrance and lobby areas and should be focal points for the interior design of the building. Although finishes need to be durable, high-quality architectural design of cabs and entrances is a priority. Surfaces should be scratch resistant and easily replaced or refinished.

Hard surface floors, such as stone, brick, or tile, are usually poor choices because cab floors tend to be unstable. Over time, grouted materials often loosen or crack. Carpet, wood, or high-quality resilient materials are better choices and perform well acoustically. Use carpet materials with low pile height and high density.

Wall materials must present a high-quality image and be sufficiently durable to take some abuse. Materials must be installed on removable panels or other replaceable devices to facilitate maintenance and renewal of finishes. Ceilings must be replaceable. In passenger elevators recessed down-lights or indirect fixtures should be used.

Finishes for freight elevators must be very durable and easy to clean. Stainless steel walls and doors are preferred. Flooring must be sheet vinyl or resilient vinyl tile. Ceiling light fixtures must be recessed and protected from possible damage.

Elevator and Escalator Lobbies

Elevator and escalator lobbies should harmonize with the finishes used in the main entrance lobby or atrium. These elements are functionally related to the public entrance and lobby areas and, therefore, should be treated with the same level of finish and compatible materials as those spaces. It is appropriate to introduce special floor, wall, and ceiling treatments, and distinctive lighting that should be repeated on the upper floors for consistency.

Finishes for Tenant Space

This category of space comprises a large proportion of area in Federal buildings. Designers should select where possible and practical, recycled content materials that are local or regional. When altering existing tenant space, consider salvaged materials such as beams and posts, flooring, paneling, doors, frames, cabinetry, brick, and moveable walls.

Office spaces characteristically change with their occupants, occupancy configurations, and utility requirements. Moveable wall systems should be considered for maximum flexibility. Interior finishes should allow these transformations to occur with minimal disturbance and cost.

Carpet tiles should be used on raised access floor. Carpet tiles must be adhered to floor panels with a VOC (volatile organic compound) with a limit (g/L less water) of 50. Adhesive-free installation is preferred.

The majority of the ceiling system for general office space must be suspended acoustical materials to allow for accessibility. Grid size and spacing should be based on the building-planning module. Limited use of drywall soffits must be used to delineate space and provide relief from open expanses of acoustical tile materials. Drywall ceilings must be located only where maintenance access is not required.

The finish for solid core wood doors in general office spaces should be limited to a paint grade finish and stained or painted with low-VOC or VOC-free paints and stains. Glass doors may be used at entrances to tenant suites.

Finishes for Training and Conference Rooms

These areas should be finished at levels of quality equivalent to but differentiated from the adjacent office areas. The material choices and spatial configurations should be appropriate for the use of the space. In addition, the application of tackable acoustic wall panels, whiteboard wall coverings and rails for the display of presentation materials within these spaces is appropriate. Coordinate all lighting, audiovisual, communication, and technology requirements with the building systems.

Customer Specific Finishes

Court buildings, border stations, and child care centers have special requirements for finishes. See the respective design guides for finish requirements.

Finishes for Building Support Space

Toilet Rooms

Continuous vanities of stone, artificial stone, or solid surface material must be designed for lavatories. Sinks must be under-mounted.

Toilets are part of the permanent building core and must be designed with good quality, long-lived finishes.

- General-use toilets—Toilets are part of the permanent building core and must be designed with good quality, long-lived finishes. They are an extension of the public spaces of the building. Toilet partitions must be suspended from the ceiling or extended from walls to expedite cleaning and avoid soil buildup at floor supports.
- Use ceramic or porcelain tile for the floors and walls in toilet rooms. Carefully chosen patterns and colors can enhance the design image.
- Seamless vanities of stone, artificial stone, or solid-surface material must be designed for lavatories. Lavatory bowls must be under-mounted and have front lips that keep water from spilling onto the floor.
- Provide a large, continuous mirror on at least one wall of each toilet room.

Locker Rooms

Use ceramic or porcelain tile for the floors and walls in locker rooms. Ceilings must be solid with water resistant finishes.

Table 3-5

Indoor Air Quality Before Occupancy

The A/E must specify a flush-out before occupancy using the following parameters:

- After construction ends and with all interior finishes installed, new filtration media must be installed and the building flushed out by supplying a total air volume of 14,000 ft^3 of outdoor air per ft^2 of floor area while maintaining an internal temperature of at least 60º F and, where mechanical cooling is operated, relative humidity no higher than 60 percent.
- The space can only be occupied following the delivery of a minimum of 3,500 ft^3 of outdoor air per ft^2 of floor area to the space, and provided the space is ventilated at minimum rate of 0.30 cfm/ft^2 of outside air or the design minimum outside air rate, whichever is greater, a minimum of three hours before occupancy and during occupancy, until the total of 14,000 ft^3/ft^2 of outside air has been delivered to the space.

Storage Rooms

Storage rooms will have painted walls and VCT flooring.

Mechanical, Electrical, and Communication Spaces

Walls and ceilings of all equipment and maintenance shops should be gypsum board, concrete masonry surfaces or other durable surfaces; exposed batt or other forms of insulation should not be used at wall surfaces. Paint walls and ceilings in mechanical and electrical spaces. Floors will be sealed or painted concrete.

Table 3-6

Construction Waste Management

The A/E must specify that the contractor develop a plan for construction waste management to divert at a minimum 50 percent of construction waste materials. As industry best practice, these percentage levels per material type are strongly encouraged:

Material	Best Practice Percentage Diverted
Metals	95%
Paper and cardboard and plastic wraps	95%
Rigid foam, carpet, and insulation	90%
All others*, combined weighted average	80%

*Asphalt; concrete and concrete blocks; brick, tile, and masonry materials; untreated lumber; plywood, oriented strand board, and particle board; gypsum wallboard scrap; glass; plumbing fixtures; windows; doors; cabinets; architectural fixtures; millwork, paneling, and similar; electric fixtures, motors, switch gear, and similar; HVAC equipment, duct work, control systems, switches.

Custodial Spaces

Janitor's closets will have painted walls and ceramic tile floor and base.

Maintenance Shops

Maintenance shops will have painted walls and waterproof floors.

Building Engineer's Office and Security Control Center

The building engineer's office and security control center will have painted walls and vinyl tile floors.

Finishes for Specialty Areas

Food Service Areas

These areas are operated under concession agreements. Finishes are governed by health regulations and the requirements of the concessionaire. Designers should coordinate their work with the GSA handbook *Concession Management Desk Guide* PMFC-93.

Kitchens/Lounge Areas

This section describes smaller kitchens typically used by employees. Flooring in these kitchens should be resilient. Walls should have durable, washable finishes such as vinyl wall covering or ceramic tile, depending on intensity of use. Ceilings should be acoustic material with consideration given to the use of moisture resistant ceiling materials in kitchens with higher humidity.

3.17 Artwork

The A/E lead designer is substantially involved in the integration of art into the design of new or existing Federal buildings and must personally participate as a member of the Art in Architecture panel (see Introduction for brief description of panel's responsibilities).

The Art in Architecture project begins concurrently with the selection of the A/E and is timed so that the artist or artists have sufficient time to collaborate with the A/E on integrating their work into the overall design concept for the building.

Please consult the Art in Architecture Program Policies and Procedures.

When artwork from the Fine Arts Collection, including works previously commissioned through the Art in Architecture program, is installed in or on the grounds of a Federal facility, GSA policy is to retain the existing location of the artwork. The funding available for art will be used to conserve the artwork, to enhance its presentation, and to provide interpretive information such as a plaque.

For more information, please consult the Fine Arts Policies and Procedures.

Cris Bruch, Artist
Shortest Distance

Wayne Lyman Morse
United States Courthouse
Eugene, Oregon

Artist Cris Bruch was one of four artists commissioned by the Art in Architecture program to create works for the new courthouse. *Shortest Distance* is installed on the front plaza.

3.18 Signage

Signage Master Plan

A proposed Signage Master Plan inclusive of facility interior through the areas covered by the First Impressions Program, including parking areas, must be developed by the A/E and reviewed by the regional chief architect and the First Impressions program manager for consistency and design before fabrication and installation. Signage must identify site entrances, parking, and the main building entrance. Contact the GSA First Impressions National program manager for additional information regarding signage in Federal facilities.

Note: Site signage is found in Chapter 2.

Graphics and signs must be clear and simple, and must be standardized to ensure easy identification of the building entrance, parking, and all the tenant agencies and services located in the building. Signs combining pictograms and printed messages are recommended for a more universal understanding. Sign design must comply with ABAAS; Underwriters Laboratory (UL)— Illuminated Signs Standard; and OSHA standards for safety signs.

Signage in historic buildings must be compatible with original designs, using historic finishes, colors, and typefaces. Typefaces must be acceptable within ABAAS requirements; signs required to comply with ABAAS must have sans serif characters.

Signage must be designed to be adjustable for tenant moves and changes. These techniques should be specified to ensure easy maintenance and compatible expansion.

Integrating electronic monitors and other available new technology is an important design consideration. Employing electronic means to display building amenities, missing persons, Federal job postings, building-related messages, and other public notices makes updating easier and reduces clutter. While using new technology is useful and conveys progress, it is important that these installations be successfully integrated into the building's architecture, most particularly in historic buildings.

Additional information about GSA graphic standards can be found at **www.gsa.gov/logo**.

Cornerstone

A cornerstone is required for all new buildings as a part of the exterior wall. The cornerstone must be a cut stone block having a smooth face of size adequate to present the following incised letters: UNITED STATES OF AMERICA, (PRESIDENT'S NAME), PRESIDENT, GENERAL SERVICES ADMINISTRATION, (ADMINISTRATOR'S NAME), ADMINISTRATOR, (YEAR OF PROJECT COMPLETION). Only these two names are allowed on the cornerstone. The words UNITED STATES OF AMERICA should be in letters 50 mm (2 in.) high and other letters should be proportionally sized by rank.

All names should be those individuals in office at the time construction funds were appropriated, if construction is completed during a subsequent President's term of office.

Emergency Evacuation Route Signage

Emergency evacuation route signage must be posted in a tamper-resistant frame or engraved on a placard that is mounted on the walls in each passenger elevator lobby, freight elevator lobby, and any mechanical spaces that may be occupied by contractors or other personnel not familiar with floor layouts and exit locations. The minimum size of the signage must be 8½ inches by 11 inches. This signage must be depicted in either landscape or portrait form depending on the architectural layout and orientation of the elevator lobbies at each floor. Provide labeling as required in PBS ORDER 3490.1.

The signage must consist of a CADD-generated floor plan for each floor with the evacuation routes identified (show routes to two different exits with directional arrows). Provide a "YOU ARE HERE" designation pointing directly to the sign's final installed orientation. Also, provide a main heading titled "EVACUATION PLAN." This signage may contain a zoomed-in core area of the building (for a larger view of routes) if all evacuation routes and evacuation stairways are legibly shown. The signage must contain a legend for clarification purposes of any additional items shown on these evacuation plans. For buildings that have occupant evacuation elevators and/or fire service access elevators, note on plans with the appropriate signage. For other buildings, include the following statement on plans "IN CASE OF FIRE DO NOT USE ELEVATORS—USE STAIRS," unless there have been acceptable elevators provided for emergency egress.

Registry of Builders and Designers

A plaque must be placed inside the building with the names of the individuals on the GSA project design team, the consultant architects and engineers, the on-site construction managers, and the construction workers inscribed on the plaque. The GSA project manager will provide the specifications for the design and construction of the plaque.

All signage in public areas of Federal buildings must comply with Federal, State, and local code requirements and must meet ABAAS requirements, UL—Illuminated Signs Standard, OSHA Standards for safety signs, and Federal Standard 795.

Standard Public Signs

This sign list distinguishes between mandatory lobby messages and those that are included due to a presidential directive or through tradition. Signage must mitigate clutter and be designed to be adaptable. A comprehensive, permanent, aesthetic system must be used.

Mandatory (messages that must be displayed before passing through security):

- Nonsmoking signs (with symbol) are to be placed by entry doors. (No smoking is allowed within 25 feet of a building entrance or opening).
- Accessible entry signs (with symbol) are to be placed at entry doors.
- Signs prohibiting weapons—Federal Weapons Warning (Title 18, Section 930) are to be placed by the security approach.
- Signs regarding search procedures—Federal Management Regulation—Rules and Regulations Governing Conduct on Federal Property (Title 41 CFR, Part 102-74,Subpart C) are to be placed by the guards' desk.
- Signs requiring display of Federal identification—Federal Management Regulation—Rules and Regulations Governing Conduct on Federal Property (Title 41 CFR, Part 102-74,Subpart C) are to be placed by the guards' desk.
- Rules and Regulations Concerning Public Buildings and Grounds—Federal Building Regulations (Title 41, 101-20.3).

Presidential Directive

- Missing Children Posting

Tradition

- Photographs of the President and Vice-President–Executive Branch Identification (sizes: 20x24 inches, 11x14 inches, 8x10 inches).
- The Bill of Rights, Constitution, and Declaration of Independence Charters of Freedom Display.

3.19 Alterations in Existing Buildings and Historic Structures

The general goal of alteration projects is to meet the P100 standards for new projects. Renovation designs must satisfy the immediate occupancy needs and anticipate additional future changes. As they are remodeled, building systems should become more flexible and adaptable to changing occupancy needs.

Alteration projects are defined at three basic scales: refurbishment of an area within a building, such as a floor or a suite; major renovation of an entire structure; and upgrade/restoration of historic structures.

In the first instance, the aim should be to satisfy the program requirements within the parameters and constraints of the existing systems. The smaller the area in comparison to the overall building, the fewer changes to existing systems should be attempted. Components, equipment, and construction should match the existing as much as possible to facilitate building maintenance.

In the second case, the opportunity exists to approximate the standards and flexibility of a new building, within the limits of the existing space and structural capacity.

Where a historic structure is to be altered, special documents will be provided by GSA to help guide the design of the alterations. The most important of these is the Building Preservation Plan, which identifies zones of architectural importance, specific character-defining elements that should be preserved, and standards to be

E. Ross Adair Federal Building and U.S. Courthouse Fort Wayne, Indiana

Originally a postal lobby, this first floor space retains its historic finishes and features: marble floors, marble walls, decorative plaster ceilings, and ornamental cast-aluminum door and window surrounds.

employed. Refer to pages 1-14 in The Secretary of the Interior's Standards for Rehabilitation and Guidelines for Historic Preservation. For some buildings a Historic Structures Report is also available. Early and frequent coordination between the architect, state historic preservation officer, regional historic preservation officer, preservation specialists, external review groups, and other appropriate GSA specialists is imperative to timely resolution of conflicts between renovation and preservation goals.

To the extent feasible, GSA seeks to achieve the rehabilitation of historic structures. Rehabilitation is defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features that convey its historical, cultural, or architectural values.

In general, alterations in historically significant spaces must be designed contextually to blend with original materials, finishes, and detailing, and to ensure a uniform and inviting first impression. When substantial repairs or alterations are undertaken in significant and highly visible locations, opportunities must be sought to restore original features that have been removed or insensitively altered, to re-establish the original design integrity of the space. Alterations affecting the configuration of significant spaces should be as transparent as possible, using glass and contemporary materials, as appropriate, to minimize the visibility of the alteration(s) while subtly distinguishing new construction from original construction.

The architectural, mechanical, and electrical systems in historic buildings often differ greatly from today's design and construction standards, and frequently many of these building systems need to be upgraded substantially or completely rebuilt or replaced. The end result should be a building whose architectural, mechanical, and electrical systems support its modern use while retaining its historic and architectural character.

Understanding the exact requirements of the user is essential to effectively implement the program for remodel projects. Close interaction between designers and users, to communicate and incorporate program information during the concept design phase, will enable the designers to meet the users' needs without incurring excessive construction cost. Practical solutions often develop in a dialogue with the users that would not have been relayed by an administrator.

Alteration design requires ingenuity and imagination. It is inherently unsuited to rigid sets of rules. Each case is unique. The paragraphs that follow are intended to be guidelines and helpful hints to be used when appropriate and disregarded when not.

Evaluation of Existing Systems

Every alteration project includes an evaluation that describes the physical condition of building systems, identifies variances from present codes, and notes available capacity for structural, mechanical, electrical, and communications systems.

Code Requirements for Alterations

For most major renovations an evaluation of code deficiencies is appropriate. See Chapter 1, Nationally Recognized Codes and Standards, Code Requirements for Alterations. Code deficiencies that relate to life safety, particularly egress, should be remedied. Strict adherence to the letter of the code is often impossible. An equivalent method of protection will have to be developed to achieve an equal or greater level of safety. See Chapter 1, Purpose of the Facilities Standards for the Public Buildings Service. Architects will be expected to work closely with the GSA regional fire protection engineer, who will have final authority on life safety code compliance issues. Alternative approaches outlined in state historic building codes, rehabilitation codes, and performance-based codes to resolve conflicts between prescriptive code requirements and preservation goals should be explored.

For alteration projects, meet current codes unless a special hazard is created by combining new and old systems. When such conflicts occur they need to be resolved with the GSA project manager.

See Chapter 7, Fire Protection and Life Safety, for additional information.

Asbestos in Renovation and Demolition Projects

The OSHA construction standard for asbestos contained in 29 CFR 1926.1101 requires that surfacing and thermal systems insulation in buildings constructed before January 1, 1981, be presumed to contain asbestos unless proven otherwise through sampling and testing. While buildings constructed after 1980 are not specifically regulated, OSHA still requires building owners to use due diligence to identify any suspect asbestos-containing material. In addition, the EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61) require that before the commencement of a demolition or renovation, the building owner or operator thoroughly inspect the affected facility where the demolition or renovation operation will occur for the presence of asbestos. NESHAP is silent regarding the age of the building. While the use of asbestos-containing building materials has declined significantly over the last few decades, it must be noted that asbestos has not been entirely banned. Even today asbestos sometimes finds its way into such products as drywall mud and flashing cement.

Therefore, before the design of a renovation or demolition project, an evaluation must be conducted to determine if asbestos is present in the project area. This evaluation includes the review of any available asbestos surveys and consultation with GSA regional environmental, health, and safety offices.

If asbestos is present, presumed, or suspected in the project area, a prealteration asbestos assessment must be performed to determine whether and to what extent asbestos may be disturbed (41 CFR 102-80.15). A site inspection is required. Presumed and suspected asbestos must be sampled and tested. Inaccessible areas affected by the project must also have “destructive” samples collected and tested.

Projects with the potential to disturb asbestos must include controls to protect the construction contractor, building occupants, the public, and the environment. GSA complies with State and local asbestos regulations where they exist, in addition to the Federal NESHAP, including notification requirements. Designers should consult with GSA regional environmental, health, and safety offices for specific guidance. Waste containing asbestos is generally not considered as hazardous waste but must be transported and disposed of in accordance with Federal, State, and local environmental regulations.

Commemorative Plaques

Design commemorative plaques to blend with the surrounding architectural finishes and fabricate in high-quality materials resistant to damage by impact and other risks common to high traffic areas. Avoid damaging masonry wall materials by anchoring into mortar joints only, or devise other nondestructive support acceptable to GSA. For historic facilities, use historic features such as original signage and ornamental hardware as a guide for selecting plaque materials, finishes, detailing, and lettering styles. All sign installations in restoration zones, such as historic entrance lobbies and ceremonial spaces, are subject to NHPA Section 106 review, coordinated by GSA's regional historic preservation officer (RHPO). Sign placement, anchoring, size, and design must be approved by the RHPO before external reviews are initiated or plaques are fabricated. The RHPO needs to approve the location.

Mechanical Electrical Systems in Renovated Buildings

Vertical Distribution

Retain original elevator doors when they are significant to the original building fabric. Base the design for new hoist way and cab doors on the detailing of the original doors. Match original materials and adapt ornamentation as necessary to comply with code.

Maintain original hardware wherever possible; upgrade as needed to provide functionality. New lobby and corridor floor landing indicators should be scaled to avoid the destruction of original ornamental finishes that framed the original indicators.

Horizontal Distribution

Fortunately, many older buildings have tall floor-to-floor heights, which give the architect two options: a raised access floor or a very deep ceiling space.

The other option is to create a deep ceiling space and zone it carefully for the most efficient fit of all engineering systems. Ceilings should never be dropped below the level of the window head. In historic buildings, care should be taken not to allow the installation of dropped ceilings to damage character-defining architectural details and, if possible, to maintain visual access to such details. Carefully designed exposed system installations are encouraged in workspaces where exposing systems will a) enable original ornamental ceilings and finishes to remain exposed, b) maintain original high ceiling volume and daylight in new open space offices, or c) avoid disturbing hazardous materials such as asbestos. Exposed systems in historic spaces should be designed to minimize interference with historic details.

William Kenzo Nakamura
U.S. Courthouse
Seattle, Washington

During the renovation of the building's interior in 1983–1984, the public elevator lobbies were restored but retain their original finishes and locations.

In narrow buildings, it may be possible to create a furred horizontal space adjacent to the exterior and core walls, which can be used as a raceway for utilities. Vertical furring on columns and walls for receptacles is another possibility and can be integrated as an architectural feature. If space is tight, all-water or water-and-air systems should be considered for air conditioning, instead of all-air systems.

Utility distribution in historic buildings is the most difficult because ceilings and floors often have to be preserved or restored. In these cases, decentralized air conditioning units with little or no ductwork become feasible. Prewired systems furniture, which is available in wood, is also a very good solution.

Space Planning Strategies

Office Space

It may be necessary to design a slightly larger space allocation—about 12 m^2 (135 sq. ft.) per person—for office layouts in older buildings. This compensates for less than ideal bay sizes and existing wall configurations. The planning standards described earlier in the Facilities Planning section should be used as much as possible.

Prewired systems furniture may be an appropriate solution for distribution of power and communications wiring in renovated buildings. Open plans have been used successfully in historic buildings. Furniture systems must be selected with great care to minimize any adverse impact on the historic features of the building. Modular furniture system dimensional planning restrictions, best adapted to large open office areas, may have limited feasibility in older structures with short or irregular structural spans.

Acoustics in Historic Buildings

Hard surfaces often predominate in old buildings and create resonance and echoes. While it may be possible to upgrade the acoustical environment, this should not be done at the expense of the historically significant features of the building. See the Acoustics section in this chapter.

Alteration of Building Elements

Exterior Closure

Design alterations to avoid damaging original finishes in preservation zones as defined in the Historic Structure Report or the Building Preservation Plan.

Refer to Building Elements Section of this chapter for references regarding treatment of existing windows. See also GSA Technical Preservation Guideline Upgrading Historic Windows.

Exterior masonry should be cleaned first and then repointed. Elastomeric joints should be resealed.

Uncommon Products Used in Rehabilitations

In historic preservation it may be necessary to specify uncommon materials that may be hard to find. These products may be described with the supplier's name and address in the specifications. If more than one supplier exists, multiple manufacturers must be stated. The specifications should also contain a note stating: "The use of a trade name in the specifications is to indicate a possible source of the product. The same type of product from other sources must not be excluded provided it possesses like physical characteristics, color and texture."

Do not install new equipment on structural glass, marble, or ceramic tile.

4

NANCY HANKS CENTER
OLD POST OFFICE BUILDING
WASHINGTON, DC

ARCHITECT: WILLOUGHBY J. EDBROOKE
CONSTRUCTED: 1892–1899
RESTORATION AND RENOVATIONS: 1977–1992

LISTED IN THE NATIONAL REGISTER
OF HISTORIC PLACES IN 1973.

Structural Engineering

Chapter 4 Structural Engineering

4.1 Goals and Objectives

This chapter provides structural design criteria for buildings and for building systems constructed of concrete, masonry, steel, and wood. The design requirements provided here, or cited by reference, are based on the International Building Code, ASCE standards, industry standard practices and FEMA guidelines. Deviation from these criteria, where a valid need exists or an alternative solution is more desirable, may be accepted subject to evaluation and approval by GSA. See Chapter 1 General Requirements Section 1.2, Deviations from the P100.

The use of special construction, innovative methods, and the installation of any material is permitted when necessary, advantageous, and economical. However, specifying new or untried materials or methods of construction should be avoided until the merits of the methods or materials have been established. When the merits are established, new, unusual, or innovative materials, systems, or methods may be incorporated into designs when evidence shows that such use is in the best interest of the Government from the standpoint of economy, lower life-cycle costs, and quality of construction. When new and innovative methods and materials are proposed for a specific building, a peer review panel, determined by GSA, must evaluate the adequacy of the methods, systems, and materials proposed by the engineer. The evaluation will be based on the best interest of the Government from the standpoint of economy, lower life-cycle costs, and quality of construction.

Three characteristics distinguish GSA buildings from buildings built for the private sector: longer life span, changing occupancies, and the use of a life-cycle cost approach to determine overall project cost.

GSA generally owns and operates its buildings much longer than private sector owners. Accordingly, a higher level of durability and serviceability is required for all systems. In terms of structural design, this has resulted in more stringent requirements than those stipulated in model building codes; the floor load capacity requirement described in Section 4.9, Structural Load Requirements, is an example.

During the life span of a typical GSA building, many minor and major alterations are necessary as the missions of Government departments and agencies change. The capability to accommodate alterations must be incorporated into the building from the outset. In some cases structural systems should be designed to provide some leeway for increases in load concentrations in the future. They should also be designed to facilitate future alterations, e.g., the cutting of openings for new vertical elements such as piping, conduit, and ductwork.

Security is an important consideration in structural design. Structural building systems and elements must support risk mitigation efforts to reduce casualties, loss of critical functions, and property damage.

Harvey W. Wiley Federal Building for the FDA College Park, Maryland

Metal trusses support large skylights in the 60-foot high wedge-shaped atrium.

4.2 References

Codes and Standards

The codes and mandatory standards adopted by GSA for the design of all new buildings are discussed in Chapter 1. Additional codes and standards for the design of structural systems are included in the text of this chapter and listed in Appendix B1, References.

IBC for Structural Design of New Buildings

The structural design (including wind, snow, and earthquake) of new buildings, structures, and portions thereof must be in full compliance with the latest edition of the International Building Code (IBC). Unless otherwise specified, all new buildings must be classified as Occupancy Category II structures according to Chapter 16 of the IBC.

ISC Security Standards

The ISC Physical Security Criteria for Federal Facilities apply to new construction of Federal office buildings and courthouses. Where prudent and appropriate, the criteria apply to major modernization projects.

The criteria are intended for design and security professionals in the development of detailed project requirements to reduce the potential for widespread catastrophic structural damage and the resulting injury to people. Because the criteria allow flexibility and are therefore subject to interpretation, users must prepare project-specific requirements.

The designer must exercise good judgment when applying these criteria to ensure the integrity of the structure and to obtain the greatest level of protection practical given the project constraints. There is no guarantee that specific structures designed in accordance with this document will achieve the desired performance. However, the application of the criteria will enhance structural performance if the design events occur.

Designers of GSA projects must contact the GSA/PBS Office of the Chief Architect to obtain access to the ISC Physical Security Criteria for Federal Facilities.

Methods and References

The ISC Physical Security Criteria for Federal Facilities require that all building components requiring blast resistance be designed using established methods and approaches for determining dynamic loads, structural detailing, and dynamic structural response. Design and analysis approaches must be consistent with those in the technical manuals (TMs) listed in the ISC Physical Security Criteria for Federal Facilities.

The ISC Physical Security Criteria for Federal Facilities addresses: alternative analysis and mitigation, blast engineer qualifications, compliance with risk assessment, design narratives and calculations, loads and stresses, progressive collapse, protection levels, structural and nonstructural elements, and basic approaches to blast-resistant design.

4.3 Alterations in Existing Buildings and Historic Structures

Alteration requires ingenuity and imagination. It is inherently unsuited to rigid sets of rules, since each case is unique. It is recognized that total compliance with standards may not be possible in every case. Where serious difficulties arise, creative solutions that achieve the intent of the standard are encouraged.

Where a historic structure is to be altered, GSA will provide special documents to help guide the design of the alterations. The most important of these is the Building Preservation Plan (BPP), which identifies zones of architectural importance, specific character-defining elements that should be preserved, and standards to be employed. For some buildings a detailed Historic Structures Report is also available. See Chapter 1, General Requirements.

U.S. Post Office and Courthouse
Brooklyn, New York

A ten-year preservation and expansion effort rescued this 1892 landmark. The restored four-story atrium brings natural light into the heart of the building.

4.4 Design Standards

In selecting load resisting systems, the goals are simplicity of the structural framing layout and symmetry in the structural system reaction to design loadings. The selection must consider the need for economy, function, and reliability.

Both load resistance factor design (LRFD) and allowable stress design (ASD) are acceptable design procedures for GSA buildings. If LRFD is chosen, the design narrative must specifically address floor vibration.

4.5 Structural Systems

Cast-in-Place Systems

Systems that have fewer limitations in cutting openings during future alterations are preferred over other systems.

Precast Systems

Precast floor framing systems should be used only for GSA office buildings when the design can be demonstrated to adapt well to future changes in locations of heavy partitions or equipment. Precast systems may be considered for low-rise structures such as parking garages, industrial buildings, and storage and maintenance facilities.

Pretensioning and Posttensioning Systems

As with precast floor framing, these systems should be used only when the design can be demonstrated to not impede future flexibility. These systems should not be used where they compromise blast mitigation.

United States Courthouse
Hammond, Indiana

The four-story courthouse is composed of twin monolithic limestone-clad wings joined by a three-story, glass-walled atrium with a vaulted ceiling.

4.6 Progressive Collapse

Assessment of the potential for progressive collapse and the evaluation of risk reduction measures must be in accordance with the *Progressive Collapse Analysis and Design Guidelines for New Federal Office Buildings and Major Modernization Projects*. Designs that facilitate or are vulnerable to progressive collapse must be avoided. Designers may apply static and/or dynamic methods of analysis to meet this requirement. Ultimate load capacities may be assumed in the analyses.

In recognition that a larger-than-design explosive (or other) event may cause a partial collapse of the structure, new facilities with a defined threat must be designed with a reasonable probability that, if local damage occurs, the structure will not collapse or be damaged to an extent disproportionate to the original cause.

4.7 Building Materials

All building materials and construction types acceptable under the model International Building Code are allowed. However, special consideration should be given to materials that have inherent ductility and are better able to respond to load reversals (i.e., cast-in-place reinforced concrete and steel construction). Careful detailing is required for material such as prestressed concrete, precast concrete, and masonry to adequately respond to the design loads. The construction type selected must meet all performance criteria of the specified level of protection of the ISC.

BEST PRACTICE

LESSONS LEARNED FROM HURRICANES KATRINA AND RITA

- Rooftop mechanical equipment must be designed to withstand hurricane wind loads. The structural engineer must detail how the equipment is attached to the structure.
- Perimeter security systems can prevent storm surges from impacting the building.
- Windows designed to meet ISC glazing protection level 3b held up well during the hurricane.
- Roof ballast from adjacent structures caused some windows to fail.
- Outside louvers must be capable of withstanding hurricane-wind-driven rain.
- Also refer to "Performance of Physical Structures in Hurricane Katrina and Hurricane Rita: A Reconnaissance Report, NIST Technical Note 1476." Visit **http://www.bfrl.nist.gov/investigations/pubs/NIST_TN_1476.pdf**.

4.8 Building Elements

Floor Vibration

The floor-framing members must be designed with a combination of length and minimum stiffness that will not cause vibration beyond the “slightly perceptible” portion of the Modified Reiher-Meister Scale or equivalent vibration perception/acceptance criteria. Recommended vibration design criteria for general office space should be based on T. M. Murray, *Tips for Avoiding Office Building Floor Vibrations, Modern Steel Construction,* March 2001, and Steel Design Guide Series 11, *Floor Vibrations Due to Human Activity,* American Institute of Steel Construction. More stringent vibration considerations may be required for fixed seating areas such as those in courtrooms or judges’ chambers.

Nonstructural Elements

All nonstructural elements, components, and equipment located within a building or on the site must be anchored and/or braced to withstand gravity, wind, seismic, temperature, and other loads as required by IBC for new buildings and ASCE/SEI 41 for existing buildings.

Building Facade

The building facade must be designed and detailed so connections will be corrosion resistant, can accommodate movements, and can resist the imposed forces.

Footings

Footings and permanent support structures, such as tiebacks, must not project beyond property lines.

United States Courthouse
San Diego, California

4.9 Structural Loads

Design loads must be in accordance with International Building Code (IBC) except as noted:

Flexibility in the Use of Space

Since locations of corridors are not always known until after the completion of construction documents and are subject to change over time, use a uniform live load of 4.75 kPa (100 pounds per square foot) over the entire floor area for all elevated slabs, which includes the 0.74 kN/m^2 (15 psf) partition load as required by the IBC. Areas with higher live loads than this must be designed for the code required minimum or the actual live load, whichever is greater.

Live Load Reductions

Do not use live load reductions for 1) horizontal framing members, 2) transfer girders supporting columns, or 3) columns or walls supporting roofs where mechanical equipment can be located. Live load reductions must be considered in the design of foundation members regardless of the restrictions placed on individual members.

Telecommunication Closets

Use 4.75 kPa (100 psf) minimum distributed live load capacity, which exceeds the minimum live load capacity stated in EIA/TIA Standard 569, standard part 7.2.3 of 2.4 kPa (50 psf). Verify if any equipment will exceed this floor load requirement.

Telecommunication Equipment Rooms

The floor-loading capacity of telecommunication equipment rooms must be sufficient to bear both the distributed and concentrated load of installed equipment. EIA/TIA Standard 569 prescribes a minimum live load capacity for distributed loads of 12.0 kPA (250 psf) and a minimum concentrated live load of 4.5 kN (1,000 pounds) over the area of greatest stress to be specified.

4.10 Geotechnical Considerations

The requirements for the geotechnical engineering investigation and report are listed in Appendix A, Submission Requirements.

Pioneer Courthouse
Portland, Oregon

A National Historic Landmark, the Pioneer Courthouse is shown supported on pin piles as the stone foundation is prepared for seismic base isolation. Seventy-five friction pendulum isolators were placed under the building, allowing the building to move 18 inches in any direction during a seismic event.

4.11 Seismic Safety Standards

Proper seismic design is of basic life safety importance in Federal buildings. The following section describes requirements for seismic safety for new construction and existing buildings.

United States Courthouse Seattle, Washington

Several innovative structural concepts were undertaken in the construction of this courthouse, resulting in significant cost savings and improved building safety. Primary among these was a hybrid shear-wall core to provide seismic safety.

Seismic Performance

The performance objective of a seismic upgrade is life safety, defined as safeguarding against partial or total building collapse, preventing the obstruction of entrance or egress routes, and preventing falling hazards in a design basis earthquake.

Seismic Safety Standards for Existing Federally Owned Buildings

Seismic Evaluation and Mitigation of Existing Buildings

Not all seismic deficiencies warrant remedial action. Seismic upgrading is an expensive and often disruptive process, and it may be more cost effective to accept a marginally deficient building than to enforce full compliance with current standards.

Evaluation and mitigation of existing GSA buildings must meet the requirements of ICSSC RP 6 (NISTIR 6762), Standards of Seismic Safety for Existing Federally Owned and Leased Buildings, with the following modifications:

Evaluation of existing buildings must be in accordance with the provision of the ASCE Standard, Seismic Evaluation of Existing Buildings, ASCE/SEI 31. The primary objective of the standard is to reduce the life-safety risk to occupants of Federal buildings and to the general public. Life safety is the minimum performance objective appropriate for Federal buildings.

Seismic rehabilitation of existing buildings must be in accordance with the provisions of ASCE/SEI 41, Seismic Rehabilitation of Existing Buildings. Life safety is the minimum acceptable performance level for existing Federal buildings. ASCE/SEI 41 further provides for an extended level of performance, immediate occupancy, where required to meet the agency's mission. ASCE/SEI 31, ASCE Standard, Seismic Evaluation of Existing Buildings, and ASCE/SEI 41, Seismic Rehabilitation of Existing Buildings, provide the basis for defining these performance objectives, evaluation criteria, and, if necessary, mitigation.

If shown by ASCE/SEI 31 evaluation that the desired performance level is not satisfied, the rehabilitation of the building to attain the desired performance level must substantially satisfy the Basic Safety Objective (BSO) criteria of ASCE/SEI 41, including the use of both the BSE-1 and BSE-2 earthquake criteria.

Note that the hazard level (ground motion) used in ASCE/SEI 31 to evaluate buildings is based on earthquakes with a 2 percent probability of exceedance in 50 years (2%/50 years). On the other hand, the hazard level used for a rehabilitation design in ASCE/SEI 41 is based on compliance with the BSO. The BSO requires compliance with both the BSE-2 earthquake (2%/50 years earthquake accelerations) at the collapse prevention performance level and with the BSE-1 earthquake (the lesser of the accelerations from the 10%/50 years earthquake or ⅔ of the 2%/50 years earthquake) at the life-safety performance level. The earthquake accelerations associated with the ⅔ of the 2%/50 years earthquake will result in significantly higher seismic design values than those resulting from a 10%/50 years earthquake in some areas of the country.

4.12 General Design Considerations for Seismic Upgrading

Upgrade Priorities

It may not be practical to upgrade an entire structure to current requirements at any one time. Whenever upgrading is only partially done, the first priority must be given to items that represent the greatest life-safety risk, such as the lateral force-resisting system, unreinforced masonry load-bearing walls, or both.

Seismic Upgrades for Historic Buildings

Historic buildings should meet the same life-safety objectives as other buildings while preserving historic spaces and features to the greatest extent possible. Decisions made to preserve essential historic features must not result in a lesser seismic performance than that required by ICSSC RP 6. Early and frequent coordination between the structural engineer, preservation architect, GSA regional historic preservation officer, and external review groups is imperative for timely resolution of conflicts between safety standards and preservation goals. See Chapter 3, Architecture and Interior Design, Section 3.19, Alterations in Existing Buildings and Historic Structures.

Seismic Strengthening Criteria for Nonstructural Elements

Where deficiencies in the attachment of elements of structures, nonstructural components, and equipment pose a life-safety risk, they must be prioritized and those elements with the greatest life-safety risk strengthened first to meet current standards.

Seismic Instrumentation

New and existing Seismic Design Category D, E, and F buildings over six stories in height with an aggregate floor area of 5,574 m^2 (60,000 sq. ft.) or more, and every Seismic Design Category D, E, and F building over 10 stories in height regardless of floor area, must be provided with U.S. Geological Survey (USGS)-approved recording accelerographs. USGS developed guidelines and a guide specification for Federal agencies for the seismic instrumentation of buildings. The guidelines describe the locations and the types of instruments used for several typical buildings. Typical costs were also developed for existing buildings. The Seismic Instrumentation of Buildings (with Emphasis on Federal Buildings), Special GSA/USGS project, USGS Project No: 0-7460-68170, can be downloaded as a PDF file at **http://nsmp.wr.usgs.gov/celebi/gsa_report_instrumentation.pdf**.

Base Isolation

Base isolation must be considered for buildings located in regions of high seismicity for 2- to 14-story buildings, particularly on rock and firm soil sites that are stable under strong earthquake ground motion. The base isolation system must be shown to be as cost effective as conventional foundation systems. The effects of the base isolation system on the framing, mechanical, and electrical systems must be included in the evaluation of cost effectiveness.

4.13 Use of Recycled Materials

GSA is committed to incorporating principles of sustainable design and energy management into all of its building projects. For additional information refer to Chapter 1, Sustainable Design. Specific information on recycled materials is described in Chapter 3.

U.S. Census Bureau Headquarters
Suitland, Maryland

Construction materials include recycled content, and the various woods on both the exterior and interior were harvested from sustainable forests.

5

Mechanical Engineering

U.S. CENSUS BUREAU HEADQUARTERS
SUITLAND, MARYLAND

ARCHITECT: SKIDMORE, OWINGS & MERRILL
PROJECT MANAGER: JAG R. BHARGAVA

Chapter 5 Mechanical Engineering

5.1 Goals and Objectives

This chapter identifies the mandatory criteria that must be used to program and design mechanical systems, which are defined here as heating, ventilating, and air conditioning (HVAC) systems, humidification and water treatment systems, primary heating systems, primary cooling systems, pumping and piping systems, building automation systems, and plumbing systems.

Design Intent

An integrated design procedure must be used, beginning with the pre-concept design phase of the project, to ensure that the mechanical systems and other building components function together and result in a building that meets the project's program requirements, as referenced in Chapter 1, General Requirements.

Mechanical systems must be designed to support all performance objectives defined for the project's program requirements. Compliance with Appendix A, Submission Requirements, is required to demonstrate that mechanical systems have been integrated into the project at each phase of the design.

Maintainability and reliability are requirements for Federal buildings. The design and installation of all mechanical systems and equipment must allow for their removal and replacement, including major components such as boilers, chillers, cooling towers, pumps, and air-handling equipment.

HVAC systems must be specifically designed to meet all of the defined performance objectives of the project at the full-load and part-load conditions that are associated with the projected occupancies and modes of operations.

U.S. Court and U.S. Land Port of Entry Facilities

For design considerations for U.S. Court facilities and their unique operation, also see Chapter 8 and the 2007 *U.S. Court Design Guide*. For design considerations for U.S. Land Port of Entry facilities, also see the *U.S. Land Port of Entry Design Guide,* 2010.

Land Port of Entry
Champlain, New York

A dynamic use of light, siting, form and surface in the design of this station emphasizes the sense of arrival and passage.

5.2 Codes, Standards, and Guidelines

The latest editions of publications and standards listed here are intended as guidelines for design. They are mandatory only where referenced as such in the text of this chapter or in applicable codes. The list is not meant to restrict the use of additional guides or standards.

Codes and Standards

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

ASHRAE Handbook of Refrigeration

ASHRAE Handbook of HVAC Applications

ASHRAE Handbook of HVAC Systems and Equipment

ASHRAE Standard 15-2007: Safety Code for Mechanical Refrigeration

ASHRAE Standard 52.2-2007: Method of Testing: General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASHRAE Standard 55-2004: Thermal Environmental Conditions for Human Occupancy

ASHRAE Standard 62.1-2007: Ventilation for Acceptable Indoor Air Quality

ASHRAE Standard 90.1-2007: Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE Standard 100-2006: Energy Conservation in Existing Buildings

ASHRAE Standard 105-2007: Standard Method of Measuring and Expressing Building Energy Performance

ASHRAE Standard 111-2008: Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC Systems

ASHRAE Standard 113-2005: Method of Testing for Room Air Diffusion

ASHRAE Standard 135-2008: BACnet: A Data Communication Protocol for Building Automation and Control Networks

ASHRAE Standard 180-2008: Standard Practice for inspection and Maintenance of Commercial Buildings

ASHRAE Guideline 0-2005: The Commissioning Process

ASHRAE Guideline #4-2008: Preparation of Operating and Maintenance Documentation for Building Systems

ASHRAE Guideline #12-2000: Minimizing the Risk of Legionellosis Associated with Building Water Systems

ASHRAE Guideline #29-2009: Guideline for Risk Management of Public Health and Safety in Buildings

American Society of Plumbing Engineers ASPE Data Books

Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) HVAC Duct Construction Standards: Metal and Flexible

SMACNA HVAC Air Duct Leakage Test Manual

SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems

SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems

National Fire Protection Association (NFPA) 30 Flammable and Combustible Liquids Code

NFPA 70 National Electric Code

Underwriters' Laboratory (UL) 710 Standard for Exhaust Hoods for Commercial Cooking Equipment

All applicable regulations and requirements of local utility companies having jurisdiction

EIA/TIA Standard 569: Commercial Building Standard For Telecommunications Pathways And Spaces (and related bulletins)

5.3 HVAC Performance Characteristics

Sustainability is integral to any HVAC design and is accomplished by integrating the performance characteristics listed below through a design methodology involving all design team members.

Code and Program Compliance

The HVAC design must comply with the applicable codes described in Chapter 1 and the standards listed in Section 5.2.

All tenant specific program requirements for HVAC design must be met. These criteria include but are not limited to: the *United States Land Port of Entry Design Guide* (PBS P 130), the *United States Courts Design Guide,* the *U.S. Marshals Service Judicial Security Systems Requirements and Specifications,* Volume 3, Publication 64, the *Child Care Center Design Guide* (PBS P 140), and other tenant specific HVAC program requirements. Use the latest version of these guides to include supplements issued at the time of design award.

Occupant Health and Comfort

Thermal Comfort and Humidity Requirements

The HVAC system must be designed to maintain the thermal and humidity parameters shown in Table 5-1.

Ventilation

Provide ventilation as required by ASHRAE Standard 62.1-2010: Ventilation for Acceptable Indoor Air Quality.

The HVAC system must have Dedicated Outdoor Air Ventilation Systems (DOAVS) sized to meet the latent or total heat exchange. The DOAVS must deliver temperature and humidity conditioned outside air to the occupied spaces at the required ventilation air flow rates. The DOAVS are used to maintain positive pressure in the perimeter zones with respect to outdoor air pressure, and to keep the space dew-point temperature less than 12.8°C (55°F) at all times in conjunction with other HVAC systems.

The DOAVS must be capable of operating independent of any other air distribution system. The DOAVS can be coupled with building exhaust air heat recovery to precondition the outdoor air.

During unoccupied hours, run the DOAVS at reduced capacity to maintain positive pressure in the perimeter zones with thermally conditioned air that provides a space dew-point temperature less than 12.8°C (55°F).

Use one of these three installation methods:

1. The DOAVS ducted directly to the occupied spaces

2. The DOAVS ducted directly to terminal units serving occupied spaces or zones

3. The DOAVS ducted through air flow control devices (airflow measuring station and airflow control damper) to the return side of the floor-by-floor air-handling units. In this case, the DOAVS must be provided with a means of bypassing the air-handling units and directing airflow to the supply ducts during unoccupied hours. Do not use return air plenums to provide airflow pathways for pressurization during unoccupied hours.

Air Quality

To provide for the health and comfort of the building occupants, design the ventilation system using either the Ventilation Rate Procedure (Section 6.2) or the Indoor Air Quality Procedure (Section 6.3) specified in ASHRAE Standard 62.1-2010.

Filtration

Air filtration must be provided in every air-handling system including the DOAVS. Air-handling units must have a pre-filter and a final filter, each located upstream of the cooling and heating coils. The filter media must be fabricated so that fibrous shedding does not exceed levels prescribed by ASHRAE 52.2-2007. The pre-filters must have a Minimum Efficiency Reporting Value (MERV) of 8, and the final filters must have a MERV of 13, as defined in ASHRAE 52.2-2007. Filter racks must be designed for a maximum bypass leakage air around the filter media of 0.5 percent of the design supply airflow rate. Filters must be sized at 2.5 m/s (500 fpm) maximum face velocity.

Contaminant Control

The HVAC system must prevent occupant exposure to harmful and objectionable levels of indoor air contaminants. These include but are not limited to: carbon dioxide, carbon monoxide, formaldehyde, ozone, particulates, and radon.

Pressurization Control

To reduce the infiltration of warm moist air and resultant mold problems in moist ASHRAE climate zones, the DOAVS must continually provide a positive pressure in the perimeter zones with respect to outdoor air pressure. At a minimum the DOAVS must bring in ten percent more air than the mechanically exhausted airflow rates. The amount of outside air needed will vary for occupied and unoccupied hours. Under CO_2 demand control the ventilation airstream of DOAS must be 10% greater than the fixed exhaust. Generally during unoccupied hours the exhaust systems will be off and the DOAS will supply only enough OA to pressurize the building. No exhaust (energy recovery) should be necessary to pressurize the building.

In dry climates the building pressurization should be neutral or slightly positive to minimize thermal infiltration.

Acoustics

Limit tenant exposures to noise and vibration from HVAC systems. Acceptable limits are provided in Chapter 3 of this standard. The *U.S. Court Design Guide,* the *Land Ports of Entry Design Guide* and the *Child Care Design Guide* have more stringent requirements. Other specific tenant mission requirements must be met.

The effects of noise and vibration control of HVAC components, ductwork and piping in terms of Room Criteria and Vibration Criteria at full and part-load heating and cooling conditions are to be calculated in accordance with the procedures described in Chapter 47, *ASHRAE Applications Handbook,* 2007

Occupant Controls

Limit the size of thermostatically controlled zones so that tenants have more direct control over their thermal comfort and to reduce impacts of variable loads to the tenants. Off hours operations should reset the control sequence to energy conserving conditions.

Energy Efficiency

Although the HVAC system uses energy to heat, cool and ventilate the building, many of the loads that create the need for heating and cooling are not generated from the HVAC components. Lighting design, fenestration, envelope design, solar orientation, equipment loads, and tenant activity all affect the loads that must be controlled by the HVAC system. Effective energy conservation can only result from an integrated design approach. Nevertheless, the HVAC system must be designed to address the building loads in the most energy efficient manner possible. Energy use maximums for the building are given in Chapter 1. The A/E must use energy modeling as described in Appendix A to verify the energy performance of the design.

Conservation of Water

Design the HVAC system to conserve the use of domestic water. Use water efficient cooling towers. In moist climate zones condensate water from the DOAVS should be reused rather than drained to the sewer system. Consider condensate reuse from other air-handling units (AHU's) as appropriate.

Operable and Maintainable

Accessible for Maintenance

Install equipment so that it can be safely and easily maintained and inspected. Comply with requirements for mechanical room sizes and manufacturer's recommended clearances around installed equipment.

Do not install equipment that requires maintenance below a raised access floor.

All mechanical equipment must be located at least 1.6 meters (5 ft.) above the 100 year flood plain elevation.

Simple/Understandable to Operate

The sequence of operation for the control systems must be clearly described and comprehensively documented. The HVAC system design should minimize the need for overly complex control systems.

Operations

Design the HVAC system so that equipment failures and normal maintenance have minimal impact on the tenants. Failure of one piece of equipment should not shut down large portions of the building. Install piping and valves so that equipment can be easily isolated for repair and so that different combinations of equipment can be used during replacement and overhaul. Equipment components, spare parts, and materials should be readily available and the equipment should be repairable by crafts people available in the local area. This is especially important in the remote locations of some Land Ports.

Robust and Reliable

Extended Life Expectancy

Public buildings have a longer life expectancy than most commercial office buildings. Forty percent of GSA's occupied inventory is over 50 years old. Many buildings are over 100 years old and are expected to continue in service for decades to come. HVAC systems are expected to have extended service lives. They will be modified many times over the life of the building and operated by many different maintenance firms and occupied by many different tenants. Selection of robust, reliable, energy efficient equipment is important. Systems that can be reliably operated at near design conditions over the long term are needed.

Tenant Fit Out

The HVAC system should be installed to allow reconfiguration of tenant space with minimal cost and disruption while still providing required performance characteristics.

Recapitalization

GSA often upgrades HVAC systems in large buildings in phases over many years while parts of the building are occupied. The design should consider how the systems will be replaced in the future. Vertical and horizontal distribution should allow parts of the system to remain in operation and zones of the building to be occupied during system replacement.

5.4 Design Criteria

This section identifies the criteria to be used for the design of the HVAC system.

Outdoor Design Criteria

Outdoor air design criteria must be based on weather data tabulated in the latest edition of the *ASHRAE Handbook of Fundamentals*. Winter design conditions must be based on the 99.6-percent column dry bulb temperature. Summer design conditions for sensible heat load calculations must be based on the 0.4-percent column dry bulb temperature, with its mean coincident wet bulb temperature. Design conditions for the summer ventilation load, cooling tower selection, and all dehumidification load calculations must be based on the 0.4-percent dew point, with its mean coincident dry bulb temperature.

Indoor Environmental Criteria

Temperatures and Relative Humidity

Indoor design temperature and relative humidity requirements are stated in Table 5-1 and must be maintained at these values to within 460 mm (18 in.) of the exterior wall surfaces.

Within areas where artwork is stored or displayed, or where building materials and furnishings are likely to be damaged by changes in moisture content, as defined in the project performance requirements, the RH in the areas must be maintained in accordance with Chapter 4.1 of *Installation Standards,* of the *Fine Arts Collection Policies and Procedures.*

Indoor Air Quality

Either the Ventilation Rate Procedure (Section 6.2) or the Indoor Air Quality Procedure (Section 6.3), specified in ASHRAE Standard 62.1-2010, must be used as the basis for design.

In addition, compliance with the following criteria for the control of continuous occupant exposure during full-load and part-load conditions must be demonstrated at each phase of the design:

The design of the HVAC system must prevent occupant exposure to the following levels of contaminates during full-load and part-load conditions.

- Carbon dioxide (CO_2): Not to exceed 1000 ppm
- Carbon monoxide (CO): Not to exceed 9 ppm
- Formaldehyde (HCHO): Not to exceed 0.05 ppm
- Ozone (O_3): Not to exceed .05 ppm
- Particulate matter: Not to exceed 15 $\mu g/m^3$ for particles less than 2.5 μm (PM2.5), and not to exceed 50 $\mu g/m^3$ for particles less than 10 μm (PM10)
- Radon (Rn): Not to exceed 4 picocuries/liter

Table 5-1

Indoor Design Conditions

Type of Area	Summer DB [1,3]	RH [2,3,4]	Winter DB [1,3]	RH [2,3,4]
General office[13]	24 (75)		22 (72)	
ADP, computer, and information technology equipment rooms[9]	22 (72)	45	22 (72)	30
Corridors[13]	24 (75)		22 (72)	
Building lobbies and atriums[10,13]	24 (75)		22 (72)	
Toilets[13]	24 (75)		22 (72)	
Locker rooms	26 (78)		21 (70)	
Electrical closets	26 (78)		13 (55)	
Mechanical spaces	35 (95)[5]		13 (55)	
Electrical switchgear	35 (95)[5]		13 (55)	
Elevator machine room[10]	26 (78)[5]		13 (55)	
Emergency generator room	40 (104)[6]		18 (65)	
Transformer vaults	40 (104)[5]			
Stairwells	(none)		18 (65)	
Communications/ telecommunications frame room[7]	24 (75)	45	22 (72)	30[12]
Storage room	30 (85)		18 (65)	
Conference room[11,13]	24 (75)		22 (72)	
Auditorium[10,13]	24 (75)		22 (72)	
Kitchen[10]	24 (75)		22 (72)	
Dining[10,13]	24 (75)		22 (72)	
Cafeteria[10,13]	24 (75)		22 (72)	
Courtrooms[13]	24 (75)	45	22 (72)	30*

*May require humidification in the winter. See Program Requirements.

Table 5-1 Notes

1. Dry bulb (DB) temperatures are degrees Celsius (Fahrenheit), to be maintained at +/-1°C (+/-2°F) of setpoint.

2. Unless specifically noted, minimum permissible relative humidity in conditioned areas is 30 percent and maximum permissible relative humidity is 60 percent.

3. Dry bulb and relative humidity are to be maintained at 150 mm (6 in.) to 1,800 mm (6 ft.) above the floor.

4. Relative humidity should be maintained within +/-5 percent RH of setpoint in spaces.

5. Maximum temperature. The space is to be mechanically cooled if necessary.

6. Room must not exceed temperature with generator running.

7. Must comply with EIA/TIA Standard 569.

8. Minimum DB temperature in the building must be 13°C (55°F), even when unoccupied.

9. A/E to confirm ADP equipment manufacturer's requirements as more stringent. Provide in-room display and monitor device (such as wall-mounted temperature and humidity chart recorder).

10. System must be designed for process cooling. Cooling system must be a dedicated independent system.

11. Provide independent temperature control.

12. Minimum relative humidity requirements may be omitted in moderate southern climate zones, upon the approval of local GSA representatives.

13. The values shown are for dry bulb temperatures in occupied spaces, when the air speed is less than 0.2 m/s (40 ft/min) and when the net thermal radiant exchange between the occupants and surrounding surfaces is negligible. Otherwise, the values shown are for operative temperatures as defined in ASHRAE Standard 55.

Envelope Load Criteria

Heat and Moisture Transfer

The elements and components of the building envelope design must comply with the heat transfer requirements Sections 5.4 and 5.5 of ASHRAE Standard 90.1-2007, and with the moisture transfer requirements in ASHRAE Standard 62.1-2007.

Building Pressurization

In moist climate zones keep dry air flowing through building cavities to retard infiltration through the building envelope using a control strategy and a "Sequence of Operations" designed to maintain the outdoor air ventilation rates at least 10 percent higher than the mechanically exhausted air. The control strategy should be specific to each floor of the building during both occupied and unoccupied periods. The building HVAC and BAS systems must have an active means of measuring and maintaining this airflow differential.

The following areas must be kept under negative pressure relative to the surrounding building areas:

- Detention cells
- Isolation and/or decontamination areas
- Toilets
- Showers
- Locker rooms
- Custodial spaces
- Mail sorting rooms
- Battery charging rooms
- Kitchen areas—air can be returned from the dining area space; air from all other spaces must be exhausted directly to the outdoors.

Additional areas may be required to operate under negative pressure based on the tenant program of requirements.

Internal Load Criteria

Occupancy Loads

Occupancy loads must be determined as follows:

- Determine occupant density (persons/m^2 or persons/ft^2) from the occupancy schedule of the Project Program of Requirements.
- In the event this information is not available, use the occupancy density values in ASHRAE 62.1-2010.
- For dining areas, auditoriums, and other high-occupancy spaces, occupancy densities must represent the number of seats available.
- Sensible and latent loads per person must be based on the latest edition of the *ASHRAE Handbook of Fundamentals*.

Equipment Power Densities

Evaluate internal heat gain from all appliances—electrical, gas, or steam. Base the rates of heat gain from equipment on the latest edition of the *ASHRAE Handbook of Fundamentals* and manufacturers' data.

Coordinate internal heat gain from equipment with electrical power design, the electrical load analysis and on the estimated receptacle demand load outlined in Chapter 6.

Lighting Power Densities

Coordinate heat gain from electric lighting systems with the electric lighting design and based on the criteria in Chapter 6.

HVAC Zoning Criteria

Thermostatic Zoning Design Criteria

Interior thermostatic control zones must not exceed 139 m^2 (1,500 sq. ft.) per zone for open office areas, or a maximum of three offices per zone for closed office areas.

Perimeter thermostatic control zones must not exceed 28 m^2 (300 sq. ft.) or one column bay width, and must be no more than 4.6 m (15 ft.) from an outdoor wall along a common exposure. Each corner office and conference room must be a separate zone.

Air Handling Unit Zoning Criteria

Air handling units must be selected to serve areas with similar functions and operating hours.

Ventilation Load Criteria

Outdoor air ventilation for the thermostatic zones must be in accordance with ASHRAE 62.1-2010, and the load of the ventilation air quantity must be calculated based on the outdoor design dew point and coincident dry bulb temperatures. Full-load and part-load calculations must be conducted as required in Appendix A and must include the impacts of heat recovery equipment.

Diversity

A diversity factor must be determined for loads on air-handling units, based on simultaneous peak loads at the thermostatic zones served by each air handler. Central plant equipment must be designed based on the block load whole-building simultaneous peak load.

HVAC Load Calculation Method

The HVAC load calculations must be performed with a computer-based program using the latest *ASHRAE Handbook of Fundamentals* Heat Balance (HB) Method, Radiant Time Series (RTS) Method, or Transfer Function Method (TFM), developed for the hourly analysis of heating and cooling loads in commercial buildings.

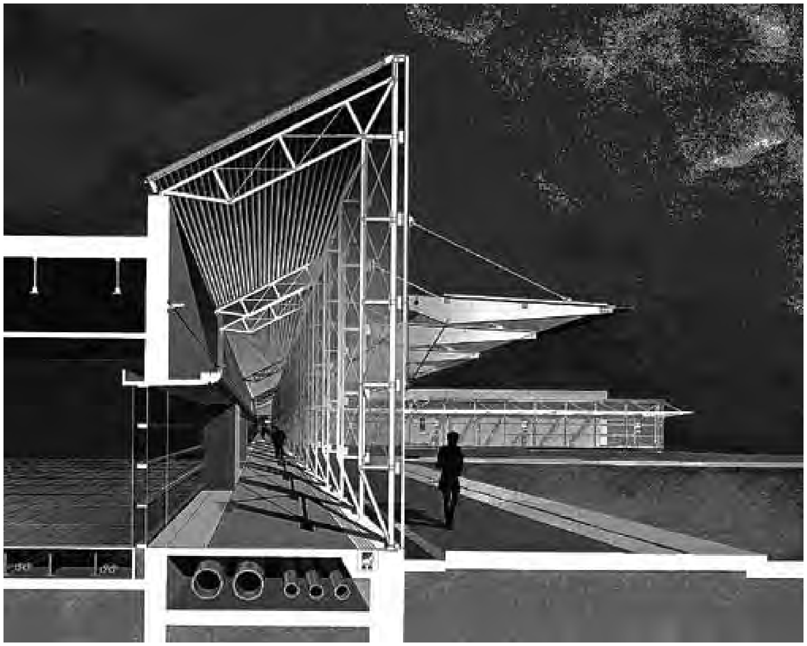
The program must be capable of calculating each zone's peak heating and cooling loads as well as the whole-building simultaneous peak load. The program must, at a minimum, calculate solar gains through fenestration, internal gains from occupants, including latent heat for cooling purposes, internal gains from lighting and equipment, outside air loads (sensible and latent) from ventilation and infiltration, and heat and moisture gains or losses through fenestration, walls, floors, and roofs. The heating load calculations must be done without credit for occupants and internal gains. The HVAC load calculations must not include additional safety factors unless specifically asked for in the applicable tenant design guides (i.e. the courts design guide has 20% sensible add to courtrooms).

HVAC Load Calculations Report

Provide HVAC load calculations at each design as required by Appendix A. The HVAC load calculations report must include all input and output used in the heating and cooling calculation program. The report must also include zone peak heating and cooling loads results and whole-building simultaneous peak load, air-handling unit coil selections, and psychometric charts that show the complete cycle of all of the processes in the HVAC system.

U.S. Census Bureau
Computer Facility
Bowie, Maryland

A section drawing shows the underfloor air-handling system.



Energy Analysis Criteria

Performance Goals

A building energy analysis must be performed at each phase of the design to demonstrate that the building design meets or exceeds the energy performance goals established for the project. Refer to Chapter 1 for specific energy performance goals and requirements.

Methodology

The compliance methodology must be in accordance with Sections 5 (except Section 5.6), 6, 7, 8, 9, and 10 of ASHRAE Standard 90.1-2007, and with A.6 in Appendix A of the P100. Each analysis must be based on the actual parameters and values defined in the project's program requirements and not simply on defaults assigned by the simulation program. The optimization of envelope and massing must be completed in the concept stage. Systems and subsystems must be finalized in design development. The energy analysis done for the construction documents must use actual design parameters.

The simulation program must be a computer-based program for the analysis of energy in buildings. Simulations must be based on 8,760 hours per year, with hourly variations in occupancy, lighting power, miscellaneous equipment power, vertical transportation, thermal mass effects, and thermostat setpoints. The simulation program must provide for HVAC system operation defined in accordance with the operational program for each day of the week and holidays, the number of required HVAC zones, part-load performance curves for mechanical equipment, capacity and efficiency correction curves for mechanical equipment, airside and waterside economizers, heat recovery, and automatic control systems as defined in Appendix Section A.6. Any variations in the input summary must be documented.

Use one of the following public domain or commercial software programs: Energy-Plus, DOE-2.1E, DOE-2.2, Trane Trace 700, Carrier HAP, ELITE.

Reports

The energy analysis report for each phase of design must include a narrative describing how the energy goal is to be achieved and be based on the input and output parameters as described in Appendix Section A.6. Include a statement of the expected error in the energy analysis.

5.5 HVAC Systems

The design team must select and design an HVAC system that provides the performance criteria listed in Section 5.3 and is optimized for the building type, climate zone, and program requirements. Generally the HVAC system consists of three components: a central system, a distribution system and a terminal control system (Building Automation System).

Central Systems

The term "central" refers to systems that are singularly located within the building such as a chiller or boiler plant. Section 5.8 describes additional requirements for the components of these systems.

All mechanical and electrical equipment within the building or on the property must be located 1.6 meters (5 ft.) above the 100-year flood plain.

All central system equipment must have direct digital control (DDC) self-contained controllers that are connected to the Building Automation System (BAS). All equipment such as chillers, boilers, and motors for pumps and air-handling units, and other auxiliary equipment with motors must have metering devices for determining energy consumption data, and must be capable of transmitting the data to the BAS.

Chiller Plant

If the whole building or property simultaneous peak cooling load is 1760 kW (500 Tons) or more, a minimum of three chillers must be provided. The three units must have a combined capacity of 120 percent of the total peak cooling load, with load split percentages 40-40-40 or 50-50-20. If the whole-building simultaneous peak cooling load is less than 1760 kW (500 tons), a minimum of two equally sized chillers at 67 percent of the peak capacity must be provided. All units must have adequate valving to isolate of the offline unit without interruption of service.

A waterside-economizer cycle must be analyzed during the design of the chiller plant and incorporated in the design if it improves the performance criteria listed in Section 5.3.

Boiler Plant

The central boiler plant within the building or on the property must be provided with modular boilers. For boiler plants greater than 300kW (1,000 MBH), a minimum of three boilers must be provided, each sized at 40 percent of peak load of heating and humidification, for a total of 120 percent capacity. If peak capacity requirements require more than three boilers, provide equal-sized boilers to meet 100 percent of capacity plus one boiler. For buildings less than 300kW peak demand, two equally sized modular boilers sized at 67 percent of peak demand must be provided.

Domestic water heaters requirements are described in Section 5.20.

Circulation Systems

All hydronic circulation systems must be designed for variable flow, in accordance with the requirements of Section 5.8.

Cooling Towers

Each chiller must have its own matching cooling tower or cell, and condenser and chilled water pump. Multiple cooling towers must have equalizing lines and the necessary automatic control valves for individual chiller/ cooling tower operation.

Thermal Storage

Ice on coil thermal storage systems must include prefabricated tanks with glycol coils and water inside the tank. The tank must be factory insulated and the vendor must guarantee its capacity and performance. Other types of thermal storage systems may be considered.

The ice storage system must have self-contained BACnet or LonTalk microprocessor controls for charging and discharging the ice storage system.

Ground-Source and Water-Source Heat Pump Systems

The geotechnical survey and test wells establish the feasibility of using a ground-source or water-source heat pump system.

Absorption Chiller System

If waste heat is available on the building site, an absorption chiller system is permitted.

Combined Heat and Power Plant (CHP)

Based on an analysis of the potential for coincidental power and thermal loads, an on-site CHP system is permitted if the CHP efficiency is at least 75 percent at full load capacity. The LCC analysis must include all expected service and overhaul costs.

District Steam System

A district steam system is permitted based on a life-cycle cost analysis. The design must provide space for future hot water boilers in the building to allow alternatives should the district system become unreliable or not economical.

District Chilled Water System

A district chilled water system is permitted based on a life-cycle cost analysis. The system must be documented to be at least 99 percent reliable. The design must provide space for future chillers and cooling towers in the building to allow alternatives should the district system become unreliable or not economical.

Renewable Energy Alternatives

Other renewable energy alternatives such as solar thermal, photovoltaic, geothermal, wind, bio-waste and biogas should be investigated and evaluated on a life-cycle cost basis.

Distribution Systems

Requirements for the construction, configuration, location and control of distribution systems and equipment are provided in the following Sections:

5.6 Special Area HVAC Systems
5.7 Mechanical and Service Space Requirements
5.8 HVAC Components
5.9 Air Distribution
5.10 Humidification
5.11 Water Treatment
5.12 Primary Heating Systems
5.13 Primary Cooling Systems
5.14 Piping Systems
5.15 Thermal Insulation
5.16 Vibration Isolation, Acoustical Isolation, and Seismic Design
5.17 Meters, Gauges, and Flow Measuring Devices

Air Distribution Systems

The following types of air distribution systems are acceptable: in-line and fan-powered variable air volume units for overhead or sidewall distribution, ducted underfloor air distribution systems, and ducted displacement ventilation systems.

Supply air distribution systems must be fully ducted to the spaces that are served. Underfloor supply air distribution system must also be fully ducted, except in computer rooms.

Do not install equipment with motors greater than 375 watts (½ horsepower) overhead, where it will be difficult to operate and maintain.

Install large equipment (with motors greater than 2,240 watts (3 horsepower)) in an equipment room.

VAV systems

All fan-powered variable air volume (VAV) boxes must be equipped with a minimum of MERV 10 filters and access panels.

For interior zones, heating coils are not permitted in VAV boxes except for areas below the roof or the floors above unheated exposed spaces.

Fan-powered, series-type, VAV terminals are permitted in zones, such as conference rooms, courtrooms, or other assembly areas that require constant supply air flow rates.

Air-Handling Units

When using VAV heating and cooling systems, horizontally zoned AHUs for each floor are preferred. Locate AHUs either on the floor they serve or one floor above or below.

Return air from the floor it serves must be ducted directly to the AHU. Do not use the mechanical room as a return air or relief plenum.

Fan systems with motor ratings greater than 22.4 kW (30 horsepower), or designed such that failure of the fan will result in significant impacts on the performance of the building HVAC system are not permitted.

Underfloor Air Distribution

A fully ducted underfloor air distribution (UFAD) system or displacement ventilation system is permitted except in courtrooms, restrooms, cafeterias, kitchens, laboratories, loading docks, mail rooms, U.S. Marshal's areas, and detention areas. The insulated supply air ductwork from the AHU must be connected directly to each floor diffuser or sidewall grille. Unducted or partially ducted UFAD systems or displacement ventilation systems with pressurized plenums are not permitted. Unducted supply is allowed only in computer rooms.

Equipment such as air-handling units, VAV boxes, or other equipment that requires maintenance, is not permitted below a raised-access floor.

Airside Economizer Cycle

Airside economizers are permitted for horizontally zoned AHUs with capacities over 1,416 L/s (3,000 cfm) only if economically feasible on a life-cycle cost basis. The locations of the outdoor air intakes of the economizer must comply with the ISC security requirements.

Hydronic Distribution Systems

In climates that exceed 1,000 heating degree-days (F-d), hot water heating coils must be used. In climates at or below 1,000 heating degree-days (F-d), electric heating coils are permitted.

The following types of hydronic distribution systems are acceptable: convectors, radiators, baseboard units, finned-tube radiation, radiant flooring, radiant ceiling panels, unit heaters, cabinet heaters, and passive chilled beams.

The fluid temperature in overhead piping, either exposed or in ceiling space, must be maintained at a temperature at least 1.5°C (3°F) above the dew-point temperature of the space to prevent condensation on the piping.

Provide control valves for each thermostatic interior and perimeter control zone.

Install valves on hydronic units so that they can be easily maintained or replaced.

If piping is installed under raised floors, provide moisture-detecting devices connected to the BAS and self-priming floor drains, to prevent flooding and excessive loading of the raised floor cavity.

Hybrid Distribution Systems

Hybrid systems are a combination of air, water, or refrigerant sources. Acceptable hybrid systems include: fan coil units, VAV units with reheat or recool coils, air-source and water-source heat pumps, unit ventilators, unit heaters, humidifiers, active chilled beams, floor mounted induction units and similar equipment types.

Fan Coil Units

In perimeter zones use a four-pipe fan coil unit system for heating and cooling. In interior zones use a two-pipe fan coil unit system for cooling. Due to maintenance and potential condensate problems, ceiling-mounted fan coil units are permitted only in machine rooms and other back-of-house type spaces.

Radiant Heating and Cooling

Radiant heating is permitted in ceilings or embedded in the floors of perimeter zones, in ceilings of interior zones that are below the roof, and in the floors above unheated exposed spaces.

Chilled beams and radiant cooling panels must be used with caution. The dew point temperature of the space must be maintained below the chilled beam water temperature at all times.

The integrity of the building envelope must be determined before using chilled beams and radiant cooling panels. Condensation can develop on the unit in buildings without tight envelopes that are located humid climates zones.

Naturally ventilated buildings or buildings using off hours set backs are problematic with chilled beams. Condensation above the work area or above the ceiling must be avoided.

To maintain acoustical comfort, avoid high air flow rates from the induction nozzles on active chilled beams.

Controls/Building Automation Systems (BAS)

For new construction, use DDC with an open BACnet or LonTalk communication protocol in accordance with ASHRAE Standard 135-2004.

For repair and alteration projects and new additions to existing projects, the following options are permitted: 1) installation of DDC with the BACnet or LonTalk protocol, 2) integrating the existing system with customized gateways to the BACnet or LonTalk protocol.

See Sections 5.6 and 5.18 for additional requirements.

Coordination of Digital Control Systems

Digital building control systems are beginning to share common protocols, compatible equipment, and uniform standards with other building IT services. GSA seeks BAS designs that integrate with other IT systems to minimize costs and improve operations. Since this technology is in a constant state of improvement and contract methodologies are not well established in the design and construction industry, the A/E and Project Manager must coordinate the design of controls and monitoring systems with the PBS CIO (Chief Information Officer) at the beginning of design. These systems include, but are not limited to; utility metering, HVAC building automation systems, lighting controllers, and renewable energy systems.

The CIO may provide Government Furnished Equipment and will specify system components to insure compatibility with the GSA network. Related IP network design must be reviewed and approved by the CIO. All network connections will be made through the GSA network. All server applications must be able to be hosted in a virtual server environment. Other GSA IT policies and procedures may also apply.

5.6 Special Area HVAC Systems

Special areas such as atriums, entrance lobbies and vestibules, cafeterias, mail rooms, loading docks, computer and server rooms, fire pump rooms, and fire command centers must have dedicated air-handling units, separate from all other air-handling units in the building, with individual controls to condition these spaces as required. The energy requirements for these special areas are significant and must be included in the building energy analyses.

Lobbies, Atriums, and Entrance Vestibules

Lobbies and atriums must be maintained at positive pressure with respect to the outdoors, but negative with respect to adjacent spaces. Entrance vestibules must be maintained at negative pressure with respect to adjacent spaces, but at positive pressure with respect to the outdoors. Radiant floor cooling and chilled beams are not permitted.

Courtrooms

In accordance with the *Courts Design Guide* each courtroom must have its own dedicated air-handling unit, and each courtroom must be provided with a minimum of three thermostatic zones. Refer to Chapter 8 and the 2007 *U.S. Courts Design Guide* published by the Administrative Office of the United States Courts (AOC) for additional requirements.

Auditoriums

Auditoriums must have dedicated air-handling units. The use of airside economizer cycles must be determined in accordance with Section 5.5.

U.S. Marshals Service Areas

The U.S. Marshals Service area HVAC system must be designed for continuous operation and must be independently controlled and zoned. All ductwork, grilles and air circulation openings that penetrate the secure area, including prisoner circulation areas and detainee holding areas, must be provided with security bars. Detainee holding areas must be negatively pressurized with regard to adjacent spaces and exhausted directly to the outdoors through special filters. For additional requirements, refer to Chapter 8 and the U.S. Marshals Service (USMS) Publication 64.

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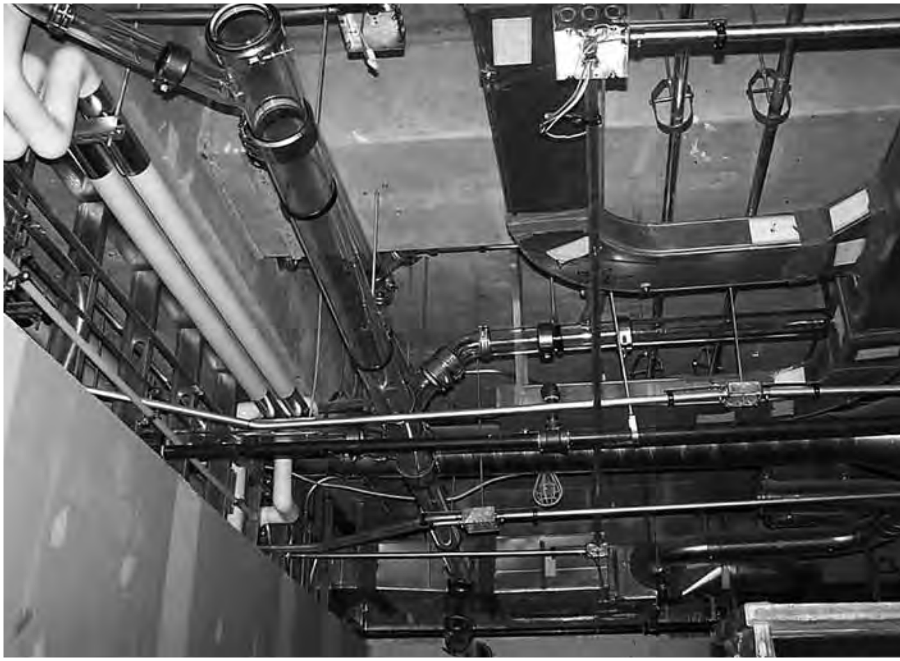
Energy performance of the building's HVAC, hot water, and interior lighting is optimized to be 30 percent above national standards set by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).



Firing Ranges

Special HVAC considerations are required for firing ranges. A firing range must be provided with a dedicated air-handling system. Heating and cooling supply air must be delivered to the area along and behind the firing line for occupant comfort conditions and to maintain a positive pressure in this area relative to down range and target areas. Powered exhaust air must be extracted from down range and target areas in sufficient quantity to remove smoke and maintain a clear line of vision to the target. Sixty percent of the total exhaust must be extracted at a point approximately one-third the distance from the firing line to the target area, and 40 percent of the total exhaust must be extracted from above the target area. All exhaust air must be filtered to preclude the emission of lead particulates and gunpowder residue into the atmosphere. The discharge of firing range exhaust air to the outdoors must be carefully located to prevent recirculation into the outdoor air intake of any HVAC system. Firing range systems must be capable of continuous operation, isolated from other building systems. A special filtration system must be provided to have clean air in the firing range. Design must include pre- and final high-efficiency particulate air (HEPA) filters.

Mail Rooms

A separate dedicated air-handling system must be provided for each mail room. Airflow must maintain negative pressure in the room relative to adjacent spaces.

Kitchens and Dishwashing Areas

Kitchens with cooking ranges, steam kettles, ovens, and dishwashers must be provided with dedicated makeup air and exhaust hoods or exhaust systems in accordance with the IMC and *ASHRAE Applications Handbook.* The operation of the kitchen exhaust systems must not affect the pressure relation between the kitchen and surrounding spaces. Both supply air and makeup air must be supplied and exhausted through the kitchen hood heat recovery system.

Kitchen hoods must extract air for exhaust from the surrounding areas to maintain the kitchen at negative pressure relative to the dining and adjacent areas. A separate AHU must be provided for the kitchen hood whenever makeup air from adjacent spaces is inadequate to meet the exhaust and pressurization requirements.

Areas of Refuge

Where required by the program or the client agency, the areas of refuge for emergency conditions must be provided with dedicated air-handling units, connected to emergency power to maintain positive pressure relative to surrounding spaces. See Chapter 8, *USMS Security Guidelines,* and ISC for additional design criteria.

Twenty-Four-Hour Spaces

All areas designated as requiring 24-hour operations must be provided with dedicated HVAC systems. Among these areas are:

- Computer and server areas
- Command Centers
- BAS computer processing areas
- Other areas designated by client agencies.

During normal operating hours, the use of the building central heating and cooling system is permitted. If the building's 24-hour peak load, including the dedicated outdoor air ventilation systems, exceeds 176 kW (50 tons), a dedicated chiller must be combined with the central system in which a dedicated central chilled water supply loop is provided.

All 24-hour HVAC systems must be supported by emergency power.

Information Technology Equipment Rooms

Information technology equipment rooms must be positively pressurized with respect to adjacent areas.

For rooms with cooling loads up to 281 kW (80 tons), self-contained units must be provided. These units must be specifically designed for this purpose and must contain compressors, air filters with at least a MERV 13 rating, humidifiers, and controls. They must be sized to allow for a minimum of 50 percent redundancy, either two units at 75 percent load or three units at 50 percent load. If the nature of the computer room is critical (as determined in the project's program requirements), three units sized at 50 percent of the design load must be used. Heat rejection from these self-contained units must be by air-cooled condensers or recirculating water-cooled condensers connected to a cooling tower or evaporative-cooled condenser. Waterside economizers must be used when possible.

For cooling loads greater than 281 kW (80 tons), chilled water air-handling systems must be provided. A dedicated chiller is required. A means of redundant backup must be provided for the dedicated chiller, either by multiple machines or through connection to the facility's chilled water plant.

To the extent possible, avoid any plumbing, piping, sanitary or storm piping in these areas.

In large information technology equipment rooms of 465 m^2 (5,000 sq. ft.) or larger, cooling of the sensible load (computer load) and control of the outdoor air ventilation and space relative humidity must be provided by separate air-handling systems.

If the computer room houses critical components, as defined in the project's program, the HVAC systems must be connected to the emergency generators.

Enclosed Vehicle Garages

Vehicle garage exhaust fans must be activated based on carbon monoxide sensors within the garage. Carbon monoxide sensors must also be located in all floor areas where vertical shafts penetrate the garage areas. Outdoor air must be provided through the shaft with the intake located on the roof or a minimum of 12.2 m (40 ft.) above grade. All the air must be exhausted above the roof or a minimum of 5 m (16 ft.) above grade.

Conference Rooms

Each conference room must have a separate thermostatically controlled zone. The outdoor air ventilation rate for each conference room must be designed for its peak occupancy.

5.7 Mechanical and Service Space Requirements

Space Requirements

A minimum of 4 percent of each floor's gross floor area must be provided for air-handling equipment. Where additional equipment is required, additional space on that floor must be provided as needed. A minimum of 1 percent of the building's gross area must be provided for the central heating and cooling plant (location to be agreed upon during the preparation of concept submission). All mechanical equipment rooms must be a minimum of 3.7 m (12 ft.) in height. Space requirements of mechanical and electrical equipment rooms must be based on the layout of required equipment drawn to scale within each room. All mechanical rooms above or below occupied spaces, including central plant equipment rooms, must have concrete enclosures or a double drywall system for minimizing noise transmission. See Chapter 3 for additional noise control requirements.

Service Access

Freight Elevators

To facilitate equipment access, maintenance, removal and replacement, a freight elevator stop must be provided to serve each floor and penthouse level housing HVAC equipment.

Stairways

Where stairs are required, they must allow for safe transport of equipment and components. Ship's ladders for access to the roof are not permitted.

Access Doors and Panels

Space must be provided around all HVAC system equipment as recommended by the manufacturer and for routine maintenance. Access doors or panels must be provided in ventilation equipment, ductwork, and plenums as required for on-site inspection and cleaning. Equipment access doors or panels must be readily operable and sized to allow full access for replacement or repair. Large central equipment must be situated to facilitate its replacement. The HVAC design engineer must ensure that provisions are made for removal and replacement of the largest and heaviest component that cannot be further broken down, without damage to the structure.

Ensure access doors and panels are fire rated and self-close where installed in a fire rated enclosure.

Equipment Access

Adequate methods of access must be included for items such as chillers, boilers, air-handling units, heat exchangers, cooling towers, reheat coils, VAV terminals in ceiling spaces and in equipment rooms, pumps, water heaters, and all devices that have maintenance service requirements.

Vertical Clearances

Central plant mechanical equipment rooms must have clear ceiling heights of not less than 3.7 m (12 ft.). Catwalks with stairways must be provided for all equipment (including cooling towers) that cannot be maintained from floor level. Where maintenance requires the lifting of heavy parts [45 kg (100 lb) or more], hoists must be installed. Design of service areas must preclude the need for hatchways.

Horizontal Clearances

Mechanical equipment rooms must be configured with clear circulation aisles and adequate access to all equipment. The arrangement must consider the future removal and replacement of all equipment. The mechanical rooms must have adequate doorways or areaways and staging areas to permit the replacement and removal of equipment without the need to demolish walls or relocate other equipment. Sufficient space areas for maintenance and removal of coils, filters, motors, and similar devices must be provided. Chillers must be placed to permit the pulling of tubes from all units. The clearance must equal the length of the tubes plus 610 mm (2 ft.). Air-handling units require a minimum clearance of 762 mm (2 ft. 6 in.) on all sides, except on the sides where filters and coils are accessed, where clearance must be equal to the length of the coils plus 610 mm (2 ft.).

Maintenance plans must be prepared on separate drawings that indicate the paths for removal and replacement of major equipment items. These clearance plans must also show clearances and, where applicable, access panels. These plans must be submitted in accordance with Appendix A.3.

Roof-Mounted Equipment

Mechanical equipment, except for cooling towers, air-cooled chillers, evaporative condensers, and exhaust fans, is not permitted on the roof of the building. Access to roof-mounted equipment must be by stairs or freight elevator; ship's ladders are not permitted.

Housekeeping Pads

Housekeeping pads must be at least 152 mm (6 in.) wider on all sides than the equipment they support and must be 152 mm (6 in.) thick.

Mechanical Rooms

All mechanical rooms must be mechanically ventilated to maintain room space conditions as indicated in ASHRAE Standard 62.1-2007 and ASHRAE Standard 15-2007. Unit heaters must be provided to maintain thermal conditions listed in Table 5-1. Water lines must not be located above motor control centers or disconnect switches and must comply with the requirements of NFPA 70. Mechanical rooms must have floor drains in proximity to the equipment they serve to reduce water streaks or drain lines extending into aisles. Mechanical rooms must not be used as return air, outdoor air, or mixing plenums.

Combustion Equipment Rooms

All rooms that contain combustion equipment must comply with the requirements in the ICC Mechanical Code. At a minimum, combustion equipment rooms must provide the required amounts of outdoor air for the combustion equipment through motorized dampers that are interlocked with the combustion equipment control system, and the room must be ventilated with a minimum of eight outdoor air changes per hour. Unit heaters must be provided to maintain thermal conditions in the combustion equipment room listed in Table 5-1. All valves above 8 feet from the floor must have chain-operated devices for ease of operation.

Chiller Equipment Rooms

All rooms for refrigerant units must be constructed and equipped to comply with ASHRAE Standard 15-2007: Safety Code for Mechanical Refrigeration. Chiller staging controls must be capable of DDC communication to the central building energy management system. All valves 2.4 m (8 ft.) above the floor line must have chain-operated devices for ease of operation.

Electrical Equipment Rooms

No water lines are permitted in electrical rooms, except for fire sprinkler piping.

Communications Equipment Rooms

Communications equipment rooms must be cooled in accordance with the requirements of EIA/TIA Standard 569. Rooms that house critical communications components must be provided with dedicated 24-hour air-conditioning systems that must be connected to the emergency power distribution system.

Elevator Machine Rooms

A dedicated heating and/or cooling system must be provided to maintain room mechanical conditions required by equipment specifications, and in accordance with Table 5-1 of this chapter.

Emergency and Standby Generator Rooms

The environmental systems must meet the combustion air requirements of the equipment. Rooms must be ventilated sufficiently to remove heat gain from equipment operation.

Ventilation for Heat Exchanger

The supply and exhaust louvers must be located to prevent short circuiting and the rooms must be maintained under negative pressure. The location of the air intakes and exhausts must be in compliance with ISC criteria.

Combustion Air

Generator combustion exhaust must be discharged at a minimum of 1 m (3 ft.) above the roof level and in compliance with the generator manufacturer's installation guidelines.

UPS Battery Rooms

Exhaust Air Requirements

The battery rooms must be maintained at a negative pressure with respect to adjacent spaces and must be exhausted directly to the outdoors at a rate calculated to be in compliance with IMC requirements and manufacturer's recommendations. Fans must be spark resistant and explosion proof, with motors out of the air stream. A dedicated exhaust air system must be provided to maintain negative pressure in the ductwork. The ductwork and accessories must be noncorrosive. The exhaust air must be discharged directly outdoors. Acoustical enclosures must be provided to maintain a maximum NC level of 35 in the room. The exhaust fans must be connected to the emergency power distribution system.

Safety Requirements

Battery rooms must be equipped with emergency eyewash and shower equipment (ANSI Standard Z358.1). Floor drains required at the emergency shower (within the battery room acid containment curb) must extend with acid waste piping to an acid neutralization tank before discharge to the sanitary sewer or building drain.

Loading Docks

The entrances and exits at loading docks and service entrances must be maintained at negative pressure relative to adjacent spaces. Overhead radiant heating or unit heaters must be provided.

Vertical Chases and Shafts

All pipes in vertical chases and shafts must have drain valves at the bottom of the risers for ease of maintenance. A floor drain must be provided in each chase or shaft. Access to the valves and floor drains must be provided.

5.8 HVAC Components

Air-Handling Units

AHU Capacities

All air-handling units must be sized to not exceed 11,800 L/s (25,000 cfm). Smaller units are permitted to facilitate flexible zone control, particularly for spaces that involve off-hour or high-load operating conditions.

AHU Housing and Accessories

All AHUs except OAVS must be provided with factory-fabricated mixing boxes on the return side of the AHU.

The AHU housing must consist of formed and reinforced, insulated panels, fabricated to allow removal for access to internal parts and components.

Use of a lining exposed to the air stream, including perforated inner wall, is not permitted. All AHUs must be double wall construction.

All joints between housing sections and all penetrations must be sealed airtight in accordance with SMACNA seal Class A. Penetrations must be covered with escutcheons, gaskets, or filled with suitable compound so there is no exposed insulation. Shaft seals must be provided where fan shafts penetrate the housing.

Access panels and doors must be provided with the same materials and finishes as the housing, and must be complete with hinges, latches, handles, and gaskets. Airtightness of the access panels and doors must be in accordance with SMACNA Class A. Inspection and access panels and doors must be sized and located to allow periodic maintenance and inspections.

Outdoor Air Intake Locations

The placement and location of outdoor air intakes are critical to the health and safety of the occupants and must be in compliance with the ISC criteria.

On buildings more than 12 m (40 ft.) tall, intakes must be located a minimum of 40 feet above grade. On buildings less than 12 m (40 ft.), the intakes must be located as high as practical on the roof or on a wall. Table 5-2 provides requirements for minimum separation distances between ventilation air intakes and other building features.

Outdoor air intakes must be ducted directly to the AHU cabinet; the equipment room must not be used as an outdoor air intake plenum.

Table 5-2

Air Intake Minimum Separation Distances

Object	Minimum Distance m	Minimum Distance ft
Garage entry, loading dock	7	25
Driveway, street, or public way	3	10
Limited-access highway	7	25
Cooling tower or evaporative condensers	7	25
Exhaust fans and plumbing vents	5	15
Kitchen supply and exhaust air	7	25

Temperature and Airflow Control

Psychrometric process charts must be prepared for each air-handling unit application, characterizing full-load and part-load operating conditions for all processes in the system, in accordance with Sections A.3 and A.4 of Appendix A. Air-handling unit/coil designs must ensure that conditioned space temperatures and humidity levels are within an acceptable range, per programmed requirements, Table 5-1, and other criteria in Section 5.3.

Limitation of Supply Air Temperature

HVAC systems with supply air temperatures below 10° C (50° F) (i.e., low temperature systems) are not permitted.

Supply air must be no lower than 10° C (50° F) dew point temperature and 11° C (52° F) dry bulb temperature to prevent condensation on the duct surfaces.

Supply, Return, and Relief Air Fans

Fan system power requirements that comply with the values obtained from Table 6.5.3.3.1A in ASHRAE Standard 90.1-2007, must be the basis for the design of AHUs. The performance of the fans must be tested in accordance with AMCA Standard 210. Fans must be selected on the basis of the system power and sound power requirements for full-load and part-load conditions. Fan motors must be sized so they do not run at overload anywhere on their fan operating curves. Fan operating characteristics must be checked for the entire range of flow conditions. Fan drives must be selected for a 1.5 service factor, fan shafts must be selected to operate below the first critical speed, and bearings must be selected for a minimum rating of 120,000 hours. A variable frequency drive (VFD) must be provided for each fan motor and located within the mechanical equipment room for the AHU. Metering devices for determining energy consumption data for each fan motor must be provided that are capable of transmitting the data to the central BAS.

Cooling and Heating Coils

Individual finned-tube cooling coils must be between six and eight rows with at least 2.1 mm between fins (12 fins per inch), to ensure that the coils can be effectively and efficiently cleaned. Dehumidifying coils must be selected for no more than negligible water droplet carryover beyond the drain pan at design conditions. All hot water heating and chilled water cooling coils must be copper tube and copper finned materials. Equipment and other obstructions in the air stream must be located sufficiently downstream of the coil so that it will not come in contact with the water droplet carryover. Cooling coils must be selected at or below 2.5 m/s (500 fpm) face velocity to minimize moisture carryover. Heating coils must be selected at or below 3.8 m/s (750 fpm) face velocity.

Drains and Drain Pans

Drain pans must be made of stainless steel, insulated, and adequately sloped and trapped to ensure drainage. Overflow connections must be provided and connected to the sanitary or storm line in accordance with the prevailing code. Drains in draw-through configurations must have traps with a depth and height differential between inlet and outlet equal to the design static pressure plus 25 mm (1 in.) minimum.

UV-C Emitters/Lamps

UV-C Irradiation: Ultraviolet light (C band) systems must be incorporated in all AHU containing cooling coils. The UV-C lamps must be installed downstream of the coils and above the condensate pans. UV-C systems must be designed for the minimum irradiance required to prevent the growth of microorganisms. Ozone concentrations in the discharge air from the UV-C system must not exceed 50 ppb (see Section 5.3). Systems must be specifically manufactured for this intended use. Safety interlocks must be provided on all access panels/doors. AHUs large enough for personnel entry must contain a provision for the deactivation, isolation, and locking out of the system power source in addition to safety interlocks provided. One or more sight glasses must be located to allow maintenance personnel to safely determine lamp operation.

Filters and Filter Sections

Air filtration must be provided in every air-handling system. Air-handling units must have a pre-filter and a final filter, each located upstream of the cooling and heating coils. The filter media must be fabricated so that fibrous shedding does not exceed levels prescribed by ASHRAE Standard 52.2-2007. The prefilters must have a MERV of 8, and the final filters must have a MERV of

13, as defined in ASHRAE Standard 52.2-2007. Filter racks must be designed for a maximum bypass leakage air around the filter media of 0.5 percent of the design supply airflow rate. Filters must be sized at 2.5 m/s (500 fpm) maximum face velocity.

The filter housing and all air-handling components downstream of the filter housing must not be internally lined with fibrous insulation. Double-wall construction or an externally insulated sheet metal housing is permitted. The filter change out pressure drop, not the initial clean filter rating, must be used in determining fan pressure requirements. Differential pressure gauges and sensors must be placed across each filter bank to allow quick and accurate assessment of filter loading as reflected by air-pressure loss through the filter, and the sensors must be connected to the BAS.

Where occupancy requirements or building functions are likely to generate airborne particles, vapors, or gases that result in concentrations exceeding those in Section 5.3, special air filtration or air cleaning components must be provided for the supply and return air, or dedicated and localized exhaust systems must be used to contain these contaminants.

Controls

All AHU must have DDC (BACnet or LonTalk) self-contained controls that are capable of being connected to the central BAS. Also, the controller must have a current-sensing device that transmits information to the BAS for calculating the energy consumption of the AHU motor.

VAV Terminal Units

VAV terminal units must be certified under the ARI Standard 880 Certification Program and must carry the ARI Seal. If fan-powered, the terminal units must be designed, built, and tested as a single unit including motor and fan assembly, primary air damper assembly, and any accessories. VAV terminals must be pressure-independent-type units. Air leakage from the casing of a VAV box/terminal must not exceed 2 percent of its rated capacity. VAV terminal units must be selected to provide the airflow rate required for the full-load thermal capacity of the zone and for the noise requirements for the space.

Fan-Powered Terminal Units

Fan-powered terminal units must have electrically communicated motors (ECM) for speed control to allow continuous fan speed adjustment from maximum to minimum, as a means of setting the fan airflow.

Fan-powered terminal units must have a filter/filter rack assembly with the filters having a MERV of 10 as defined in ASHRAE Standard 52.2-2007. The filter media must be fabricated so that fibrous shedding does not exceed levels prescribed by ASHRAE Standard 52.2-2007.

Filter racks must be designed to minimize the bypass of air around the filter media with a maximum bypass leakage of 0.5 percent of the rated airflow rate of the terminal unit. Filters must be sized at 2.5 m/s (500 fpm) maximum face velocity.

The return plenum box for fan-powered terminal units must be a minimum of 610 mm (24 in.) in length and must be double wall with insulation in between or contain at least one elbow where space allows. Fan-powered terminal units may have hot water heating coils used for maintaining temperature conditions in the space under partial-load conditions. Electric heating coils are allowed for climatic zones with 1,000 F-d or less.

Controls

All fan-powered VAV terminal units must have DDC (BACnet or LonTalk) self-contained controls that are capable of being connected to the BAS. Also, the controller must have a current-sensing device that transmits information to the BAS for calculating the energy consumption of the fan motor.

Fan Coil Units

Fan coil units must be certified under the ARI Standard 880 Certification Program and must carry the ARI seal. For perimeter spaces, four-pipe fan coil units must be equipped with cooling and heating coils with copper fins and tubes, MERV 10 filters, internal condensate drain, and overflow drain pan. For interior spaces, two-pipe fan coil units (cooling) are permitted. Installation of fan coil units above ceilings is not permitted. Fan coil controls must use three-speed motors. Two-way control valves must be used wherever variable-speed water flow devices are used in the system.

Controls

All fan coil units must have DDC (BACnet or LonTalk) self-contained controls that are capable of being connected to the BAS. Also, the controller must have a current-sensing device that transmits information to the BAS for calculating the energy consumption of the fan motor.

Radiant Panels and Chilled Beams for Cooling and Heating

Chilled beams and radiant panels must be certified by the Air Conditioning, Heating and Refrigeration Institute (AHRI). This certification, or the supporting documentation for certification, must be provided with the Concept Design Documentation.

For perimeter spaces, four-pipe control for each chilled beam or radiant panel zone is required. For interior spaces, two-pipe control for each chilled beam or radiant panel zone (cooling) is permitted. Two-way control valves must be used whenever variable-speed water flow devices are used in the system. For active chilled beam units, MERV 10 filters must be provided in the return air intakes.

Active chilled beams, or air delivery devices used with passive chilled beams or radiant panels, must be designed such that necessary minimum static pressure shall be generated by the DOAVS to maintain a sufficient airflow rate (e.g. induction ratio to the terminal units) at part-load conditions to remain above the minimum Air Distribution Performance Index (ADPI) pursuant to the requirements of PBS P 100-2010, Section 5.9.

Controls

Chilled beams and radiant panels must have DDC (BACnet or LonTalk) self-contained zone controls that are capable of being connected to the BAS. Also, the controllers must have current-sensing devices that transmit information to the BAS for calculating the energy consumption of the fan and pump motors for the supply air and water.

Finned-Tube Radiation

Hot water finned-tube radiation must have individual zone thermostatic control capable of connecting to a self-contained microprocessor that can interface with a BACnet or LonTalk DDC BAS.

Heat Recovery Equipment (Enthalpy or Sensible)

Heat recovery equipment must operate at a minimum of 70 percent efficiency at winter and summer outdoor design conditions.

Filters having a MERV of 10, as defined in ASHRAE Standard 52.2-2007, must be provided in all heat recovery equipment. The filter media must be fabricated so that fibrous shedding does not exceed levels prescribed by ASHRAE Standard 52.2-2007. Filters must be sized at 2.5 m/s (500 fpm) maximum face velocity.

The type of heat recovery equipment may be selected from the following alternatives:

Sensible Heat Recovery

- A runaround-type heat pipe system with solenoid valve control to operate under partial-load conditions.
- A cross flow, air-to-air (z-duct) heat exchanger. Z-ducts must be constructed entirely of non-corrosive sheet metal.
- A sensible heat-wheel. Sensible heat-wheels with variable-speed drives for controlling the temperature leaving the unit.
- A propylene glycol runaround coil with control valves and a pump for part-load conditions. The runaround coils, if selected, must be installed at the exhaust or relief discharges from the building and at the outdoor air intake into the building.

Total Heat Recovery

Enthalpy wheels must have a minimum purge area of 2 percent and variable-speed drives for controlling the enthalpy leaving the unit.

Kitchen Ventilation Equipment

Products of combustion from kitchen cooking equipment and appliances must be discharged directly from the building to outdoor air through the use of kitchen ventilation systems involving exhaust hoods, grease ducts, and makeup air systems where required. A Type I hood must serve commercial kitchen equipment applications constructed in compliance with UL 710 and designed in accordance with the IMC. Grease ducts must be constructed in accordance with the IMC. Both supply air and makeup air must be supplied and exhausted through the heat-recovery type kitchen hood system. The velocity of the kitchen exhaust air must comply with the applicable IMC requirements.

Motors

All motors must comply with the requirements of Section 10.4.1 of ASHRAE Standard 90.1-2007. Motors that are 0.37 kW (½ hp) and larger must be polyphase.

Boilers

Boilers for hydronic heating applications must be modular units, with efficiencies that comply with the values given in Table 6.8.1F, Chapter 6 of ASHRAE Standard 90.1-2007. Boilers must be installed in a dedicated mechanical room with all provisions made for breaching, flue stack, and combustion air, as stated in Section 5.7.

The modular units must be packaged, with all components and controls factory preassembled. Controls and relief valves to limit pressure and temperature must be specified separately.

Boilers must be piped to a common heating water header with provisions to sequence boilers online to match the load requirements. All units must have valving to provide isolation of offline units without interruption of service. Boiler systems must be provided with expansion tanks, heat exchangers, water treatment, and air separators, as required.

Gas and Fuel Oil Trains

Boiler gas trains and fuel oil supply trains must be in accordance with International Risk Insurance (IRI) standards.

Controls

Each boiler must have a DDC (BACnet or LonTalk) self-contained controller that is capable of being connected to the BAS. The controller must have a current-sensing device that transmits information to the BAS for calculating the energy usage (natural gas, fuel oil, electricity), and the energy consumption of the fan and fuel-pump motors.

Hot Water Piping and Pumps

Pumps must be of a centrifugal type and must generally be selected to operate at 1,750 RPM and at 80 percent to 85 percent pumping efficiency. Both partial-load and full-load performance must be shown on the pump curve. The number of primary hot water pumps must correspond to the number of boilers, and a standby pump must be designed to supply any of the circuits. Variable volume pumping systems are required for all secondary piping systems. The specified pump motors must not overload throughout the entire range of the pump curve. Pumps for each boiler group must be arranged with piping, valves, and controls to allow each boiler group to operate independently of the other boiler groups.

Controls

Each hot water pump or combination of pumps must have a DDC (BACnet or LonTalk) controller that is capable of being connected to the BAS. Also, each controller must have one or more current-sensing devices that transmit information to the BAS for calculating the energy consumption of the pump motors.

Chillers

Chiller efficiencies for full-load and part-load operations (i.e., COP and IPLV) must not be less than those listed in Section 6.4.1.1 of ASHRAE Standard 90.1-2007.

For chilled water systems of 500 tons and larger, centrifugal chillers must be used. Below 500 tons, reciprocating compressor, scroll, and rotary screw-chillers are permitted. Below 65 tons, air cooled chillers are permitted. Variable frequency compressors or head pressure control, if used, must be demonstrated on a life-cycle cost basis.

Chillers must be piped to a common chilled water header with provisions to sequence chillers online to match the load requirements. All required auxiliaries for the chiller systems must be provided, such as expansion tanks, heat exchangers, water treatment, and air separators, as required. Each chiller must have an automatic shutoff valve.

Chiller condenser piping must be equipped with recirculation/bypass control valves to maintain incoming condenser water temperature within the chiller manufacturer's recommended minimum set point.

The design of refrigeration machines must comply with the Clean Air Act amendment Title VI, Stratospheric Ozone Protection, and CFR 40, Part 82, Protection of Stratospheric Ozone.

CFC refrigerants are not permitted in new chillers. Commonly used refrigerants such as HCFC-123, HFC-134a, and HFC-410a are acceptable.

Refrigeration machines must be equipped with isolation valves, fittings, and service apertures, as appropriate for refrigerant recovery during servicing and repair, as required by Section 608 of the Clean Air Act, Title VI. Chillers must also be easily accessible for internal inspections and cleaning.

BACnet or LonTalk microprocessor-based controls must be used. The local control panel must have self-diagnostic capability; integral safety control and setpoint display, such as run time; operating parameters; electrical low voltage and loss of phase protection; current and demand limit control; and output/input-COP [input/output (kW/Ton)] information. Chiller staging controls must be capable of DDC communication to the central BAS. Each chiller must have a metering device for transmitting energy consumption data to the central BAS.

Cooling Towers

Multiple cell towers and isolated basins are required to facilitate operations, maintenance, and redundancy. The number and capacity of cells must match the number and capacity of chillers. Supply piping must be connected to a manifold to allow for any combination of equipment use. Cooling tower basins and housing must be constructed of stainless steel. Wind and seismic design must be in conformity with the International Building Code.

Cooling towers must be equipped with makeup and blowdown meters, conductivity controllers and overflow alarms. Cooling towers must be equipped with efficient drift eliminators that achieve drift reduction to a maximum of 0.002 percent of the recirculated water volume for counterflow towers and 0.005 percent of the recirculated water flow for cross-flow towers.

Where economically feasible, capture and use condensed water from the cooling coils of OAVS with cooling capacities greater than 65,000 Btu/h (19kW) as a supplemental source for cooling tower makeup water.

Induced draft cooling towers with multiple-speed or variable-speed condenser fan controls must be provided. Induced draft towers must have a clear distance equal to the height of the tower on the air intake side to comply with the air velocity requirements of the manufacturer.

Multiple towers must have equalization piping between cell basins. Equalization piping must include automatic isolation valves and shutoff valves between each cell to control water flow only over those towers that are in use. The piping arrangement, and strainer and filter placement must be provided for removal of accumulated solids and sediments from the system. Cleanouts for sediment removal and flushing from basin and piping must be provided.

Cooling towers must have ladders and platforms for ease of inspections and replacement of components. Variable-speed pumps for multiple cooling towers must not operate below 30 percent of rated capacity.

If the cooling tower is located on the building structure, vibration and sound isolation must be provided (see Section 5.16 for additional details). Cooling towers must be elevated to maintain required net positive suction head on condenser water pumps and to provide a 1.2 m (4 ft.) minimum clear space beneath the bottom of the lowest structural member, piping, or sump, to allow reroofing beneath the tower.

Special consideration must be given to de-icing cooling tower fills if they are to operate in subfreezing weather, such as chilled water systems designed with a waterside economizer. A manual shutdown for the fan must be provided. If cooling towers operate intermittently during subfreezing weather, provisions must be made for draining all piping during periods of shutdown. For this purpose, indoor drain-down basins are required. Cooling towers with waterside economizers that are designed for year-round operation must be equipped with basin heaters. Condenser water piping located above grade and down to 1 m (3 ft.) below grade must have heat tracing.

See Chapter 7, Fire Protection Engineering and Life Safety, for fire protection requirements for cooling towers.

Controls

Each cell must have a DDC (BACnet or LonTalk) self-contained controller that is capable of being connected to the BAS. Each cell must have a metering device for transmitting energy and water consumption data to the central BAS. The controller must have a current-sensing device that transmits information to the BAS for calculating the energy consumption of the fan motor.

Waterside Economizers

Plate heat exchangers, designed and manufactured specifically for use as waterside economizers, must have a 1.2°C (2°F) approach between the entering condenser water and the leaving chilled water temperatures. The waterside-economizer must be capable of providing 5.5°C (42°F) chilled water at the heat exchanger and must have a dedicated pumping system. The cooling towers used for the waterside economizer cycle must have complete freeze protection and must be capable of operation at design winter conditions.

Waterside economizers must be piped in parallel and sequenced with the chillers online to match the load requirements. Waterside economizers must have automatic control and shutoff valves.

Controls

BACnet or LonTalk microprocessor-based controls must be used. The local control panel must have self-diagnostic capability; integral safety control and setpoint display. Waterside economizer staging controls must be capable of DDC communication to the central BAS. The waterside economizer must have a metering device for transmitting energy consumption data to the central BAS. The controller must have a current-sensing device that transmits information to the BAS for calculating the energy consumption of the pump motors.

Chilled Water and Condenser Water Piping and Pumps

Pumps must be centrifugal type and must generally be selected to operate at 1,750 RPM and 80 percent or greater pumping efficiency. Both partial-load and full-load performance must be shown on the pump curve. The number of primary chilled water and condenser water pumps must correspond to the number of chillers, and a standby pump must be provided for each chilled water and condenser water circuit. Variable-volume pumping with variable-speed drives is permitted. The specified pump motors must not overload throughout the entire range of the pump curve.

Controls

Each pump or combination of pumps must have a DDC (BACnet or LonTalk) self-contained controller that is capable of being connected to the BAS. Also, the controller must have a current-sensing device that transmits information to the BAS for calculating the energy consumption of the pump motor or motors.

5.9 Air Distribution

Air Delivery Devices

Supply air is distributed to occupied zones through various types of air delivery devices, including ceiling diffusers, and grilles mounted in sidewalls, sills, and floors. Air is supplied to these devices from variable air volume (VAV) terminal units or constant air volume (CAV) terminal units, including series-type fan-powered VAV terminal units. Ceiling diffusers or booted-plenum slots must be specifically designed for VAV air distribution. Booted plenum slots must not exceed 1.2 m (4 ft.) in length unless more than one source of supply air is provided. The locations of the air delivery devices and the ranges of their outlet airflow rates must be selected to ensure that the air diffusion performance index (ADPI) values remain above 80 percent during all full-load and part-load conditions, and below the specified noise level to achieve the background noise criteria, in accordance with the test procedures specified in Appendix A of ASHRAE Standard 113-2005. Adequate space ventilation requires that the selected diffusers effectively mix the total air in the room with the supplied conditioned air that contains adequate ventilation air.

Table 5-3

Recommended Air Velocities for Supply, Ducted Return, and Exhaust

	Controlling Factor—Noise Generation			
	Main Ducts		Branch Ducts	
Application	m/s	fpm	m/s	fpm
Private offices Conference rooms Libraries	6	1,200	4	800
Theaters Auditoriums	4	800	2	400
General offices	7.5	1,500	5	1,000
Cafeterias	9	1,800	6	1,200

Air is to be returned or exhausted from occupied zones through grilles, slots and other openings located in sidewalls and ceilings.

Sizing of Ductwork

Constant-volume supply, return, and exhaust ductwork must be sized using the equal friction method. Pressure drops must not exceed 20 Pa (0.08 in. w.c.) for every 30 m (100 ft.).

Supply air ductwork for variable-volume systems must be sized using the static regain method.

Supply, return, and exhaust air ductwork must be sized to limit the design static pressure to values that will minimize fan power, consistent with the functional requirements of the zones being served.

The design air velocities must not exceed the values shown in Table 5-3, when noise generation is a controlling factor.

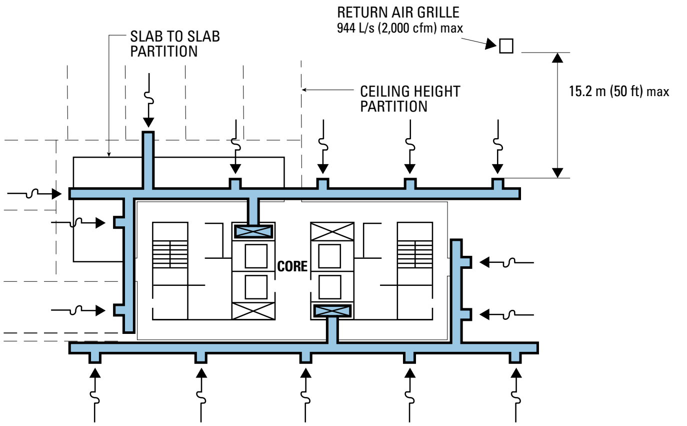
Energy consumption, security, and sound attenuation must be major considerations in the routing, sizing, and material selection for the air distribution ductwork.

In mechanical equipment rooms a minimum 2.1 m (7 ft.) clearance must be maintained under ductwork for maintenance purposes.

Sizes and pressure classification of all ductwork must be identified, labeled and specified in the construction documents.

Figure 5-1

Ceiling Return Plenum with Minimal Return Ductwork



Plenum and Ducted Return Air Distribution

To ensure that air drawn through the most remote zone actually reaches the horizontally zoned air-handling unit (AHU), the horizontal distance from the return air register in the farthest zone in a plenum to a return duct inlet must not exceed 15.2 m (50 ft.). For areas where special conditions or noise criteria are to be met, such as auditoriums, judge's chambers, and courtrooms, return air must be ducted from each return air register. No more than 944 L/s (2,000 cfm) must be collected at any one return register. Figure 5-1 illustrates an example of an open ceiling plenum with return air ductwork. All multi-floor-type return air risers must be ducted.

Where fully ducted return systems are used, consider placing return grilles low in walls or on columns to complement ceiling supply air.

Return air ducts in the ceiling plenum of the floor below the roof must be insulated.

Construction of Ductwork

Supply, return and exhaust air ductwork must be designed and constructed in accordance with ASHRAE Standard 90.1-2007, Section 6.4.4.2: Ducts and Plenum Leakage; the *ASHRAE Handbook of Fundamentals*, Duct Design Chapter; the *ASHRAE HVAC Systems and Equipment Handbook*, Duct Construction Chapter; *SMACNA HVAC Duct Construction Standards—Metal and Flexible*; and the following:

Materials

Ductwork must be fabricated from galvanized steel, black iron, copper, aluminum, or stainless steel sheet metal, depending on applications and code requirements.

Metal thickness, configurations of ducts and fittings, methods of ductwork reinforcement, and duct construction methods must comply with the *SMACNA HVAC Duct Construction Standards—Metal and Flexible*. Sheet metal materials must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

Insulated flexible duct (flex duct) may be used for ductwork downstream of the terminal units where static pressures are less than 250 Pa (1 in. w.c.). The length of the flex duct must not exceed the distance between the low-pressure supply air duct and the diffuser plus 20 percent, to permit relocation of diffusers in the future, while minimizing replacement or modification of the hard ductwork distribution system. Flex duct runs must not exceed 1.5 m (5 ft.), must not contain more than two bends, and must be installed in accordance with manufacturers' guidelines.

Pressure loss in ductwork must be designed to comply with the criteria stated in 5.9. This can be accomplished by using smooth transitions and elbows with a radius of at least 1.5 times the radius of the duct. Where mitered elbows are used, double foil sound-attenuating turning vanes must be provided. Mitered elbows are not permitted where duct velocity exceeds 10.2 m/s (2,000 fpm).

Joints and Connections

All supply, return and exhaust ductwork construction must be specified to meet Seal Class A in accordance with *ANSI/SMACNA 006-2006 HVAC Duct Construction Standards Metal And Flexible*—Third Edition. All ductwork joints and all connections to air-handling units and air distribution devices must be sealed with mastic—including all supply and return ducts, any ceiling plenums used as ducts, and all exhaust ducts. If using tape, the joint sealing tape for all connections must be of reinforced fiberglass backed material with field-applied mastic and hardcast coating. Use of pressure sensitive tape (e.g., duct tape or metal tape) is not permitted.

Return air plenums must be sealed airtight with respect to the exterior wall and roof slab or ceiling deck to avoid creating negative air pressure in exterior wall cavities that would allow an intrusion of untreated outdoor air.

Testing of Air Distribution Systems

Air distribution systems must be tested for leakage twice during the construction process: a) before insulation or field installation; and b) after connections to terminal units, air delivery and return devices, and return air and exhaust air fans have been made.

Before Field Installation

A random selection of individual duct sections is to be tested to validate fabrication procedures and the tightness of longitudinal joints. Each air supply, return, and exhaust duct section to be tested must have a minimum of a 6.1 m (20 ft.) straight run, and a minimum of two elbows. For these tests, the duct sections are to be positively or negatively pressurized to the values that represent the pressures exerted on the duct system at the intended locations of the tested sections (i.e., supply, return, exhaust), and not the total static pressure developed by the supply, return, or exhaust fan. The maximum leakage rate of each duct section must not exceed 38 l/s/100 m^2 (7 cfm/100 ft^2) of duct surface area. If the failure rate is more than one out of ten tests, all sections must be tested.

After Connections to Terminal Units and Air Delivery Devices

Air leakage in the supply air and return/exhaust air distribution systems must be conducted separately.

After field installation and connections of the supply air ductwork are made to the AHU and the OAVS, the terminal units, and the air delivery devices, the ends of the ducts are to be blanked off (airtight) and the supply air distribution system pressurized with calibrated fans to values that represent the upstream pressures at the terminal units at full flow conditions. At least three contiguous measures at 10-minute intervals are to be obtained with repeated values to within +/- 5 percent of the test pressure. The maximum leakage rate of the supply air distribution system from fan discharge to air delivery devices must not exceed 5 percent of the design airflow rate for the AHU. For systems greater than 11,800 l/s or 25,000 cfm, the supply air distribution system may be tested in sections with plastic sheeting separating the sections. After the test, the plastic is to be cut away through access doors installed for that purpose. The maximum leakage rate of the sections combined must not exceed 5 percent of the design airflow rate for the AHU.

For return and exhaust air distribution systems, the test procedure is similar, except the tests are to be conducted under negative pressures. After field installation and connections of the return and exhaust air ductwork are made to the return air fan, AHU, and the exhaust air fan, the ends of the ducts are to be blanked off (airtight) and the return and exhaust air distribution system negatively pressurized with calibrated fans to values that represent the upstream pressures at the return air fan, AHU and exhaust fans at full flow conditions. At least three contiguous measures at 10-minute intervals are to be obtained with repeated values to within +/- 5 percent of the test pressure. The maximum leakage rate of the return and exhaust air distribution system from the return or exhaust air grilles to the return air fan, AHU or exhaust fan must not exceed 5 percent of the design return airflow rate for the return air fan, AHU, or the exhaust airflow rate of the exhaust fan. For large systems (approaching the 11,800 l/s or 25,000 cfm limitation), the return and exhaust air distribution system may be tested in sections with plastic sheeting separating the sections. After the test, the plastic is to be cut away through access doors installed for that purpose. The maximum leakage rate of the sections combined must not exceed 5 percent of the design return airflow rate for the return air fan, AHU or exhaust air fan.

5.10 Humidification

Makeup water for direct evaporation humidifiers must originate directly from a potable source. Humidifiers must be designed so that microbiocidal chemicals and water treatment additives are not emitted in ventilation air. All components of humidification equipment must be stainless steel. Air washer systems are not permitted for cooling.

Where humidification is necessary, atomized hot water, clean steam, or ultrasound must be used and must be generated by electronic or steam-to-steam generators; chemically treated water must not be used for humidification.

When steam is required during summer seasons for humidification or sterilization, a separate clean steam generator must be provided and sized for the seasonal load. Humidifiers must be centered on the air stream to prevent stratification of the moist air. All associated equipment and piping must be stainless steel.

Controls

Each humidifier must have a DDC (BACnet or LonTalk) self-contained controller that is capable of being connected to the BAS. Each humidifier must have a metering device for transmitting energy and water consumption data to the central BAS.

5.11 Water Treatment

A licensed water treatment specialist must design the water treatment for closed and open hydronic systems with consideration of the operational and maintenance needs of all system equipment including such components as boilers, chillers, cooling towers, other heat exchangers, pumps, and piping. The design must address four aspects of water treatment: biological growth, dissolved solids and scaling, corrosion protection, and environmental discharge regulations. Subject to the specific requirements of the components, the performance of water treatment for closed and open systems must include:

Closed Systems:

- The pH must be in the ranges of 8.5–9.5 for chilled water systems, and 9–10.5 for heating water systems.
- The alkalinity of the water must be maintained between 100 and 500 ppm.
- Total dissolved solids must have a maximum value not to exceed 5 ppm.

Open Systems:

- The pH of the water must be maintained between 7.5 and 9.5.
- The alkalinity of the water must be maintained between 100 and 500 ppm.
- The iron content of the water must have a maximum value not to exceed 3 ppm.
- Soluble copper must have a maximum value not to exceed 0.2 ppm.
- Total dissolved solid must have a maximum value of 5 ppm.
- Total aerobic plate counts shall have maximum values not to exceed 1,000 organisms/ml, and an additional limit of 10 CFU/ml *Legionella.*

The methods used to treat the systems' makeup water must have demonstrated prior success in existing facilities on the same municipal water supply and must follow the guidelines outlined in *ASHRAE Applications Handbook.*

The chemical feed system must have BACnet or LonTalk self-contained controls.

John J. Duncan Federal Building
Knoxville, Tennessee

Renovation to this 1988 building (shown at far left) included replacing the cooling tower and installing a super-efficient chiller half the size of the original unit.

5.12 Primary Heating Systems

GSA requires low-temperature hot water heating systems, with the lowest working pressure suitable for the system and a maximum temperature limitation of 93.3°C (200°F). Supply temperatures and the corresponding temperature drops for space heating hot water systems must be set to best suit the equipment being served. Total system temperature drop must not exceed 16.7°C (30°F). The temperature drop for terminal unit heating coils must be 11.1°C (20°F). The design water velocity in piping must not exceed 2.4 m/s (8 fps), or the design pressure friction loss in piping systems must not exceed 0.4 kPa/m (3 ft. per 100 ft.), whichever is smaller, but not less than 1.2 m/s (4 fps). Steam heating for individual spaces is not permitted.

District Steam Heating

If steam is furnished to the building, it must be converted to hot water with a heat exchanger in the mechanical room near the entrance into the building. The designer must investigate the use of district steam condensate for preheating domestic hot water. Steam heating is not permitted inside the building, other than the conversion of steam to hot water in the mechanical room.

Hot Water Heating Systems

The use of electric resistance and/or electric boilers as the primary heating source for the building is prohibited in climates that exceed 1,000 F-d.

Freeze Protection

Propylene glycol manufactured specifically for HVAC systems must be used to protect hot water systems from freezing where extensive runs of piping are exposed to weather where heating operations are intermittent, or where coils are exposed to outdoor air. Freeze protection circulation pumps must be provided along with polypropylene glycol. Heat tracing systems are not acceptable for systems inside the building. Glycol solutions must not be used directly in boilers, because of corrosion caused by the chemical breakdown of the glycol. The water makeup line for glycol systems must be provided with an inline water meter to monitor and maintain the proper percentage of glycol in the system. Provisions must be made for drain down, storage, and reinjection of the glycol into the system.

Radiant Heat

Radiant heating systems (hot water or gas fired) may be overhead or underfloor type. Electric radiant heating is permitted for small, remote areas.

5.13 Primary Cooling Systems

The primary cooling system includes chillers, chilled water, and condenser water pumps, cooling towers, piping, and piping specialties. The chilled water systems must have a temperature differential between 5.5°C and 6.7°C (10°F and 12°F) for HVAC systems that primarily use fan coil units. For HVAC systems that primarily use air-handling units, the temperature differential must be between 6.7°C and 8.9°C (12°F and 16°F). The chilled water system must have a design supply water temperature between 4.4°C and 7.2°C (40°F and 45°F). In climates with low relative humidity, 7.8°C (46°F) may be used. Design water velocities must not exceed 2.4 m (8 ft.) per second, and pressure drop must not exceed 0.4 kPa/m (3 ft per 100 ft) of pipe.

Byron G. Rogers
U.S. Courthouse
Denver, Colorado

This renovated courthouse's operations and maintenance practices earned GSA's first LEED Gold rating for an existing building.

District Chilled Water

If chilled water is furnished to the building, it must be used in conjunction with a heat exchanger in the mechanical room near the entrance into the building.

Chilled Water Systems

Mechanical equipment rooms must be designed in accordance with the requirements of ASHRAE Standard 15-2007: Safety Code for Mechanical Refrigeration. Chiller leak detection and remote alarming must be connected to the BAS.

Propylene glycol manufactured specifically for HVAC systems must be used for freeze protection. The concentration of antifreeze must be kept to a practical minimum because of its adverse effect on heat exchange efficiency and pump life. The water makeup line for glycol systems must be provided with an inline water meter to monitor and maintain the proper percentage of glycol in the system. All coils exposed to outdoor airflow must be provided with freeze protection thermostats and control cycles. Provisions must be made for drain down, storage, and reinjection of the glycol into the system.

5.14 Piping Systems

All HVAC piping systems must be designed and sized in accordance with the latest editions of the *ASHRAE Fundamentals Handbook* and the *ASHRAE HVAC Systems and Equipment Handbooks.*

Hot water and chilled water systems must use a four-pipe main distribution system. Dual temperature piping systems are not permitted. Loop piping for terminal or branch circuits must be equipped with automatic flow control valves. Each terminal unit or coil must be provided with isolation valves on both the supply and return, a flow-indicating balance valve on the return line, a two-way control valve, and either variable primary pumping or constant primary/variable secondary pumping. Isolation valves must be provided on all major pipe branches, such as at each floor level, building wing, or mechanical room. Connections to terminal units shall be with rigid piping; flexible piping or hose is not permitted.

Piping Material

Materials acceptable for piping systems are black steel, cast iron and copper. Table 5-4 cites which commercial standard must be used for piping material.

Table 5-4

Piping Material Applications

Standard Piping Schedule	Use	Comment
ASTM Schedule 40	Chilled water up to 300 mm (12 in.) dia. Condenser water up to 300 mm (12 in.) dia.	1035 kPa (150 psig) fittings
	Hot water up to 100 mm (4 in.)	Test to 2,100 kPa (300 psig)
	Natural Gas Fuel Oil	Weld and test to 2,100 kPA (300 psig)
	Steam	100 kPa (15 psig) to 1035 kPa (150 psig)
ASTM Schedule 30	Chilled water over 300 mm (12 in.) dia. Condenser water over 300 mm (12 in.) dia.	1,035 kPa (150 psig) fittings Standard weight pipe over 300 mm (12 in.) dia.
ASTM Schedule 80	Steam condensate	
Copper Tubing	Chilled water up to 102 mm (4 in.) Condenser water up to 102 mm (4 in.)	Use Type K below-ground with brazed joints and Type L above ground
	Domestic water	Lead-free solder connections
	Refrigeration	Type ARC
Cast Iron	Sanitary waste, vent, storm	

Pipe Fittings

Pipe fittings must be in conformance with the GSA specifications. For copper piping, brazed and soldered fittings are acceptable; press type, grooved or mechanically formed T type fittings are not acceptable. Steel piping may be threaded, flanged, welded, or grooved type.

Hydronic Criteria for High Rise Buildings

All HVAC and plumbing systems in buildings that exceed 45 m (150 ft.) in height or have operating pressures exceeding 860 kPa (125 psi) at the pump discharges must be designed to perform in accordance with the high pressure piping criteria in ASTM Standards, and to be dynamically tested at 1.5 times the operating pressures.

Air Control

Pressurized diaphragm expansion tanks must be appropriately sized for closed piping systems. Air separators and vents must be provided on closed hydronic systems to remove accumulated air within the system. Automatic bleed valves must only be used in accessible spaces in mechanical rooms, where maintenance personnel can observe them, and they must be piped directly to open drains. Manual bleed valves must be used at terminal units and other less accessible high points in the system. Air vents must be provided at all localized high points of the piping systems and at each heating coil. Likewise, system drains must be provided at all localized low points of the heating system and at each heating coil.

Cathodic Protection

The need for corrosion protection for underground metallic piping must be evaluated by a soils resistivity test. Cathodic protection or another means of preventing pipe corrosion must be provided, if required by the geotechnical report.

Isolation of Piping at Equipment

Isolation valves, shutoff valves, bypass circuits, drain valves, flanges, and unions must be provided for piping at equipment to facilitate equipment repair and replacement. Equipment requiring isolation includes boilers, chillers, pumps, coils, terminal units, and heat exchangers. Valves must also be provided for zones off vertical risers, including drain valves.

Flexible Pipe Connectors

Flexible pipe connectors must be fabricated from annular close pitched corrugated and braided stainless steel. All pumps, chillers, cooling towers, and other rotating equipment must have flexible connectors. All flexible piping must be sized one size larger than the piping connected size.

Piping System and Equipment Identification

All pipes, valves, and equipment in mechanical rooms, shafts, ceilings, and other spaces accessible to maintenance personnel must be identified with color-coated piping or color-coded bands, and permanent tags indicating the system type and direction of flow for piping systems or type and number for equipment, in accordance with the ASHRAE handbooks. The identification system must also tag all valves and other operable fittings in accordance with ASTM Standard A13.1-1961(R-1965).

5.15 Thermal Insulation

All insulation materials and accessories must comply with the fire and smoke-developed index in accordance with the requirements in the IMC. Accessories such as adhesives, mastics, cements, and tapes must meet the same requirements.

Insulation must be provided in accordance with Section 6.4.4.1 of ASHRAE Standard 90.1-2007. Insulation that is subject to damage or reduction in thermal resistivity must be contained within a metallic jacket. If subject to becoming wet, it must also be enclosed with a vapor seal (such as a vapor barrier jacket). All exposed piping must have PVC jacketing, and concealed piping must have all-purpose jacketing.

Duct Insulation

All exposed ductwork must have sealed canvas or rigid fiberboard jacketing. All concealed ductwork must have foil face jacketing.

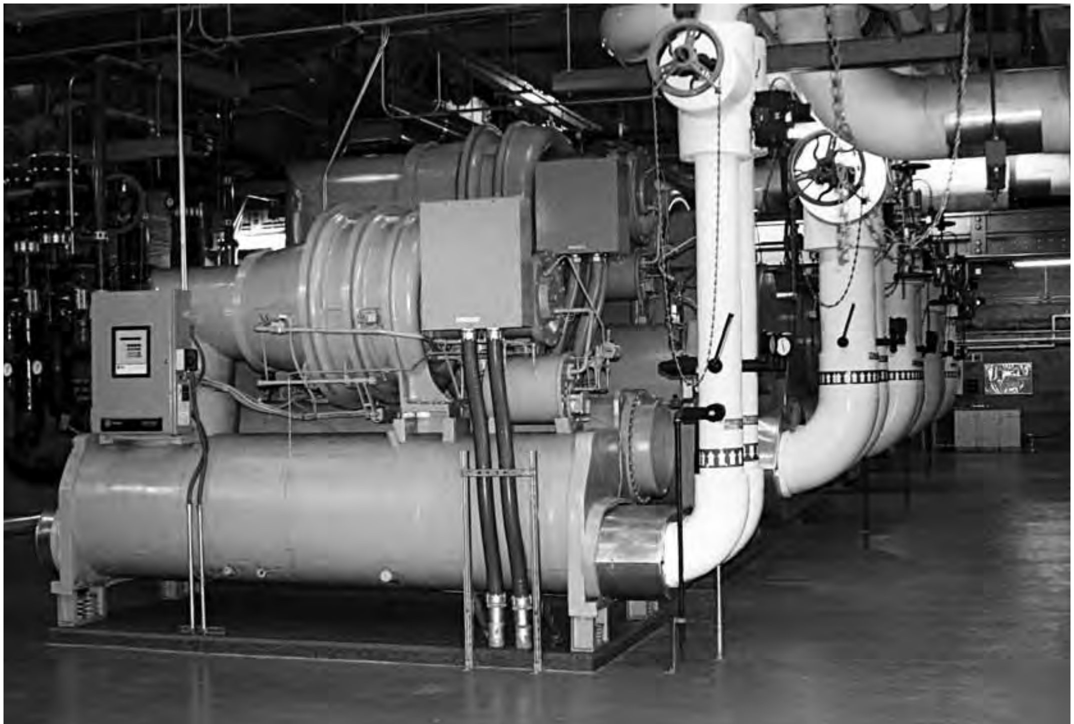
The insulation must comply with fire and smoke-developed index in accordance with the requirements in the IMC. Accessories such as adhesives, mastics, cements, tapes, etc., must meet the same requirements.

Supply Air and Outside Air Ductwork

All supply air and outside air ducts must have external insulation of sufficient thermal and moisture resistance to prevent condensation formation on the surface of the ductwork. The use of ductboard or internal ductlining is not permitted in supply air ductwork.

Sam Nunn Federal Center
Atlanta, Georgia

System commissioning optimized the mechanical system of the building.



Return and Exhaust Air Ductwork

The insulation of return air and exhaust air distribution systems must be evaluated for each project and for each system, to guard against condensation formation and heat gain/loss on a recirculating or heat recovery system.

Piping Insulation

Thermal Resistance

All piping systems, including hot water, steam and steam condensate, domestic hot cold water, chilled water, condenser water, brine, and refrigerant must be insulated in accordance with 6.4.4.1.3 of ASHRAE Standard 90.1-2007, without exceptions.

Permeance and Condensation

All piping systems, including plumbing, with surface temperatures below the average dew point temperature of the indoor ambient air must be insulated with a vapor barrier to prevent condensation formation, regardless of whether piping is concealed or exposed.

Chilled water, condenser water piping for waterside economizers, and domestic cold and/or chilled water piping systems must be insulated with nonpermeable insulation (of perm rating 0.000), such as cellular glass. Composite vapor barrier and jacket must have a 0.000 permeability rating, such as cellular glass and five-ply laminate.

Equipment Insulation

All equipment, including air-handling units, chilled and hot water pumps, and heat exchangers, must be insulated in accordance with the requirements in the IMC. All pumps must have removable jacketing. All hot water and chilled water heat exchangers must be insulated in accordance with ASHRAE Standard 90.1-2007.

Thermal Pipe Insulation for Plumbing Systems

All sanitary sewer vents terminating through the roof must be insulated for a minimum of 1.83 meters (6 ft.) below the roof line to prevent condensation from forming and must include a vapor barrier jacket on this insulation.

All piping exposed in plenums, or above the ceiling, must be insulated to prevent condensation. The thermal pipe insulation for plumbing systems must comply with fire and smoke-developed index in accordance with the requirements in the IMC.

5.16 Vibration Isolation, Acoustical Isolation, and Seismic Design

Noise and Vibration Isolation

Refer to and incorporate the basic design techniques as described in Chapter 3, Acoustics; the *U.S. Courts Design Guide;* and *ASHRAE Applications Handbook, Sound and Vibration Control.*

All rotating equipment in the building must be isolated.

All piping and ductwork must be isolated as it penetrates shafts and chases to prevent propagation of vibration to the building structure. All openings for ducts and piping must be sealed.

Isolators

Isolators must be specified by type and by deflection, not by isolation efficiency. See *ASHRAE Guide for Selection of Vibration Isolators* and *ASHRAE Application Handbook* for types and minimum deflections. Specifications must be worded so that isolation performance becomes the responsibility of the equipment supplier.

Concrete Inertia Bases

Inertia bases must be provided for reciprocating and centrifugal chillers, air compressors, all pumps, axial fans, and centrifugal fans.

Ductwork

Use acoustical coating or external wrapping on the ductwork to impede fan-generated noise immediately outside of any mechanical room wall. The ductwork design must address airborne equipment noise, equipment vibration, duct-borne fan noise, duct breakout noise, airflow-generated noise, and duct borne crosstalk noise. All ductwork connections to equipment having motors or rotating components must be made with a 15 cm (6 in.) length of flexible connectors. All ductwork within the mechanical room or serving courtrooms must be supported with isolation hangers.

Piping Hangers and Isolation

Isolation hangers must be used for all piping in mechanical rooms and adjacent spaces, up to a 15.2 m (50 ft.) distance from vibrating equipment. The pipe hangers closest to the equipment must have the same deflection characteristics as the equipment isolators. Other hangers must be spring hangers with 19 mm (0.75 in.) deflection. Positioning hangers must be specified for all piping 203 mm (8 in.) and larger throughout the building. Spring and rubber isolators are required for piping 51 mm (2 in.) and larger that is hung below noise-sensitive spaces.

Floor supports for piping must be designed with spring mounts or rubber pad mounts.

Anchors and guides for vertical pipe risers must be attached rigidly to the structure to control pipe movement. Flexible pipe connectors must be designed into the piping before it reaches the riser.

Channel supports for multiple pipes and heavy-duty steel trapezes must be provided to support multiple pipes. Hanger and support schedules must have the manufacturer’s number, type, and location.

Mechanical Equipment, Piping and Ductwork in Seismic Zones

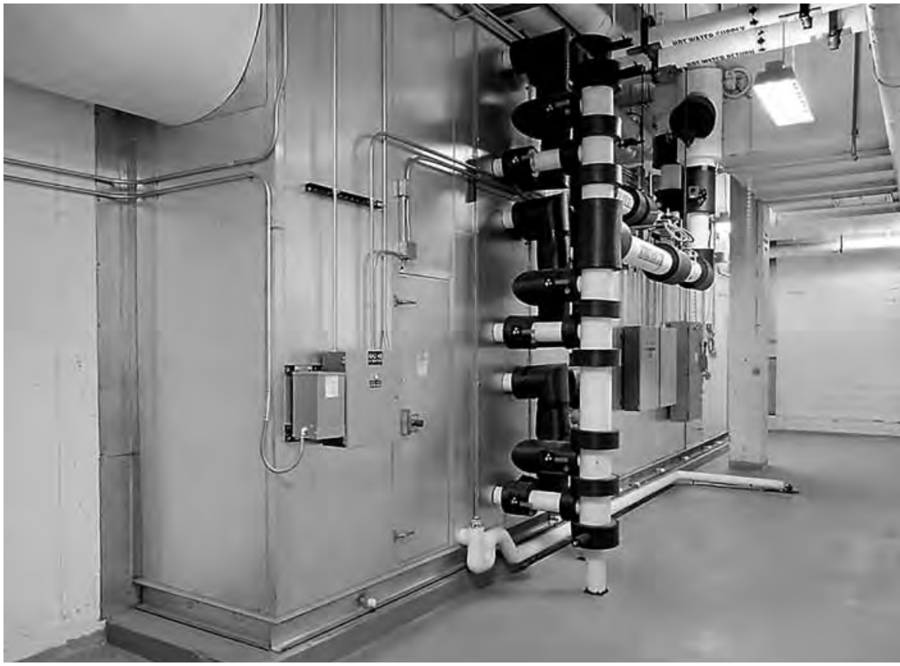
Refer to Chapter 4, Structural Engineering; *SMACNA Seismic Restraint Manual*; and *ASHRAE Application Handbook.*

Noise Control in Duct Systems

System sound levels at maximum airflow must ensure the acoustic levels required in Chapter 3. Duct noise control must be achieved by controlling air velocity, by the use of sound attenuators, by the use of double-wall ductwork with insulation in between, and by not oversizing terminal units. Duct liners are not permitted as a means of sound attenuation in supply air ductwork. Acoustic lining in the return air ductwork in courtrooms, chambers, conference rooms and similar spaces is permitted provided that fibrous materials are not exposed to the airstream. Volume dampers in terminal units must be located at least 1.8 m (6 ft.) from the closest diffuser.

Noise Transmission Attenuation (Courthouses)

Noise transmission to and from courtrooms, judges' chambers, jury rooms, and prisoner consulting rooms and from prisoner detention areas must be attenuated to meet the acoustic requirements in Chapters 3 and 8.



Patrick V. McNamara Federal Building
Detroit, Michigan

5.17 Meters, Gauges, and Flow Measuring Devices

Each piece of mechanical equipment must be provided with instrumentation or test ports to verify critical parameters, such as capacity, pressures, temperatures, and flow rates. Each meter, gauge, and flow measuring device must be calibrated before startup and must have provisions for periodic calibration at its location. All the metering devices must be capable of transmitting information to the central BAS for monitoring and control. For further information on advanced metering see Section 6.4. Following are the general instrumentation requirements.

Thermometers and Pressure Gauges

Thermometers and pressure gauges are required on the suction and discharge of all pumps, chillers, boilers, heat exchangers, cooling coils, heating coils, and cooling towers. To avoid pressure gauge tolerance errors, a single pressure gauge must be installed, valved to sense both supply and return conditions. For coils with less than 0.63 L/s (10 gpm) flow, provisions for use of portable instruments to check temperatures and pressures must be made.

Duct static pressure gauges must be provided for the OAVS and AHU air supply fan discharge, branch takeoffs of vertical supply risers, and at all duct locations at which static pressure readings are being monitored to control the operation of a VAV system.

Differential static pressure gauges must be placed across filters in air-handling units. A temperature gauge is required at the outdoor air intake to each air-handling unit.

Flow Measuring Devices

Airflow

Airflow measuring grids are required for all OAVS and AHU. Measuring grids must be provided at the supply air duct, return air duct, and outdoor air duct. Airflow measuring grids must be sized to give accurate readings at minimum flow. It may be necessary to reduce the duct size at the station to permit accurate measurement. Airflow measuring devices must conform to ASHRAE Standard 90.1-2007 requirements.

Waterflow and Energy Consumption

Measuring devices are required for all energy and water consuming equipment. Measuring devices conform to ASHRAE Standard 90.1-2007 requirements.

HVAC equipment serving out-leased spaces must be provided with energy and water consumption measuring devices. Outputs must be transmitted to a central BAS system.

Testing Stations

Permanent or temporary testing stations must be provided for startup and testing of building systems. Connections must be designed so that temporary testing equipment can be installed and removed without shutting down the system.

5.18 Building Automation Systems (BAS)

The BAS must be DDC. The BAS must be capable of scheduling operations and maintenance, and adjusting building systems to optimize their performance to minimize overall power and fuel consumption of the facility.

The BAS must use the BACnet or LonTalk open communication protocols to provide integration and interoperability between building systems and control vendors. The A/E must specify and include a functional design manual, a hardware manual, a software manual, an operation manual, and a maintenance manual. The BAS must have energy management and monitoring software.

In retrofits with an existing old-proprietary system in place, the A/E must conduct a life-cycle cost analysis to determine between the complete replacement of the existing system or integration of the existing system with customized gateways.

The BAS must consist of a series of direct digital controllers interconnected by a local area network. The BAS must be accessible through a Web browser. The BAS must have a graphical user interface and must provide trending, scheduling, downloading memory to field devices, real-time "live" graphic programs, parameter changes of properties, setpoint adjustments, alarm/event information, confirmation of operators, and execution of global commands. The BAS must record and archive all collected energy consumption data as described in Section 5.18.

Level of Integration

When planning a BAS, the necessary training must be identified and provided for the operating staff.

Lighting systems controlled by a BAS must have independent control panels and networks. The BAS must monitor the status and energy consumption of the lighting systems.

Fire alarm systems, security systems, and elevator systems must not be controlled by a BAS. These systems must have independent control panels and networks. The BAS system must monitor the status of these systems only, in order to prompt emergency operating modes of HVAC and lighting systems.

Automatic Temperature and Humidity Controls

A DDC system with host computer monitoring and control must be provided.

Temperature Controls

Preprogrammed standalone single or multiple loop microprocessor PID controllers must be provided to control all HVAC and plumbing subsystems.

PID loops must be used. All chillers, boilers, terminal units, and air-handling units must have self-contained BACnet or LonTalk controllers, which must communicate with the BAS.

Control the heating and cooling in each zone by a thermostat or temperature sensor located in that zone. Perimeter systems must have at least one thermostat or temperature sensor for each perimeter zone.

A 1.7°C (3°F) dead band must be used between independent heating and cooling operations within the same zone.

Night setback and setup controls must be provided for all comfort conditioned spaces, even if initial building occupancy plans are for 24-hour operation. Morning warm-up or cool-down options must be part of the control system. Controls for the various operating conditions must maintain pressurization requirements during occupied and unoccupied periods.

Humidity Controls

Indoor and outdoor humidity sensors must be calibrated in-place during system startup and at least annually thereafter. Dew point control provides more stable humidity levels. However, RH sensors are permitted, provided they have been calibrated in-place and collocated with dry bulb sensors so that the BAS can convert these two signals to a dew point value for control purposes.

IAQ Controls

Instrumentation and controls must be provided to ensure outdoor air intake rates are maintained during occupied and unoccupied hours.

Setpoint Reset Controls

Air Systems

Systems supplying heated or cooled air to multiple zones must include controls that automatically reset supply air temperature required by building loads or by outdoor air temperature.

Hydronic Systems

Systems supplying heated and/or chilled water to comfort conditioning systems must include controls that automatically reset supply water temperatures required by temperature changes responding to changes in building loads (including return water temperature) or by outdoor air temperature.

Energy Management and Conservation

HVAC control algorithms must include optimized start/stop for chillers, boilers, air-handling units, exhaust fans, VAV and fan coil units, and all associated equipment and feed forward controls based on predicted weather patterns. A condenser water optimization control is required to optimize the chiller, tower, and pump energy consumption.

The BAS must have the capability to allow building staff to monitor system performance and determine energy consumption. Electrical values, such as V, A, kW, KVAR, KVA, PF, kWh, KVARH, frequency, and percent THD, must be measured. See also Chapter 6, Electrical Engineering, for separate metering of power consumption monitoring requirements.

Energy management measurements must be totalized and trended in both instantaneous and time-based numbers. Energy monitoring data must be automatically converted to standard database and spreadsheet format and transmitted to a designated workstation. The measured energy data must be capable of being analyzed and compared with the calculated energy consumption estimated during design (refer to Appendix A.6 for additional parameters).

BAS Control and Monitoring Capabilities

The systems and components that must be controlled or monitored by the central BAS include chillers, boilers, air-handling units, cooling towers, exhaust fans, heat exchangers, pumps, VAV terminal units, fan coils, finned tube radiation, air conditioners for computer rooms and other special spaces, building pressurization, lighting, electrical power, and emergency generators. The BAS must be capable of scheduling the operations of the systems and equipment for occupied hours, unoccupied hours, and weekends and holidays. Examples of monitoring and control points for the equipment are shown in Table 5-5.

All automatic valves and dampers must have positive positioners installed to indicate operational status.

The BAS must be capable of receiving current sensor digital signals from all field-installed controllers and calculating the energy and water consumption by using appropriate voltages and phases.

The central BAS must provide for standalone operation of subordinate components. The primary operator workstation must have a graphical user interface. Standalone control panels and terminal unit controllers can have text-based user interface panels, which are hand held or fixed.

The BAS monitoring capability must include logs of data created by user-selectable features. In new buildings and major renovations, the BAS must have approximately 20 percent spare capacity for future expansion.

Maintenance Scheduling

The central BAS must include programs for scheduling maintenance of the mechanical and electrical equipment, including information on what parts and tools are needed to perform each task.

Table 5-5

Minimum Control and Monitoring Points for Typical HVAC Equipment

Air-Handling Units	Refrigeration Equipment	Hot Water Boilers
Start/stop	Start/stop	Start/stop
Heating control	Leaving water temperature reset	Leaving water temperature reset
Cooling control	Demand limiting	Reset
Humidification control	Isolation valve position	Isolation valve position
Supply air reset	Leaving water temperature	Leaving water temperature
Static pressure reset	Entering water temperature	Flow
Building and zone	kW draw	BTU draw
Pressurization control	Flow	Entering water temperature
Damper position (economizer)	Return airflow rate	
Supply air discharge temperature		
Return air temperature		
Mixed air temperature		
Supply airflow rate		
Filter differential pressure		
Airflow measuring station		
Cooling Towers	**Terminal Boxes**	**Pumps**
Start/stop	Start/stop	Start/Stop
Leaving water temperature reset	Discharge temperature reset	Discharge pressure reset
Flow	Supply volume reset	Differential pressure
Isolation valve position	Heating control	Flow
Entering water temperature	Zone temperature reset	
Leaving water temperature	Supply air reset	
	Zone pressurization control	
	Utilities	
	Natural gas consumption	
	Electricity consumption and demand	
	Water consumption	
	Fuel oil quantity	

5.19 Testing and Balancing

Startup

The A/E must specify that factory representatives be present for the startup of all major equipment, such as boilers, chillers, cooling towers, heat exchangers, air-handling units, exhaust fans, packaged pump systems, and BAS.

Testing, Adjusting, and Balancing

The A/E must specify testing, adjusting, and balancing (TAB) procedures that result in not only the operation of individual pieces of equipment but also the operation of the overall HVAC and plumbing systems, in accordance with the design intent. The TAB contractor who performs these procedures must have up-to-date certification by the Associated Air Balance Council (AABC), the National Environmental Balance Bureau (NEBB), or the Testing, Adjusting, and Balancing Bureau (TABB).

Performance Testing

The A/E must specify performance testing of all systems and equipment, including chillers, boilers, air-handling units, exhaust fans, water heaters, and related systems, for part load and full load during summer, winter, spring, and fall seasons, per the schedules specified by the designer. The A/E must specify the services of an organization-certified NEBB, AABC, or TABB contractor to conduct this performance testing.

Air Distribution Systems

Airflow rates together with thermal and acoustic conditions must be tested, adjusted and balanced in all supply, return, and exhaust air pathways, and as a total system, after compliance with air leakage tests has been achieved in accordance with Section 5.9.

Performance testing of the HVAC system and its components must be conducted after TAB has been completed.

The certified contractor(s) must submit written reports on the procedures and results of the TAB and the performance testing.

Hydronic Systems

Leak testing must be conducted at static pressures as required by code (or at 150 percent of maximum design working pressure of piping systems where no code requirement exists), with maximum permissible leakage.

Waterflow rates together with thermal and acoustic conditions must be tested, adjusted, and balanced in all hydronic systems after compliance with leakage tests has been achieved.

Performance testing of HVAC and plumbing hydronic systems must include remote outlet temperature maintenance, system and circuit pressure equalization, and control of water hammer at peak draw. These tests must also evaluate compliance with specifications and design intent for the operation of water heaters, mixing valves, circuit setters/balancing valves, return pumps, and pressure reducing/regulating valves.

The certified contractor(s) must submit written reports on the procedures and results of the TAB and the performance testing.

5.20 Plumbing Systems

Water conservation is a requirement of all plumbing systems. The A/E must specify low-flow plumbing fixtures.

Domestic Water Supply Systems

Domestic Cold Water Service

Domestic cold water service must consist of a pressurized piping distribution system incorporating an independent (separate) service pipe from the tap at the exterior utility service water main to the water meter and backflow preventer equipment inside the building. Copper (minimum Type L) piping is required. Plastic piping is not permitted.

In compliance with the International Plumbing Code and the water purveyor requirements, the water service must have a reduced pressure zone backflow prevention device located immediately downstream of the service water meters and upstream of all other connections and branches. Access and service clearances for meters and backflow preventers must be provided in accordance with the requirements of the manufacturer and the water purveyor.

Internal distribution must consist of a piping system that supplies domestic potable cold water to all plumbing fixtures, plumbing equipment, water heaters, mechanical makeup, and cold water equipment/system demands.

Domestic Water Service Pressure

The distribution water pressure must provide the outlet pressures required by fixtures or equipment, at the hydraulically most demanding (generally the topmost/highest and most remote) outlet. The required outlet pressure must be determined as the minimum requirements of the International Plumbing Code or by the higher requirements of the fixture or equipment, as required by the manufacturer.

Distribution water pressures must not exceed the system material, piping, and device-rated maximum working pressures, or maximum pressures at the fixture, equipment, or outlet, as required by the International Plumbing Code. The A/E must schedule and specify pressure regulating valves or valve stations where pressures at maximum working pressure may exceed the code maximum. Pilot-operated pressure reducing valves (or valve stations) with expansion bypass (for domestic hot water) must be used to regulate supply water pressures within distribution zones. Individual outlets must use pressure reducing valves compliant with International Plumbing Code requirements. Pressure reducing valves must be specified to operate at peak flow within the entire range of low hydraulic grade line (HGL) and maximum working pressure of the system (high HGL, plus pump shutoff head for pressure boosted systems).

A packaged and third-party-tested triplex (three-pump) booster pumping system or duplex (two-pump) with a 120–170 gallon hydropneumatic storage pressure tank must be used where water flow test and water purveyor low hydraulic grade line (low HGL) water pressures do not provide required pressure demands at peak draw. Water pressure boosting must generally be provided only to those areas or floor elevations where insufficient water pressures may be experienced/expected utilizing the low HGL. Outlets on floor elevations or areas that can be served with the required pressures provided at low HGL must not be pumped. The entire water service must not be pressure boosted if only portions of the building systems require pressure maintenance boosting.

The water service supply source (utility) low hydraulic grade line (low HGL), low head elevation of water source tank or pump, adjusted for friction and head losses/gains, must be used for determining the available water source pressure, pump suction calculations, and selection. The water service supply source (utility) high hydraulic grade line (high HGL), high head elevation of utility service water supply source tank or pump, plus booster pump shutoff head for boosted systems (system maximum working pressure), adjusted for static pressure head losses/gains, must be used for determining the maximum system working pressures.

Domestic Hot Water Service

Domestic potable hot water must be generated by water heaters utilizing natural gas, electricity, or steam as the primary energy source. The load calculations, storage capacities, insulation requirements, system types, and performance requirements of the water heating equipment must comply with the mandatory requirements in Sections 7.4.1 through 7.4.4 of ASHRAE Standard 90.1-2007.

Cold (or preheated) water supply to water heaters must include a service valve, check valve, expansion tank (sized for expansion of storage capacity only), 27 in. (690 mm) heat trap, mixing valve bypass primer, and hot water return connection at a minimum. A minimum trap height of 27 inches (690 mm) must be provided at water heater cold water inlets for energy savings.

Cold water temperatures supplied from the utility source vary in temperature by season and regional location. The A/E must obtain, from the water utility purveyor, seasonal cold water service temperatures supplied by the water utility purveyor (past 3-year minimum preferred). Low temperature (lowest of the past 3 years) seasonal cold water service temperatures must be used in the calculation and application of water heating, water heating energy source (steam, heating hot water, gas), and for makeup to the water heating energy source. Preheating of domestic cold water supply to the domestic water heater and cold water makeup to water heating energy source must be considered, utilizing steam condensate or heating hot water return.

Instantaneous water heaters are not permitted as a primary source of potable hot water. For incidental use, sporadic equipment demands, or remote individual fixtures (e.g., lavatory, sink, shower, service sink), the use of instantaneous water heaters is permitted. Point-of-use instantaneous water heaters are permitted for use at emergency fixtures to supply tepid water immediately at the emergency fixture or group of emergency fixtures.

Domestic hot water supply temperatures must be generated and stored at a minimum of 60.0°C (140°F), and tempered to deliver 51°C (124°F) to outlets, where permitted by the International Plumbing Code and consistent with ASHRAE Guideline 12-2000. Hand washing, lavatory, sink, and similar fixtures accessible to the disabled, elderly, or children must be tempered to deliver 29°C (85°F) – 63°C (109°F) water temperatures at the fixture or group of battery fixtures. Bathing and showering fixtures (except emergency showering) must be tempered to deliver water 29°C (85°F) – 49°C (120°F) water temperatures at the fixture or group of battery fixtures, in accordance with procedures in ASHRAE Guideline 12-2000. Individual fixture or battery thermostatic mixing valves must be provided where distributed, or zone, outlet temperatures may exceed 51°C (124°F). Hot water supply to dishwashers must be at 60°C (140°F), and the temperature must be boosted from 60°C (140ºF) to 82°C (180°F) for the final sanitizing rinse.

There must be no dead legs or capped spurs within the potable domestic water plumbing system. Rubber fittings and device components are not permitted within the potable domestic hot water or return systems, as they have been associated with persistent colonization of *Legionella* spp. For additional information on water temperature, control of *Legionella* spp., and water safety, refer to the *Centers for Disease Control (CDC) Guidelines for Environmental Infection Control in Healthcare Facilities*

(Section 5, Maintenance Procedures Used to Decrease Survival and Multiplication of Legionella spp. in Potable-Water Distribution Systems); ASHRAE Guideline 12-2000; and ANSI Standard Z358.1 (1999), Emergency Eyewash and Shower Equipment.

The domestic hot water distribution system must consist of a piping system that connects water heaters to all fixtures, equipment, and outlet demands requiring potable domestic hot water. Circulation return systems with circuit setters/balancing valves or temperature maintenance systems must be provided for all branches in excess of 25 feet from the water heater or circulated distribution main. Domestic hot water must be available at each hot water outlet within 15 seconds of the time of operation.

Domestic hot water return circuits of substantially varying pressures, as a result of pressure zoning or static head, cannot successfully be joined to a single pressure zone water heater. Locate individual pressure zone water heaters within the pressure zones, where return pressures would vary substantially, causing deadhead on the lower pressure return circuits. Hot water return systems must have circuit setters (balancing valves) and test plugs at each return circuit, and systems must be balanced.

Domestic Water Supply Equipment

Domestic water supply equipment and components must include, but not be limited to, the following equipment: water meters, water heaters, water filtration, water softening, pressure booster systems, pressure regulating valves, circulating pumps, backflow preventers, circuit setters/balancing valves, thermostatic mixing valves, expansion tanks, isolation valves, hangers and supports, and thermal insulation.

Water heaters and expansion tanks must be compliant with the ASME standards and the International Plumbing Code, stamped, and rated.

Water hammer arrestors must be provided at each elevation change of every horizontal branch to fixture batteries, at all quick-closing automatic valves (mechanical makeup, drinking fountains, flush valves, single lever control faucets, temperature regulating valves, dishwashers, return pumps, and similar), and at each floor on each horizontal main for branches with/without individual fixture or battery water hammer arrestors, for both hot and cold water. Water hammer arrestors must be compliant with the Plumbing and Drainage Institute (PDI) Standard PDI-WH201, ANSI/ASME A112.26.1M, or as required by the International Plumbing Code, and as recommended/required by the fixture and equipment manufacturer or warranty.

Domestic cold and hot water distribution systems must be insulated in accordance with Section 5.15, Thermal Pipe Insulation for Plumbing Systems.

Water Metering

Meters with remote capability must be provided to collect water use data for each water supply source (e.g., domestic potable water, reclaimed water, rainwater). Utility company service entrance/interval meters are allowed to be used. Supply meters on water systems exceeding the thresholds shown in Table 5-6.

Table 5-6

Water Supply Source Meter Thresholds

Water Source	Main Metering Threshold
Domestic potable water	1,000 gal//day (3,800 L/day)
Municipally reclaimed water	1,000 gal/day (3,800 L/day)
Alternate sources of water	500 gal/day (1,900 L/day)

Provide sub-metering with remote metering to collect water use data for each building subsystem exceeding the thresholds shown in Table 5-7.

Table 5-7 Subsystem Water Metering Thresholds

Subsystem	Sub-Metering Threshold
Cooling towers (Meter on make-up water)	Primary flow through tower(s) > 500 gpm (30 L/s)
Evaporative coolers	Makeup water > 0.6 gpm (0.04 L/s)
Steam and hot-water boilers	> 500,000 BTU/h (50 kW) input
Irrigated landscape area with controllers	> 2,500 m^2 (25,000 sq. ft.)
Separate campus or project buildings	Consumption > 1,000 gal/day (3,800 L/day)
Separately leased or rental space	Consumption > 1,000 gal/day (3,800 L/day)
Any large water-using process	Consumption > 1,000 gal/day (3,800 L/day)

All building meters and sub-meters must be configured to communicate water consumption data to a meter data management system which must be capable of electronically storing data and creating user reports showing calculated hourly, daily, monthly and annual water consumption for each meter and sub-meter.

Plumbing Fixtures

Plumbing fixtures must comply with the International Plumbing Code and local building codes.

Plumbing fixture accessibility clearances, installation, and accessories must be compliant with The Architectural Barriers Act Accessibility Standard (ABAAS).

All plumbing fixtures must be water-conserving/saving-type fixtures, faucets, and valves. Low-flow water fixtures must be provided.

Water closets (toilets)—flushometer valve type

Water closets must be either dual-flush or low-flow type, manually controlled. For single flush, maximum flush volume when determined in accordance with ASME A112.19.2– 4.8 L (1.28 gal). For dual-flush, effective flush volume determined in accordance with ASME A112.19.14 and USEPA WaterSense Tank-Type High Efficiency Toilet Specification – 4.8 L (1.28 gal).

High Efficiency Toilets (HET) Water Closets—Tank-Type

Tank-type water closets must comply with the performance criteria of the U.S. EPA WaterSense Tank-Type High-Efficiency Toilet Specification.

High Efficiency Urinals (HEU)

Urinals must be low-flow, flush-type fixtures. Maximum flush volume when determined in accordance with ASME A112.19.2 – 0.5 L(0.125 gal).

Public Lavatory Faucets

Use metered-type faucets for lavatories. Maximum water use—1.0 L 0 (.25 gal) per metering cycle when tested in accordance with ASME A112.18.1/CSA B125.1.

Emergency Fixtures

Eyewash (0.025 L/s [0.4 gpm] per fountain), face wash (0.2 L/s [3 gpm] each), or shower (1.3 L/s [20 gpm] each) must be tempered immediately at the fixture or group of fixtures within 7.6 m (25 ft) to deliver tepid water between 29°C (85°F) and 37.8°C (100°F), at 0.207 megapascal (30 psi), within 10 seconds, for a minimum period of 15 minutes, and must account for temperature drop across the valve (generally 7°C or 20°F) at flow.

Commercial Food Service Operations

Commercial food service operations (e.g., restaurants, cafeterias, food preparation kitchens) must include the following where applicable:

- High-efficiency prerinse spray valves (i.e., valves that function at 4.9 L/min (1.3 gpm) or less and comply with a 26-second performance requirement when tested in accordance with ASTM F2324)
- Dishwashers that comply with the requirements of the USEPA Energy Star Program for Commercial Dishwashers
- Boilerless/connectionless food steamers that consume no more than 7.5 L/hour (2.0 gal/hour) in full operational mode
- Combination ovens that consume no more than 38 L/hour (10 gal/hour) in full operational mode
- Air-cooled ice machines that comply with the requirements of the USEPA Energy Star Program for Commercial Ice Machines
- Hands-free faucet controllers (foot controllers, sensor-activated, or other) for all faucet fittings within the food preparation area of the kitchen and the dish room, including pot sinks and washing sinks.

Sanitary (Soil and Waste) and Vent System

Sanitary Pipe and Fittings

A complete sanitary building drainage system must be provided for all plumbing fixtures, sanitary floor drains, kitchen equipment, and equipment with sanitary, soil, or waste drainage/discharge. The sanitary waste and vent system must be designed in compliance with the International Plumbing Code. Piping must be service weight cast iron soil pipe with hub and spigot fittings and joints with elastomeric gasket (by pipe manufacturer) for below-grade piping. Aboveground piping must have hubless (no-hub) fittings and joints (by pipe manufacturer) with pipe support compliant with hubless (no-hub) pipe standard, compliant with code (generally within 12 inches of each side of each joint).

Vent Piping and Fittings

Piping below grade must be service weight cast iron soil pipe with hub and spigot fittings and joints with elastomeric gasket (by pipe manufacturer). Aboveground piping must have hubless (no-hub) fittings and joints (by pipe manufacturer) or Type-K DWV copper with 95-5 tin antimony solder joints.

Sanitary Floor Drains

Sanitary floor drains must be provided in multi-fixture restrooms, kitchen areas, mechanical equipment rooms, and locations where interior floor drainage accumulates wastes. Single-fixture toilet rooms do not require floor drains.

Floor drains must be cast iron body type with 6-inch diameter nickel-bronze strainers for public toilets, kitchen areas, and other public areas. Receptors, open-site drains, hub drains, trench drains, and similar drains must have a dome bottom strainer (in addition to pedestrian/vehicle grate strainers where required) to reduce splashing, increase free area, and prevent debris blockage. Drain body, frame, and grate strainers must be rated for expected wheel loading and must include drain adapters, extensions, receivers, deck clamps, and similar, as required by building construction. The drain strainer free area must be equal to or greater than the free area of the calculated outlet pipe size area. Drain strainers in pedestrian areas must be heel-proof type. Every

BEST PRACTICE

PLUMBING PRODUCTS

GSA requires the use of plumbing products labeled under the EPA WaterSense program.

WaterSense is a partnership program sponsored by the U.S. Environmental Protection Agency. Its mission is to protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services.

More information is available at **http://www.epa.gov/watersense/index.html**.

drain and system opening must have ¼-inch maximum strainer openings for rodent-proofing. Discharges must be elastomeric pinch valves or similar for rodent-proofing.

Receptor drain outlets must be two times the area of combined inlet pipe areas. Equipment room areas require large diameter cast iron strainers, and parking garages require large diameter tractor grates rated for expected wheel loading. Drainage for ramps requires either trench drains or roadway inlets, if exposed to rainfall. Trap primers must be provided for all sanitary drains (floor drains, receptors, open site drains, hub drains, and similar) where drainage is not routinely expected or is seasonal.

Sanitary Waste Equipment

Grease Interceptors

Drains and fixtures discharging fat, oil, or grease-laden waste; within 10 feet of the cooking battery, mop and service sinks in kitchen areas; and as required by the State health department and local authorities, must discharge to a grease interceptor before connecting into the sanitary sewer.

Grease interceptors must be sized for compliance with the requirements of the local authority. Where permitted by the local authority, grease interceptors must comply with the PDI Guideline PDI-G101. Drains, fixtures, and equipment must discharge to the grease interceptor, as required by the State health department and the local authority. Food grinders, vegetable sinks, fish scaling sinks, meat cutting sinks, and clearwater wastes are usually prohibited by the local authority from extending to the grease interceptor and must not be installed except where otherwise required by the local authority.

Sand/Oil Separator

Floor drains and/or trench drains in vehicle repair garages must discharge to a sand/oil separator before discharging to the sanitary sewer.

Automatic Sewage Ejectors

Sewage ejectors must be used only where gravity drainage is not possible. Only sanitary drainage from the lowest floors of the building must be connected to the sewage ejector; fixtures on upper floors must use gravity flow to the public sewer. Sewage ejectors must be nonclog, screenless, alternating duplex pumps, capable of passing a 2-inch solid, with each discharge not less than 102 mm (4 in.) in diameter. They must be connected to the emergency power system and properly vented.

Sanitary Drainage

Rain water, cooling coil condensate drainage, and similar clearwater drainage must not discharge to the sanitary drainage system.

Chemically treated mechanical discharge from cooling towers, boilers, chillers, and other mechanical equipment must not discharge to the sanitary drainage system without proper treatment for protection of the environment and waterways. Steam condensate must not discharge directly to the sanitary drainage system without proper treatment for protection of the environment.

Floor drains must be provided at each item of kitchen equipment where accidental spillage is anticipated and to facilitate floor-cleaning procedures. Drains to receive indirect wastes for equipment must be of the floor sink-type of stainless steel construction with a sediment bucket and removable grate.

Rainwater Drainage System

A complete rainwater (storm) building drainage system must be provided for all rainwater (storm) drainage for roofs, plazas, balconies, decks, area wells, parking structures, parking garages, and similar structures. A separate and independent secondary roof drainage system must be provided in compliance with applicable codes and standards. Rainwater discharge must enter a natural hydrological cycle for rate, quantity, and temperature.

Where practical, clearwater drainage (cooling coil condensate drainage, evaporation pan drainage, ice makers) and similar clear, nonchemically treated drainage should be recovered and reused for cooling tower makeup, irrigation, or for similar makeup purposes. Otherwise, clearwater drainage must discharge to the rainwater (storm) drainage system and not to the sanitary drainage system. Clearwater drainage without chemical, vegetable, human, animal, protein, fecal, oil, grease, or similar pollutants may be discharged to the rainwater (storm) drainage system where approved by code, State, local authority, and the Environmental Protection Agency. Rainwater must be drained away only as a last option. All rainwater should be used for irrigation, grey water use, or mechanical use.

The rainwater (storm) and vent system must be designed in compliance with applicable codes and standards. P-traps and house traps must be provided only on storm systems where required by code, State, or local authority.

Rainwater Drainage (Storm) Piping and Fittings

Piping must be service weight cast iron soil pipe with hub and spigot fittings and joints with elastomeric gasket (by pipe manufacturer). Aboveground piping must have hubless (no-hub) fittings and joints (by pipe manufacturer) for below-grade piping, with pipe support compliant with hubless (no-hub) pipe standard compliant with code (generally within 300 mm (12 in.) of each side of each joint).

The Energy Independence and Security Act (EISA 2007), Section 438, requires rainwater to enter a natural hydrological cycle for rate, quantity, and temperature.

Rainwater (Storm) Vent Piping and Fittings

Storm vent piping, where required for P-traps, sumps, interceptors, and separators, must be service weight cast iron soil pipe with hub and spigot fittings and joints with elastomeric gasket (by pipe manufacturer). Aboveground piping must have hubless (no-hub) fittings and joints (by pipe manufacturer) or Type-K DWV copper with 95-5 tin antimony solder joints.

Storm Drains

Rainwater (storm) drains include domed roof drains, secondary roof drains, hub and receptor drains (that do not receive floor drainage), deck drains, parking garage drains, trench drains, area well drains, and similar. Roof drains and planter drains in nonpedestrian/vehicle areas must have high dome strainers. Receptors, hub drains, trench drains, and similar drains must have a dome bottom strainer (in addition to pedestrian/vehicle grate strainers where required) to reduce splashing, increase free area, and prevent debris blockage.

Drain body, frame, and grate strainers must be rated for expected wheel loading and must include drain adapters, extensions, receivers, deck clamps, gravel stops, and similar, as required by building construction. The drain strainer free area must be equal to, or greater than, the free area of the calculated outlet pipe size area. Drain strainers in pedestrian areas must be a heel-proof type. Every drain and system opening must have 6 mm (1⁄4-in.) maximum strainer openings for rodent-proofing. Discharges must be elastomeric pinch valves or similar for rodent-proofing. In general, drains must be cast iron body type, with nickel-bronze strainers for finished pedestrian areas, aluminum domes for roof drains, ductile iron or bronze finish for unfinished pedestrian areas. Rainwater drains and equipment room areas must require large diameter strainers. Drainage for ramps must require either trench drains or roadway inlets, if exposed to rainfall. Trap primers must be provided for P-traps.

Rainwater (Storm) Equipment

Sand/Oil Separator

Drains in parking structures and garages must discharge to a sand/oil separator before discharging to the storm sewer, when required by code, State, or local authority.

Automatic Sump Pumps

Sump pumps must be used only where gravity drainage is not possible. Only rainwater, storm, and clearwater drainage from the lowest floors of the building must be connected to the sump pump; drainage from upper floors must use gravity flow to the public storm drain system. Sump pumps must be alternating duplex pumps. Sump pumps must be connected to the emergency power system.

The foundation and subsoil drainage system must be provided with an emergency power source, backwater prevention, perforated drain tile piping in a washed gravel bed with filter fabric, which must extend to the duplex sump pumping system as required by the applicable codes.

The requirements of the foundation and subsoil drainage system must be identified, capacity calculated, and materials identified by the geotechnical soils engineer and identified in the geotechnical report. The layout and installation details and materials (identified by the geotechnical report) must be specified and identified in the structural foundation drawings and indicated on the architectural drawing sections and details. The extension from the system end to the sump pump or daylight termination must be identified on the plumbing drawings.

Secondary (Overflow) Roof Drainage

Provide secondary (overflow) roof drainage using sidewall scuppers, scupper drains, or a secondary (overflow) roof drainage system. Secondary (overflow) roof drains must be the same as roof drains, except with integral standpipe or damming weir extension 76 mm (3 in.) above the waterproofing membrane and located within 1,525 mm (5 ft.) of (adjacent to) the primary roof drain, and extended to discharge above grade. Termination above grade must include a concealed elastomeric pinch valve or similar for rodent-proofing, near the discharge, and near the finished discharge in high finish areas. The discharge must be in a nonoccupied, nonpedestrian area that permits drainage away from the building and pedestrian access.

Rainwater Drainage Equipment

Sand/Oil Separator

Floor drains and/or trench drains in vehicle parking structures and parking garages must discharge to a sand/oil interceptor before discharging to the storm sewer.

Natural Gas Systems

Gas piping must be installed in accordance with the International Fuel Gas Code (IFGC) and International Building Code (IBC).

Service Entrance

Natural gas service utility piping entering the building must be protected from accidental damage by vehicles, foundation settlement, or vibration. Wall penetrations must be above grade and provided with a self-tightening swing joint located upstream of the building and wall penetration. Where wall penetration above grade is not possible, the gas pipe must be within a Schedule 80 black steel, corrosion-protected, sealed and vented, gas pipe sleeve that extends from 3 m (10 ft.) upstream of the building wall penetration exterior (or excavation shoring limits if greater) to a minimum of 300 mm (12 in.) downstream of the building wall penetration. Gas piping must not be placed in unventilated spaces, such as trenches or unventilated shafts, where leaking gas could accumulate (which could result in an explosion).

Gas Piping within Building Spaces

Gas must not be piped through confined spaces, such as trenches or unventilated shafts. All spaces containing gas-fired equipment, such as boilers, chillers, water heaters, and generators, must be mechanically ventilated and must include CO monitoring and alarms. Vertical shafts carrying gas piping must be ventilated. Gas meters must be located in a ventilated mechanical room, thus avoiding leakage concerns and providing access to the local gas utility. All gas piping inside ceiling spaces must have plenum rated fittings. Diaphragms and regulators in gas piping must be vented to the outdoors. There must be no gas valves (concealed or accessible) permitted above ceilings.

Fuel Oil Systems

Fuel oil piping must be installed in accordance with IFGC and IBC.

Fuel Oil Piping

Fuel oil piping systems must be double-wall containment pipe (pipe-in-pipe) when indoors, outdoors, or buried, and they must be Schedule 40 black steel or black iron piping. Fittings must be of the same metal grade as the pipe material. Valves must be bronze, steel, or iron and must be screwed, welded, flanged, or grooved. Duplex fuel-oil pumps with basket strainers and exterior enclosures must be used for pumping fuel oil to fuel burning equipment.

Underground Fuel Oil Storage Tanks (UST)

Underground fuel oil storage tanks (UST) must be of double-wall, nonmetallic construction or contained in lined vaults to prevent environmental contamination. Tanks must be sized for actual storage volume with sufficient capacity to provide a minimum of 48 hours of system operation under emergency conditions (72 hours for remote locations such as border stations). A monitored and alarmed liquid and vapor leak detection system must be provided in interstitial space of underground tanks, aboveground day-tanks, and piping. The installation must comply with local, State, and Federal requirements, as well as with EPA regulations 40 CFR 280 and 281.

5.21 Alterations in Existing Buildings and Historic Structures

The goal of alteration projects is to meet the same standards described in this document for new projects. Equipment/systems at 20 years of life or older, or beyond their useful service lives, must be demolished and new systems designed to meet the current usage of the facility. Renovation and rehabilitation designs must satisfy the immediate occupancy needs and anticipate additional future changes. Remodeling must make building systems become more flexible. Compliance with Sections 5.1 through 5.20 is required whenever feasible. Parameters of reuse and disruption of service must be clearly specified in construction documents. The result of these projects should be enhanced performance, not just equipment replacement.

Alteration projects can occur on three basic scales: refurbishment of an area within a building, such as a floor or a suite; major renovation of an entire structure; and upgrade/restoration of historic structures.

Howard M. Metzenbaum U.S. Courthouse Cleveland, Ohio

The architect's mechanical engineer used inventive methods in the preservation and upgrading of this historic building—including tucking mechanical chasers and risers into out-of-use chimneys.

In the first instance, refurbishment of an area within a building, the aim must be to satisfy the new requirements within the parameters and constraints of the existing systems. The smaller the area in comparison to the overall building, the fewer changes to existing systems must be attempted.

In the second case, major renovation of an entire structure, the engineer has the opportunity to design major upgrades into the mechanical, electrical, and communications systems. The mechanical services can come close to systems that would be designed for a new building, within the obvious limits of available physical space and structural capacity.

In the third instance, where a historic structure is to be altered, special documents must be provided by GSA to help guide the design of the alterations. The most important of these is the Historic Building Preservation Plan which identifies zones of architectural importance, specific character-defining elements that must be preserved, and standards to be employed. Refer to the GSA Technical Preservation Guideline *HVAC Upgrades in Historic Buildings* for design solutions addressing a variety of GSA historic building types and configurations.

When a system is designed, it is important to anticipate how it will be installed, how damage to historic materials can be minimized, and how visible the new mechanical system will be within the restored or rehabilitated space.

The following steps must be followed for HVAC work in historic buildings:

- Design HVAC systems to avoid impacting other systems and historic finishes, elements, and spaces.

- Place exterior equipment where it is not visible. Recess equipment from the edge of the roof to minimize visibility of the equipment from grade. Alternatively, explore creating a vault for easier access to large mechanical equipment. If equipment cannot be concealed, specify equipment housings in a color that will blend with the historic face. As a last resort, enclose equipment in screening designed to blend visually with the facade.

- Locate equipment with particular care for weight and vibration on older building materials. These materials cannot accept the same stress as when the equipment is used in newer construction.

- If new ceilings are to be installed, ensure that they do not block any light from the top of existing windows or alter the appearance of the building from the outdoors. Original plaster ceilings in significant spaces, such as lobbies and corridors, must be retained to the extent possible and modified only as necessary to accommodate horizontal distribution. Use soffits and false beams where necessary to minimize the alteration of overall ceiling heights.

- In buildings containing ornamental or inaccessible ceilings, piping and ductwork must be routed in furred wall space or exposed in the occupiable building area. Exposed ducts must also be considered in historic industrial buildings with open plan, tall ceiling, and high window spaces suited to flexible grid/flexible density treatments.

- If new vertical air distribution risers are required, they should be located adjacent to existing shafts.
- Select system types, components, and placement to minimize the alteration of significant spaces. In previously altered spaces, design systems to allow historic surfaces, ceiling heights, and configurations to be restored. Reuse of HVAC system elements is permitted only with written documentation obtained from GSA Property Management by the A/E.
- Retain decorative elements of historic systems where possible. Ornamental grilles and radiators and other decorative elements must be retained in place.
- Retain and enhance the performance of the original type of system where a new one cannot be totally concealed or would be historically problematic. For example, adapt existing radiators with modern heating and cooling units, rather than adding another type of system that would require the addition of new ceilings or other nonoriginal elements.
- To the greatest extent possible, ensure that space is available to maintain and replace equipment without damaging significant features and select components that can be installed without dismantling window or door openings.
- Select temperature and humidity conditions that do not accelerate the deterioration of building materials.

6

U.S. CENSUS BUREAU
COMPUTER FACILITY

ARTIST: KEITH SONNIER
ARTWORK: *CENOZOIC CODEX*

Electrical Engineering

Chapter 6 Electrical Engineering

6.1 Goals and Objectives

This chapter identifies the mandatory criteria that must be used to program and design electrical power, lighting, and communications systems in GSA buildings. These systems support the many types of equipment in a reliable fashion. During the life span of a Federal building, many minor and major alterations are necessary as the missions of Government agencies change. The flexibility to adjust to alterations must be designed into the building systems from the outset. Electrical power, lighting, and communications systems must provide ample capacity for increased load concentrations in the future, as described in Section 6.3, and allow modifications to be made in one area without causing major disruptions in other areas of the facility.

The electrical system design must be signed by a registered professional electrical engineer.

Design Intent

The design of electrical power, lighting, communications systems, and other building components must function together resulting in a building that meets the project's program requirements, as well as incorporating GSA's commitment to sustainability and energy efficiency.

GSA recognizes that communication needs and technology are growing at an increasingly rapid pace. Work stations are becoming more powerful, requiring faster and easier access to more information. It is GSA's intent to provide the wiring and interfaces to support these requirements. The design of all communications cabling systems is the responsibility of GSA's Federal Acquisition Service (FAS).

A computer-based Building Automation System (BAS) that interfaces, monitors, and automatically controls lighting, heating, ventilating, and air conditioning is critical to the efficient operation of modern Federal buildings, including courthouses, office buildings, and other facilities. GSA requires the integration of building automation systems, with the exception of fire alarm and security systems, which must function as stand-alone systems with a monitoring-only interface to the BAS (see Section 5.18 for additional requirements).

Security is important in the design, construction, and operation of electrical power, lighting, and communications systems design. Refer to ISC Security Guidelines.

Electrical power, lighting, and communications systems must be adapted to support all performance objectives defined for the project, typically including sustainability, workplace performance (productivity and efficiency), fire safety, security, historic preservation, and improved operations and maintenance. Compliance with Appendix A, Submission Requirements, is required to demonstrate that these systems have been adapted into the project at each phase of the design.

Maintainability and reliability are paramount to the operation of Federal buildings. Therefore, the design and installation of all electrical systems and equipment must allow for repair, removal, and replacement—including major components such as switchgear, motor control centers, and emergency/standby generators—without removal of exterior walls and impact to adjacent equipment and building occupants.

Electrical power, lighting, and communications systems must be specifically designed to meet all of the defined performance objectives of the project at full-load and part-load conditions that are associated with the projected occupancies and modes of operation.

Commissioning of major changes to electrical power, lighting, and communications systems must be initiated at the conceptual design phase of the project and continue through all design and construction phases. Refer to Chapter 1 for information regarding commissioning and the role of the electrical engineer in the commissioning process.

SPECIAL DESIGN CONSIDERATIONS

U.S. COURT FACILITIES

For special design considerations and design criteria for U.S. Court facilities, see Chapter 8, Design Standards for U.S. Court Facilities.

INNOVATIVE DESIGN

See Chapter 1, General Requirements, Proposed Alternatives to P100.

6.2 Codes, Standards, and Guidelines

Refer to Chapter 1 for guidance on code compliance.

Electrical Design Publications and Standards

The latest editions of publications and standards listed here are intended as guidelines for design. They are mandatory only where referenced as such in the text of this chapter or in applicable codes. The list is not meant to restrict or preclude the use of additional guides or standards.

When publications and standards are referenced as mandatory, any recommended practices or features must be considered as "required." When discrepancies between requirements are encountered, GSA will determine the governing requirement.

The following Codes and Standards requirements must be incorporated into any GSA project design.

Codes and Standards

ASME: American Society of Mechanical Engineers

ASME A17.1, Safety Code for Elevators and Escalators

ASTM: American Society for Testing and Materials

ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings

BICSI, (Building Industry Consulting Service International) *Telecommunications Distribution Methods Manual*

BICSI, *Wireless Design Reference Manual*

California Energy Commission, 2008 Building Energy Efficiency Standards (Title 24)

CBM: Certified Ballast Manufacturers

ETL: Electrical Testing Laboratories

FAA: Federal Aviation Agency

Federal Information Processing Standard 175, Federal Building Standard for Telecommunication Pathways and Spaces

IESNA: Illuminating Engineering Society of North America

IESNA Lighting Handbook, Ninth Edition

IESNA RP-1-04, American National Standard Practice of Office Lighting

IESNA RP-5-99, Recommended Practice for Daylighting

IESNA LM-79-08, Electrical and Photometric Measurements of Solid-State Lighting Products

IESNA LM-80-08, Measuring Lumen Maintenance of LED Light Sources

IESNA TM-15-07, Luminaire Classification System for Outdoor Luminaires

IEEE: Institute of Electrical and Electronics Engineers

ICEA: Insulated Cable Engineers Association

NEMA: National Electrical Manufacturers Association

NFPA: National Fire Protection Association

NFPA 70, National Electrical Code

NFPA 101, Life Safety Code

NFPA 110, Standard for Emergency and Standby Power Systems

NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems

NFPA 780, Standard for the Installation of Lightning Protection Systems

UL: Underwriters' Laboratories

UL50, Enclosures for Electrical Equipment for Types 12, 3, 3R, 4, 4X, 5, 6, 6P, 12, 12K, and 13

UL67, Panelboards

Communication System Pathways and Spaces Design Standards

The communications system pathways and spaces must be designed in accordance with the latest edition of the *BICSI Telecommunications Distribution Methods Manual,* and coordinated with GSA's FAS to fulfill specific system requirements. The following standards define the minimum allowable requirements.

Wireless systems must be designed in accordance with the latest edition of the *BICSI Wireless Design Reference Manual,* and coordinated with GSA's FAS to fulfill specific requirements.

Electronic Industries Alliance/Telecommunications Industry Association (EIA/TIA) Standards are listed below.

Codes and Standards

EIA/TIA Standard 568, Commercial Building Wiring Standard (and related bulletins)

EIA/TIA Standard 569, Commercial Building Standard for Telecommunications Pathways and Spaces (and related bulletins)

EIA/TIA Standard 606, Administration Standard for the Commercial Telecommunications Infrastructure (and related bulletins)

EIA/TIA Standard 607, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications (and related bulletins)

EIA/TIA Standard 758, Customer-Owned Outside Plant Telecommunications Cabling Standard

OTHER STANDARDS AND GUIDELINES

Other GSA standards and government guidelines are provided in Chapter 1.

6.3 Design Criteria

The purpose of this section is to identify the criteria that must be used to determine the requirements for the lighting, communications, and electrical power systems.

Indoor Lighting and Daylighting Criteria

General and Task Lighting Design Criteria

Task/ambient lighting systems provide the best opportunities for providing a quality illuminated environment while maximizing energy savings. The ambient lighting system provides an overall reduced level of general illumination throughout the space. The ambient illumination is provided via natural lighting, recessed ceiling luminaires, pendant mounted luminaires, or wall-mounted indirect luminaires. To minimize sources of glare and strong directional downlighting with shadows, ceiling recessed luminaires should provide appropriate optical distribution for illuminating the vertical surfaces within the space. This will provide a more visually balanced and comfortable environment.

The ambient illumination is then supplemented when required by individual focused task lights. The task lighting can be provided either via fluorescent or LED sources. The task lights can be installed below overhead storage units or can be free-standing lamps. The locally controlled task lights provide individual occupants flexibility in creating their own customized working illuminated environment. Some individuals prefer working in lower ambient environments and often do not even require the supplemental task illumination.

Daylighting

Daylighting typically refers to two separate concepts: the ability of occupants to see outdoors and the displacement of electric lighting due to the harvesting of daylight. The lighting must comply with Section 9 of ASHRAE Standard 90.1, with the following modifications and additions:

1) In addition to ASHRAE Standard 90.1, Automatic Controls for Lighting in Daylight Zones: Lighting in all daylighted zones, both under overhead glazing and adjacent to vertical glazing, should be provided with controls that automatically reduce lighting power in response to the available daylight by either:

- A combination of dimming ballasts and daylight-sensing automatic controls, which are capable of dimming the lights continuously, or
- A combination of stepped switching and daylight-sensing automatic controls, which are capable of incrementally reducing the light level in steps automatically and turning the lights off automatically.

2) Where there are multiple rows of luminaries parallel to the window within the daylight zone, wire and control each row separately. [*Advanced Energy Design Guide* (AEDG), DL9]

3) In addition to ASHRAE Standard 90.1, Reflectances for Surfaces in Daylight Zones: Surface reflectances must be a minimum of 80 percent for ceilings and 70 percent for walls in daylight zones. [*Advanced Energy Design Guide* (AEDG), DL3]

To further increase energy savings, occupancy sensors should be used in all daylighted zones with enclosed spaces such as: small offices, pantries, conference rooms, restrooms, and storage areas (refer to Section 6.8). In these spaces all occupancy sensors must have “manual on” “automatic off” local controls.

References for daylighting design include the *IESNA Lighting Handbook* and *IESNA RP-5, Recommended Practice of Daylighting*.

Whenever daylighting systems are to be included in the design for daylight harvesting, the design must ensure adequate illumination, avoid glare issues, and assist in the integration of the lighting and thermal performance with the architectural, interior, and daylighting designs. Refer to Chapters 3 and 5 for multidiscipline coordination requirements.

Circuiting and Switching

Lighting circuits must be designed based on a realistic and adequate zoning analysis. The zoning analysis must account for separate lighting control strategies, unique occupancy areas, and maintain lighting zones no larger than 100 m^2 (1,100 sq. ft.) or one structural bay. Proper zoning allows for better control of lighting, especially during after-hours operation, while proper circuiting can minimize the complexity and cost of the lighting control system. Note that when digitally addressable ballasts are used, circuiting can be installed before there is any knowledge of occupant housing and be easily rezoned. The lighting zones can be defined and modified through software after the installation is complete.

Qualifications of the Lighting Practitioner

Lighting design for new construction, lighting renovations and energy retrofits must be performed or supervised by a lighting practitioner with a minimum of 10 years full time experience in lighting design with at least two of the three following qualifications of LC, IESNA member, or IALD member, and that devotes the majority of his/her professional time to the design of architectural lighting.

Illumination Levels

Illumination level requirements and power allowances for typical interior spaces are indicated in Tables 6-1 to 6-4. The designer should consider that recommended illuminance levels do not necessarily have to be generated solely from permanently installed ceiling or wall mounted systems. In fact, task/ambient lighting systems often lead to more energy-efficient solutions and provide individual occupant control. For those areas not listed in the table, the current version of the *IESNA Lighting Handbook* must be used for reference.

IESNA Lighting Handbook

The *IESNA Lighting Design Guide* is a formal system for considering a wide range of lighting design criteria. A complete presentation and discussion of this system can be found in Chapter 10 of the *Lighting Handbook*. Table B1 in Annex B of *ANSI/IESNA RP-1-04, American National Standard Practice for Office Lighting*, contains only those portions of the *Lighting Design Guide* that directly apply to a quality visual environment in offices and related spaces.

Accepted references for lighting, daylighting, and control systems include the *IESNA Lighting Handbook*, *IESNA RP-1-04, American National Standard Practice for Office Lighting*, and *IESNA RP-5-99, Recommended Practice of Daylighting*.

Table 6-1

Interior Lighting Requirements*

Area/Activity	Required Illuminance Average Lighting Levels	
	Lux	Fc
Office enclosed (ambient)	323	30
Office open (ambient)	323	30
Conference/Meeting	323	30
Classroom/Lecture	323	30
Lobby	108	10
Atrium	108	10
Lounge/Recreation	108	10
Dining area	108	10
Food preparation	538	50
Restrooms	108	10
Corridor/Transition	108	10
Stairs	108	10
Active storage	108	10
Inactive storage	54	5
Electrical/Mechanical/ Technology	323	30

* Refer to the design guide for the courts for the lighting requirements of the designated courts areas and marshal areas (USMS Publication No.64)

Table 6-2

Maximum Power Density*

Area/Activity	Maximum Lighting Power Density†	
	W/m^2	W/ft^2
Office enclosed (ambient)‡	9.7	0.9
Office open (ambient)‡	9.7	0.9
Conference/Meeting	15.0	1.4
Classroom/Lecture	12.8	1.2
Lobby	16.0	1.5
Atrium	12.8	1.2
Lounge/Recreation	11.8	1.1
Dining area	11.8	1.1
Food preparation	17.1	1.6
Restrooms	6.4	0.6
Corridor/Transition	6.4	0.6
Stairs	6.5	0.6
Active storage	8.4	0.6
Inactive storage	6.4	0.6
Electrical/Mechanical/ Technology	16.0	1.5

† The maximum lighting power density will change in accordance with the adjustment of lighting levels. Any change in lighting power density has to be approved by OCA. The lighting designer should strive to develop systems that are 20 percent below these values.

‡ Refer to local energy code requirements for inclusion of task lighting in the calculation of lighting power density.

Color Rendering Index (CRI)

The CRI is a measure of the ability of a light source to render the color of objects the same as a reference light source. Most CRIs are calculated by using an incandescent lamp as the reference source, so that the CRI can be considered as an index of how closely a source makes objects appear, as they would appear when lit with an incandescent source. On an index from 0-100, a CRI near 100 indicates a lamp that renders colors very closely to that of an incandescent source. All regularly occupied work areas should have light sources with a CRI above 82.

Artwork

Museum standards for lighting works of art range from 5 to 10 footcandles for extremely light-sensitive materials such as paper and textiles to 20 to 40 footcandles for moderately sensitive materials such as oil paintings and wood. Ultraviolet (UV) filters should be considered for all light-sensitive artwork. Analysis of CRI (minimum suggested is 82), color temperature, and ensuring light is diffused evenly on the artwork must be addressed. See Chapter 4.1, Installation Standards, in *Fine Arts Collection Policies and Procedures 2007* for additional information.

Table 6-3

Lighting Zone Designations

Zone	Ambient Illumination	Representative Locations
LZ 0	N/A	Undeveloped areas within national parks, state parks, forest land, and rural areas. Areas where the natural environment will be seriously and adversely affected by lighting. Impacts include disturbing the biological cycles of flora and fauna and/or detracting from human enjoyment and appreciation of the natural environment. Human activity is subordinate in importance to nature. The vision of human residents and users is adapted to the total darkness, and they expect to see little or no lighting. When not needed, lighting should be extinguished.
LZ 1	Low	Developed areas of national parks, state parks, forest land, and rural areas. Areas where lighting might adversely affect flora and fauna or disturb the character of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety and convenience but it is not necessarily uniform or continuous. After curfew, most lighting should be extinguished or reduced as human activity levels decline.
LZ 2	Moderate	Area predominantly consisting of residential zoning, neighborhood business district, light industrial with limited night time use and residential mixed use areas. Lighting may typically be used for safety and convenience but it is not necessarily uniform or continuous. After curfew, lighting may be extinguished or reduced as human activity levels decline.
LZ 3	Moderately high	All other areas. Areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security and/or convenience and it is often uniform and/or continuous. After curfew, lighting may be extinguished or reduced in most areas as human activity levels decline.
LZ 4	High	High activity commercial districts in major metropolitan areas as designated by the local jurisdiction. Areas of human activity where the vision of human residents and users is adapted to high light levels. Lighting is generally considered necessary for safety, security, and/or convenience and it is mostly uniform and/or continuous. After curfew, lighting may be extinguished or reduced in some areas as activity levels decline.

Note: Lighting zone designations must be confirmed with the program requirements.

Table 6-4

Lighting Power Allowance for General Exterior Lighting (Base and Tradable)

	Lighting Application	LZ0	LZ1	LZ2	LZ3	LZ4
Base Site Allowance (may be used in tradable or nontradable surfaces)		No base site in LZ0	500 W	600 W	750 W	1300 W
Tradable Surfaces	Uncovered Parking Areas: Parking areas and drives	No tradable surfaces allowances in LZ0	0.04 W/ft^2	0.06 W/ft^2	0.10 W/ft^2	0.13 W/ft^2
	Building Grounds: Walkways less than 10 feet wide		0.7 W/lf	0.7 W/lf	0.8 W/lf	1.0 W/lf
	Building Grounds: Walkways 10 feet wide or greater Plaza areas		0.14 W/ft^2	0.14 W/ft^2	0.16 W/ft^2	0.2 W/ft^2
	Building entrances		20 W/lf of door width	20 W/lf door width	30 W/lf door width	30 W/lf door width

Table 6-5

Lighting Power Allowance for Specific Exterior Lighting (Nontradable Surfaces)

	Lighting Application	LZ0	LZ1	LZ2	LZ3	LZ4
Nontradable Surfaces	Building facades	A single luminaire of 60W or less may be installed for each roadway/parking entry, trail head, and toilet facility	Not allowed	0.1 W/ft^2 for each illuminated wall or surface 2.5 W/lf for each illuminated wall or surface length	0.15 W/ft^2 for each illuminated wall or surface 3.75 W/ft^2 for each illuminated wall or surface length	0.2 W/ft^2 for each illuminated wall or surface 5.0 W/ft^2 for each illuminated wall or surface length
	Guarded facilities		0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area
	Loading area for law enforcement and ambulance		0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area

Table 6-4 notes: Base Site Allowance: additional power allowance takes into account that most sites are not rectangular or match the iso-diagram of typical light luminaires. This is from ASHRAE 90.1-2007, Addendum i. Tradable Surfaces: lighting power densities for these areas may be traded. This is from ASHRAE 90.1-2007 Addendum i.

Table 6-5 notes: Nontradable Surfaces: lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the “tradable surfaces” section of this table. This is from ASHRAE 90.1-2007 Addendum i.

Exterior Lighting Design Criteria

Exterior Lighting Requirements

The exterior lighting system must provide for the security and safety of the occupants and passersby, as well as to enhance the architectural aesthetics of the building. The properly designed exterior lighting system must provide the required illumination while simultaneously preventing light pollution and light trespass, minimizing glare, and avoiding overlighting. Exterior lighting must comply with the requirements of Tables 6-3, 6-4 and 6-5, except as modified below. For spill light control (Backlight/Light Trespass "B rating") the lighting system must produce less than the vertical illuminance listed in Table 6-6 at a point 5 ft. above grade. To minimize light pollution (Uplight "U" rating) and glare ("G" rating) all luminaire must not exceed allowed lumens listed in Tables 6-7, 6-8 and 6-9 as defined by IESNA TM-15-07 Luminaire Classification System (LCS).

Architectural Lighting

Architectural lighting is considered to be any lighting that illuminates the architectural building form, and it is typically uplighting from the ground with minimum use of downlighting from the building to minimize light pollution. Compliance with the following criteria is required:

For stone and masonry:

- Total architectural lighting connected wattage must not be more than 0.125 W/sq. ft. of exterior surface area.
- No uplighting fixture must use a lamp rated higher than 250W.
- All light from uplighting fixtures must be directed onto the building. No light can trespass around the architectural form.

For metal or glass curtainwall:

- Total architectural lighting connected wattage must not be more than 0.100 W/sq. ft. of exterior surface area.
- No uplighting fixture must use a higher rated lamp than 175W.
- All light from uplighting fixtures must be directed onto the building. No light can trespass around the architectural form.

Site Lighting

Site lighting is considered to be any exterior lighting that illuminates the area around the building, defines entrances and exits, or enhances traffic flow. Site lighting must adhere to the following criteria:

- Illumination of exterior exit discharges must be in accordance with NFPA 101.
- Luminaires selected must have a minimum cutoff angle of 80° if the lamp lumen output is higher than 3,500 lumens.
- Illumination must be well controlled and no light can trespass off the building property.
- Implement bollards or pedestrian scale poles for pathway illumination.
- Landscape and building illumination lighting must be controlled by clock, photocell control, or the BAS.
- The flagpole must be illuminated. The light must be controlled by a photocell. See Section 2.15, Flagpoles.
- The luminaire must be mounted with the backlight toward the property line.

Open Parking Lots and Roadway Lighting

Parking lots and roadway lighting must be designed with high-efficiency, pole-mounted luminaries that have at a minimum a cutoff angle of 80° and a luminaire efficiency of 50 lumens per watt. For basic parking lots, the minimum horizontal maintained illuminance values must be 0.2 footcandles, the minimum vertical maintained illuminance values must be 0.1 footcandle, and the uniformity ratio, maximum to minimum, must be less than 20:1. For enhanced security parking lots, the minimum horizontal maintained illuminance values must be 0.5 footcandles, the minimum vertical maintained illuminance values must be 0.25 footcandle, and the uniformity ratio, maximum to minimum, must be less than 15:1. Recommended illuminance values for roadway lighting are listed by road and area classifications. Refer to the *IESNA Lighting Handbook*, Roadway Lighting, Chapter 22, Figure 22-8, for recommended maintained luminance and illuminance values for roadways.

Table 6-6

Site Lighting Trespass Maximum Vertical Illuminance Values

Lighting Zone	Maximum Illuminance
LZ0	0.05 fc
LZ1	0.10 fc
LZ2	0.30 fc
LZ3	0.80 fc
LZ4	1.50 fc

Parking Structures

Fixtures for parking areas must be either fluorescent, light emitting diode (LED), or high intensity discharge (HID). Care must be taken in locating fixtures to conform to the traffic patterns and to maintain the required vehicle clearance. Recommended illuminance levels for parking structures are shown in the *IESNA Lighting Handbook*, Roadway Lighting, Chapter 22, Figure 22-22. In general, at nighttime the minimum horizontal maintained illuminance value must be 1 footcandle (measured at the floor), the minimum vertical maintained illuminance values must be 0.5 footcandle, and the uniformity ratio, maximum to minimum, must be less than 10:1. Lighting within the parking structure must not exceed a maximum of 0.2 W/sf lighting power density (LPD). A target LPD of 0.16 W/sf is desired through the use of selected controls like occupancy sensors or daylighting controls. These controls could help save at least 20 percent of energy compared to the total installed power times the full operating schedule of the parking structure. At a minimum all luminaires located along the perimeter must be connected to photosensors for daylight harvesting strategy.

Lamp sources include:

Fluorescent lamps: 32 W (nominal) 4 ft. T8 lamps (F32T8). These lamps should have mercury meeting toxicity characteristic leaching procedure (TCLP) standards, produce at least 2,900 lumens (initial), have a correlated color temperature between 3,500 and 4,100 K, a color rendering index ≥ 80 and have a lamp lumen depreciation (LLD) of 92 percent or greater at 20,000 hours.

LED sources must have an operating temperature rating between -40°C and +50°C, have a correlated color temperature between 3,000 and 4,500 K with a color rendering index ≥ 70.

Luminaires must meet the following standards:

- Have a luminaire efficacy of a minimum of 63 lumen per watt (LPW).
- Be wet-location rated.
- Withstand mechanical vibration.
- Life of minimum 50,000 operating hours for LED fixtures before reaching the L_{70} lumen output degradation with no catastrophic failures per IESNA standard LM-80-08.
- Lumen depreciation per IESNA standard LM-79-08.

Table 6-7

Maximum Allowed Lumens in the Uplight Zone for Luminaires

	Uplight Low (90°– 100°)	Uplight High (100°– 180°)	Forward Very High (80°– 90°)	Back Very High (80°– 90°)
LZ0	0 lumens (U0)	0 lumens (U0)	10 lumens (U0)	10 lumens (U0)
LZ1	10 lumens (U1)	10 lumens (U1)	75 lumens (U1)	75 lumens (U1)
LZ2	100 lumens (U2)	100 lumens (U2)	150 lumens (U2)	150 lumens (U2)
LZ3	500 lumens (U3)	500 lumens (U3)	>150 lumens (U3)	>150 lumens (U3)
LZ4	1,000 lumens (U4)	1,000 lumens (U4)		

Table 6-8

Maximum Allowed Lumens in the Glare Zone for Asymmetric Luminaires

	Forward High (60°– 80°)	Forward Very High (80°– 90°)	Back High (60°– 80°)	Back Very High (80°– 90°)
LZ0	660 lumens (G0)	10 lumens (G0)	110 lumens (G0)	10 lumens (G0)
LZ1	1,800 lumens (G1)	250 lumens (G1)	500 lumens (G1)	250 lumens (G1)
LZ2	5,000 lumens (G2)	375 lumens (G2)	1,000 lumens (G2)	375 lumens (G2)
LZ3	7,500 lumens (G3)	500 lumens (G3)	2,500 lumens (G3)	500 lumens (G3)
LZ4	12,000 lumens (G4)	750 lumens (G4)	5,000 lumens (G4)	750 lumens (G4)

Table 6-9

Maximum Allowed Lumens in the Glare Zone for Bilaterally Symmetric Luminaires

	Forward High (60°– 80°)	Forward Very High (80°– 90°)	Back High (60°– 80°)	Back Very High (80°– 90°)
LZ0	660 lumens (G0)	10 lumens (G0)	660 lumens (G0)	10 lumens (G0)
LZ1	1,800 lumens (G1)	250 lumens (G1)	1,800 lumens (G1)	250 lumens (G1)
LZ2	5,000 lumens (G2)	375 lumens (G2)	5,000 lumens (G2)	375 lumens (G2)
LZ3	7,500 lumens (G3)	500 lumens (G3)	7,500 lumens (G3)	500 lumens (G3)
LZ4	12,000 lumens (G4)	750 lumens (G4)	12,000 lumens (G4)	750 lumens (G4)

Exterior Lighting Controls

Exterior lighting circuits must be controlled by photocell in conjunction with the BAS. A minimum of 75 percent of the architectural, site, and parking lighting must be switched off three hours after the building is typically unoccupied or at 11:00 pm, whichever is later. Note also that the minimum security lighting requirements as specified in NFPA 101 have to be met. Use of other industry standard hard wired or wireless lighting controls is also permitted. High/low controls should be provided for walkway, parking lot, and parking garage lighting (landscaping and floodlighting excluded).

Emergency Lighting Criteria

Power loss resulting from utility system interruptions, building electrical distribution system failure, or the accidental opening of switches or circuit breakers dictates the requirement for emergency lighting.

Luminaires

Emergency electric lighting systems may consist of separate luminaries and wiring with an independent power source, e.g., a diesel generator, or separate luminaries or unit devices supplied by the normal power supply and a secondary source that comes on automatically when the normal power supply fails.

Emergency Lighting

Emergency lighting for means of egress must illuminate designated stairs, aisles, corridors, ramps, escalators, walkways, and passageways leading to an exit. Emergency lighting must also be provided at exit discharges extending to the public way or a minimum distance of 50 feet from the exit discharge. In addition, emergency lighting must be provided at doors equipped with delayed egress locks and at access-controlled egress doors. Where automatic, motion sensor-type lighting controls are installed, they must be provided with illumination timers set for a minimum 15-minute duration, and the motion sensor must be activated by any occupant within the means of egress.

Egress Illumination Levels

The floors and other walking surfaces within the path of egress must be illuminated as follows:

During conditions of stair use, the minimum illumination for stairs must be an average of 5 footcandles, measured at the walking surfaces. (See Section 6.17 for Bilevel Stairwell Lighting.)

The minimum illumination for floors and walking surfaces in the event of an emergency is one footcandle, measured at the floor.

Required illumination must be arranged so that the failure of any single lighting unit does not result in an illumination level of less than 0.2 footcandles in any area that requires emergency egress lighting.

Load Criteria

In determining electrical loads for Federal buildings, it is important to look beyond the immediate requirements stated in the project program. Future moves and changes have the effect of redistributing electrical loads. Unless otherwise specifically defined in the program requirements, the connected receptacle loads (see Table 6-10) and lighting loads (see Tables 6-1 to 6-5) must be combined with other electrical loads in the building, multiplied by the appropriate demand factors and with spare capacity added, to determine the overall electrical load of the building. The specific electrical power loads must be determined independently for the following load groups:

- Lighting
- Receptacle loads
- Motor and equipment loads
- Elevator and other vertical transportation loads
- Miscellaneous loads

Lighting Loads

The lighting and daylighting systems must be sensitive to the architectural design, provide adequate quality and quantity of illumination for interior and exterior lighting, comply with the design criteria, minimize maintenance requirements, and use 30 percent less electrical energy (kwh) than required for compliance with Section 9.6 (Alternative Compliance Path: Space-by-Space Method) of ASHRAE Standard 90.1-2007.

Receptacle Loads

A list of typical receptacle load requirements is shown in Table 6-10. Refer to Section 6.10 for further information on the receptacle design conditions and constraints.

Table 6-10

Minimum Receptacle Load

Area/Activity	Service Equipment		Distribution Equipment	
	W/m^2	W/ft^2	W/m^2	W/ft^2
Office/enclosed	14.00	1.30	27	2.50
Office open	14.00	1.30	35	3.25
Non-workstation areas	5.00	0.50	10	1.00
Core and public areas	2.50	0.25	5	0.50
Technology/server rooms	540.00	50.00	700	65.00

Motor and Equipment Loads

Loads associated with motors and equipment must use the rated brake horsepower of specified equipment and nominal full-load efficiencies that exceed those in Table 10-A of ASHRAE Standard 90.1-2004. Refer to Section 5.3 for additional criteria.

Elevator and Other Vertical Transportation Loads

Electrical power loads for elevators and other vertical transportation equipment must be based on the rated brake horsepower of the specified equipment and nominal full-load efficiencies that exceed those in Table 10-A of ASHRAE Standard 90.1-2004. Demand factors identified in NFPA 70, Chapter 6 must be applied. Refer to Section 5.3 for additional criteria.

Miscellaneous Loads

These loads include:

- Security, communication, BAS, and alarm systems
- Heat tracing
- Kitchen equipment
- Central computer servers and data centers
- Uninterruptible power supply (UPS) and battery rooms

Electrical loads for miscellaneous equipment must be based on the rated electrical power requirements or brake horsepower of the specified equipment and on the nominal full-load efficiencies that exceed those in Table 10-A of ASHRAE Standard 90.1. Demand factors identified in NFPA 70 must be applied. Refer to Section 5.3 for additional criteria.

**United States Courthouse
Brooklyn, New York**

Visitors enter through an elegant, light-filled, 75-foot lobby. Round lights mounted under the balconies augment the natural light which enters through the skylights and filters through the curved glass walls.

Demand Load and Spare Capacity

To ensure maximum flexibility for future systems changes, the electrical system must be sized for the demand load with additional spare capacity as follows:

Demand factors identified in NFPA 70, Chapter 6, must be applied.

Panelboards for branch circuits:
50 percent spare ampacity and 35 percent spare circuit capacity

Panelboards serving lighting only:
50 percent spare ampacity and 25 percent spare circuit capacity

Switchboards and distribution panels:
35 percent spare ampacity and 25 percent spare circuit capacity

Main switchgear:
25 percent spare ampacity and 25 percent spare circuit capacity

All distribution equipment ampacities must be calculated in accordance with NFPA Article 220 and as modified in this chapter. If the addition of 25 or 35 percent spare circuit capacity results in the need for a two-section panel, the design engineer must limit the spares to the capacity of the panel in question and assign sufficient space in the electrical closet layout to accommodate a future panel and associated transformer.

All panelboards must be fully populated with breakers of a size and rating of breakers actively being used in the panelboard.

Spare overcurrent devices must be provided for the installation of future protective devices.

Before adding the spare equipment ampacity to account for future load growth, it is important that the load study reflect actual demand loads rather than connected loads. The designer must apply realistic demand factors by taking into account various energy-conserving devices such as variable frequency drives applied to brake horsepowers, energy-efficient motors, occupancy sensors, and so on. The designer must also avoid adding the load of standby motors and must be careful to distinguish between summer and winter loads by identifying such “noncoincidental” loads. A “diversity factor” must be applied to account for the fact that the maximum load on the elevator system, as a typical example, does not occur at the same time as the peak air conditioning load. Once the estimated “peak demand” load is established, the factor for load growth must be added.

Visual Impact

Options regarding the location and selection of electrical work that will have a visual impact on the interior and exterior of the building must be closely coordinated with the architectural design. This includes the placement and specification of the lightning protection system, colors, and finishes of light fixtures, outlets, switches, and device plates.

Equipment Grounding Conductor

Except for isolated ground systems, all low-voltage power distribution systems must be supplemented with a separate, insulated equipment grounding conductor.

Lightning Protection

Lightning protection must be provided in accordance with NFPA 780. The system must be carefully designed to ensure that static discharges are provided with an adequate path to ground. Surge arrestors on the main electrical service must be provided. Systems served at utilization voltages 208Y/120V or 480Y/277V must be provided with two levels of protection for sensitive electronic loads.

6.4 Utility Coordination

Power Company Coordination

A detailed load study, including connected loads and anticipated maximum demand loads, as well as the estimated size of the largest motor, must be included in the initial contact with the local utility company to prepare its personnel for discussions relative to the required capacity of the new electrical service.

The service entrance location for commercial electrical power must be determined concurrently with the development of conceptual design space planning documents. Standards for equipment furnished by utility companies must be incorporated into the concept design. Locations of transformers, vaults, meters, and other utility items must be coordinated with the architectural design to avoid conflicts with critical architectural features such as main entrances and must accommodate both equipment ventilation and equipment removal. All major electrical equipment must be located 5 feet above the 100-year flood plain.

Communications Service Coordination

The telecommunications design professional must contact the local telecommunications providers and coordinate with the client agency GSA's FAS to determine the number, size, and location of the incoming services and to determine the enclosure and pathway requirements for telecommunications systems. The scope of services varies with each project; it includes, at a minimum, the design of the infrastructure (pathway and enclosure) and may include the full design and specification of the telecommunications system. The design professional must contact the local telecommunications providers through GSA's FAS early in the project.

Provision must also be made to provide either cable television (CATV) or satellite service to the facility. CATV or satellite service may be independent from other communications services. The need for multiple space service conduits to accommodate multiple voice/data vendors must be evaluated.

The need for separate redundant internal and external pathways may be required depending on the level of security and mission that may be required by the building occupant.

Site Requirements

The routing of site utilities and location of manholes must be determined early in the design process in coordination with the site civil engineer. The designer must coordinate with the utility company to determine the capabilities, rate structure options, and associated initial costs to the project and must evaluate the available utility service options.

Electrical Power Services:

For buildings less than 100,000 gross square-feet (gsf), utility power must be requested at the main utilization voltage, i.e., 480Y/277V or 208Y/120V.

For buildings greater than 100,000 gsf and less than 250,000 gsf, at least one electrical secondary service at 480Y/277V must be provided.

For buildings 250,000 gsf and larger, or for campus sites, electrical service must be provided to the site, at medium-voltage distribution, up to 34.5kV, for primary power distribution to substations.

Primary Cable Selection

Medium-voltage cable selection must be based on all aspects of cable operation and on the installation environment, including corrosion, ambient heat, rodent attack, pulling tensions, potential mechanical abuse, and seismic activity. Conductors must be copper, insulated with cross-linked polyethylene (XLP) or ethylene propylene rubber (EPR). Insulation must be rated at 133 percent. Individual conductor size must not exceed 240 mm^2 (500 kcmil).

Direct Buried Conduit

Direct buried Schedule 80 PVC, coated intermediate metallic conduit (IMC), or rigid galvanized steel must be used only for the distribution of exterior branch circuits 38 mm (1½ in.) or smaller. Backfill around the conduits must be selected based on the thermal conductivity and be free of materials detrimental to the conduit surface.

Concrete-Encased Ductbanks

Concrete-encased PVC Schedule 40 ductbanks must be used where runs are under permanent pavements and where service reliability is paramount.

Concrete-encased ducts must be provided with a cover that is at least 750 mm (30 in.) thick. Ductbanks under railroads must be reinforced. Ducts must slope toward manholes and all entries into buildings must have watertight seals. Changes in direction must be by sweeps with a radius of 1.2 m (4 ft.) or more. Stub-ups into electrical equipment may be installed with manufactured elbows. Duct line routes must be selected to avoid the foundations of other buildings and structures. Electrical power and communication ducts must be kept clear of all other underground utilities, especially high-temperature water, steam, or gas.

Where it is necessary to run communication cables parallel to power cables, two separate ductbanks must be provided with separate manhole compartments. The same holds true for normal and emergency power cables. Ductbanks must be spaced at least 300 mm (1 ft.) apart. Site entrance facilities, including ductbanks and manholes, must comply with the requirements stated in Federal Information Processing Standard 175, Federal Building Standard for Telecommunication Pathways and Spaces. [See also EIA/TIA (Electronic Industrial Association/ Telecommunication Industry Association) Standard 568-A and related bulletins.]

Where redundant service is required (power, communications, and/or life safety), alternate and diverse paths with 1-hour fire separations must be provided.

Duct Sizes and Quantity

Ducts must be sized as required for the number and size of cables. All ducts for medium-voltage services must be a minimum of 100 mm (4 in.). Inner ducts must be provided inside communication ducts wherever fiber optic cables will be used. Spare ducts must be included for planned future expansion; in addition, a minimum of 25 percent spare ducts must be provided for unknown future expansion and/or cabling replacement.

Manholes

Manholes must be spaced no farther than 150 m (500 ft.) apart for straight runs. The distance between the service entrance and the first manhole must not exceed 30 m (100 ft.). Double manholes must be used where electric power and communications lines follow the same route. Separate manholes must be provided for low- and medium-voltage systems. Manholes must have clear interior dimensions of no less than 1,800 mm (6 ft.) in depth, 1,800 mm (6 ft.) in length, and 1,800 mm (6 ft.) in width, with an access opening at the top of not less than 750 mm (30 in.) in diameter. Medium-voltage manholes must be sized in accordance with utility company requirements. Manholes must have a minimum wall space of 1,800 mm (6 ft.) on all sides where splices may be racked. Manholes must be provided with pulling eyes, sumps, and grounding provisions as necessary.

Stubs

A minimum of two spare stubs must be provided (to maintain a square or rectangular ductbank), so that the manhole wall will not need to be disturbed when a future extension is made. Stubs for communications manholes must be coordinated with GSA's Federal Technology Service.

Handholes

Handholes may be used for low-voltage feeders (600V and below), branch circuits, or communications circuits. If used, they must be not less than 1,200 mm (4 ft.) in depth, 1,200 mm (4 ft.) in length, and 1,200 mm (4 ft.) in width, and must be provided with standard manhole covers and sumps of the same type provided for manholes. Generally, at least four racks must be installed. Where more than two splices occur (600V feeders only), a 1,800 mm (6 ft.) by 1,800 mm (6 ft.) by 1,800 mm (6 ft.) manhole must be required.

Penetrations

Lighting and communication circuits that penetrate fire walls, fire barriers, fire partitions, smoke barriers, smoke partitions, and between floors must be properly sealed in accordance with the requirements of the IBC with approved firestopping materials.

Exterior Concrete

Concrete pads constructed to support exterior mechanical and electrical equipment must be provided with sufficient conduit penetrations to provide the necessary power and control connections plus an additional 50 percent for future equipment additions and modifications. Spare conduits need not extend more than 1,200 mm (4 ft.) past the end of the concrete slab. All spare conduits must be capped at both ends.

Advanced Building Metering and Control

All projects must install advanced meters for electricity in accordance with EPAct 2005, and install advanced meters for gas and steam in accordance with EISA 2007, Section 434 (b), and EPAct 2005, "Guidance for Electric Metering in Federal Buildings." Government facilities must be prepared to reduce demand quickly and effectively and include intelligent electric meters capable of bidirectional monitoring of phase voltages, phase currents, power consumption (demand), power factor, kVAR, and availability. These meters must be capable of communicating via MODBUS/TCP/IP. Meters must meet at a minimum the definition stated. Government projects must also include demand reduction logic in the building automation system that is capable of activation upon input from the building operator or the intelligent meters. Ideally, the logic would be capable of three tiers of demand reduction—low/no occupant impact, minor occupant impact, and some impact. The equipment curtailed or set-points changed during each level must be identified by the A/E and agreed to by the project manager.

Further information for advanced metering and guidance is offered by the PBS Chief Information Officer's *Advanced Metering System Implementation Guide*.

Wayne Lyman Morse U.S. Courthouse
Eugene, Oregon

6.5 Distribution System Alternatives

Primary Distribution

Where the design alternatives have been thoroughly evaluated and a medium-voltage service is selected as the optimal utility service for the application, the design professional must request that the utility company provide a minimum of three 15 kV (nominal) feeders to serve the facility. Feeders must not be connected to the same utility switchgear bus section. If at all possible, request that facility feeders be extended from different substations.

The following types of primary distribution systems are listed in terms of increasing flexibility, reliability, and cost:

1 Looped primary (not recommended)

2 Radial primary

3 Primary selective

4 Primary selective-secondary selective

5 Network

The selection of a primary distribution system must be based on a study comparing the relative advantages and disadvantages of the feasible alternatives, including a life-cycle cost comparison. Where primary service is provided, GSA will provide, own, and maintain the building transformers.

Medium-Voltage Switchgear

Design of the medium-voltage switchgear must meet all of the requirements of the local utility. Switchgear must be provided with enclosed, drawout-type vacuum interrupter breakers, one per each size fully equipped spare cubicle/ breakers up to 1,600 amps, a breaker lifting device, and a ground and test device. The ground and test device must be stored in a spare switchgear cubicle.

Voltmeters, ammeters, and watt-hour digital meters with demand registers on each feeder must be provided for medium-voltage switchgear in addition to utility-approved digital relaying. Meters must be digital pulse-type for connection to and monitoring by the Advanced Metering Equipment.

All switchgear sections must be installed on four-inch concrete housekeeping pads.

Medium-Voltage Conductors

Conductors must be copper, insulated with XLP or EPR. Insulation must be rated at 133 percent of the voltage rating. Individual conductor size must not exceed 240 mm^2 (500 kcmil).

Network Transformers

Where continuity of service is determined to be critical by the program, network transformers must be considered as the first priority.

Network transformers must be liquid-filled and have a kVA rating as required, with copper primary and secondary windings. Transformers must be equipped with provisions for fans and/or dual temperature ratings to increase the rated capacity and must be provided with sufficient contacts to permit the remote monitoring of the status of the network protector, temperature and pressure in the enclosure, and other components recommended by the manufacturer. Fans must not be used in determining the initial rating of the transformer. In addition, transformers must be provided with voltage taps ± 2.5 percent with a no-load tap changer. Network transformers and tap changers located in areas subject to flooding or water backup must be specified as waterproof. Network transformers must be provided with disconnects for safe isolation servicing. The energized status of the transformers must be monitored by the Advanced Metering System.

Double-Ended Substations

Where either a primary selective or primary selective-secondary selective (double-ended) substation is selected, the following paragraph applies:

If reliability is critical and spot networks are not feasible, double-ended substations must be used. Transformers must be equipped with provisions for fans to increase the rated capacity. The sum of the estimated demand load of both ends of the substation must not exceed the rating of either transformer and must not exceed the fan cooling rating. All double-ended substations must be equipped with two secondary main breakers and one tie breaker configured for open transition automatic transfer, initiated through the use of an under-voltage relaying scheme. Breakers must be of the electrically operated drawout type.

Network Substations

Network substations are usually close-coupled to the secondary switchboards serving the respective loads. All circuit breakers up to and including the secondary switchgear main circuit breaker must be drawout type.

Transformers

Transformers in double-ended and network substations must be dry type with epoxy resin cast coils or liquid filled, 300 C° insulation, non-petroleum-based insulating-oil type. Liquid-filled transformers must be used outdoors and for below-grade vault construction. Provide lightning arrestors on the primary side of all transformers. Provide surge suppression on the secondary and/or downstream busses.

Where silicon or oil-filled transformers are used, the design must comply with all spillage containment and electrical code requirements.

Secondary Distribution

Main Switchgear (480 V Service)

In the case of double-ended substations, all main and secondary feeder breakers must be drawout power type.

Each metering section must contain a voltmeter, ammeter, and watt-hour meter with demand register. Meters must be pulse type for connection to and monitoring by the BAS. Switchgear must be front and rear accessible.

All breakers in the 480 volt-rated service main switchgear must be fully rated. Series rating is not to be permitted. Main and feeder breakers must be provided with integral solid-state ground-fault protection tripping elements.

Main Switchgears and Switchboards (208 V Service)

Switchboards with 208 V service, including substation secondary switchboards, must be freestanding and provided with a single main service disconnect device. This main device must be insulated case, power air circuit breaker, or bolted-pressure fusible switch, have ground fault protection, and must be individually mounted, drawout type (as applicable). Insulated case and power air circuit breakers must be electrically operated. Branch feeders must be protected by fusible load-break switches or by fully rated molded case circuit breakers. Front access is required.

Surge Suppression

Surge suppression on the main incoming service secondary switchboard must be provided.

Switchgear Metering

All main switchgear metering sections should contain a voltmeter capable of reading all phase-to-phase and phase-to-neutral voltages. The meter section should have a switchable ammeter and a three-phase totalizing watt-hour meter. The power meter should be networked and/or tied into the Advanced Metering System.

6.6 Space Conditions

It is the joint responsibility of the architect and the electrical engineer, functioning as part of an integrated design team, to provide adequate space and suitable locations for the electrical systems serving the facility and a planned method to install and replace this equipment. However, it is the sole responsibility of the electrical engineer, during the concept phase, to provide detailed space requirements and suggested preferred locations of all critical space requirements for the power and communications systems for the facility. The cooperation of the architect is then required to provide the required space conditions, clear of any structural columns or beams as well as shear walls, stairways, duct shafts, and other obstructions. Equipment space selection must take into consideration adjacencies, such as stairs, mechanical rooms, toilets, elevators, air/piping shafts, and fire-rated assemblies, to permit secondary distribution of electrical and telecommunications circuitry to exit the assigned spaces. In addition, electrical equipment must be located at five feet above the 100-year flood plain. The electrical engineer must determine from local jurisdictions any additional freeboard requirements above this base level.

REQUIRED FLOOD PLAIN CLEARANCE

Electrical equipment must be located at five feet above the 100-year flood plain.

Do not run electrical power or communication systems within stair enclosures unless power or communication serves the stair or is part of the emergency communication system.

Note: The designers must refer to Chapter 3, Section 3.8, Chapter 5, Section 5.7, and Chapter 7, Section 7.6 for design criteria related to the following elements of the electrical and communication systems:

Main equipment rooms	Electrical rooms
Communications rooms	Building engineer's office
Security control center	Fire command center
UPS systems and batteries	Emergency generator

Main Equipment Rooms – Electrical and Telecommunications

The size of the electrical service room will depend on the type of service provided by the local utility company. If a secondary (480 V or 208 V) service is provided, the size of the room must be determined by the number of service stubs into the room and the respective number and size of switchgear. In this case, the rooms must be located securely in a vault or inside the building along a perimeter wall at an elevation that minimizes the transformer secondary feeder lengths. Main switchgear room doors must be large enough (in width and height) to allow for the removal and replacement of the largest piece of equipment. All equipment doors and personnel doors must swing out and be provided with panic hardware.

The sizes and locations of the telecommunications service rooms must be established in concert with the local communications service provider. Depending on the equipment selected, telecommunication service rooms may require 24-hour HVAC service, and may need protection from contaminants by proper filtration equipment.

Where the application of water from fire sprinklers installed in a main electrical room constitutes a serious life or fire hazard, the main electrical room must be separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a fire-resistance rating of not less than 2 hours.

Electrical Rooms

Electrical rooms are generally located within the core areas of the facility and must be stacked vertically. Adequate numbers of electrical rooms must be provided, such that no electrical room serves more than 930 m^2 (10,000 sq. ft.). Electrical rooms must be provided with minimum clear dimensions of 1,800 mm by 3,000 mm (6 ft. by 10 ft.). If transformers are located in the rooms, ventilation must be provided. Doors must swing out.

Communications Rooms

Communications rooms are also generally located within the core areas of the facility and must be stacked vertically. Rooms must be sized to contain adequate floor space for frames, racks, and working clearances in accordance with EIA/TIA standards. Depending on the equipment selected, provisions may be required for 24-hour air conditioning in these rooms. The installation of dedicated electrical panelboards within the communications rooms should be considered to minimize electrical noise and to prevent unauthorized access.

Building Engineer's Office

Even if not included in the building program, office space for the building engineer must be evaluated. Most GSA buildings require such a space, which houses the consoles for the BAS and remote annunciators for other critical systems such as fire alarm, generator status, miscellaneous alarm systems, and lighting control systems. This space is normally located near the loading dock or main mechanical spaces.

Security Control Center

Each GSA building with a local security force must have a control center. In the event that the building will not be served by a local security force, this room may be combined with the building engineer's office or the fire command center.

The security control center must be located within the most secure area of the building and must be sized to house the command station for the security guards and their equipment, for current as well as anticipated future building needs.

Spaces for Uninterruptible Power Systems (UPS) and Batteries

Since all UPS systems are considered above standard for GSA space, the requirement for a UPS system will be a tenant agency requirement. To establish the proper size, locations, and environmental requirements for the UPS and battery systems, the electrical engineer must arrange to meet with the architect and representatives of the tenant agencies to determine the required/estimated load and physical size requirements and the nature of the critical loads. Refer to the UPS and battery manufacturers' installation instructions for heat dissipation requirements, weights, dimensions, efficiency, and required clearances in the design.

For small systems up to 50kVA, the UPS modules and sealed cabinet batteries must be installed in the room with the equipment being served.

For medium and large systems greater than 50kVA, the UPS system must be provided with standby generator backup to limit the battery capacity. The UPS system equipment and batteries must be in separate rooms and located on the lowest level above the 100-year flood plain because of the weight of the batteries and the noise of the UPS equipment.

Space for storage of safety equipment, such as goggles and gloves, must be provided. Special attention must be given to floor loading for the battery room, entrance door dimensions for installation of the UPS, and ceiling height for clearance of the appropriate HVAC systems and exhaust systems.

Fire Command Center

See Chapter 7, Fire Protection and Life Safety, for specific requirements for the Fire Command Center.

6.7 Secondary Branch Power Distribution

Feeder Assignments (Bus Ducts vs. Cable-In-Conduit)

The secondary main branch power distribution system conveys power to the various load groups distributed throughout the building. The decision as to whether this power is conveyed to the various loads in copper cables-in-conduit or in copper bus duct must be based on the following factors:

- Size and shape of the facility
- Design of the main switchgear
- Coordination with piping and ductwork in the lower levels
- Design of the electric rooms – proximity to the transformer vault
- Ceiling space available
- Access to bus splice connections for testing
- Flexibility
- Reliability
- Cost

At the early stages of a project, alternate designs comparing the factors listed above must be evaluated to determine the feeder assignments. Results must be submitted in accordance with Appendix A.

Bus Duct

Bus ducts must be copper, fully rated, 3-phase, 3-wire or 3-phase, 4-wire with 100 percent neutral and an integral ground bus, sized at 50 percent of the phase bus. NEMA Class 3R or higher jacketing should be considered if the bus duct is to be installed in areas to be sprinkled or located adjacent to steam lines. Calculations supporting the specified short-circuit rating must be submitted in accordance with Appendix A.

Motor Control Centers

Grouped motor controls must be used where eight or more starters are required in an equipment room. Motor control center (MCC) construction must be NEMA Class I, Type B copper, with magnetic (or solid-state if appropriate) starters and either molded case circuit breakers or fused switches. The minimum starter size in motor control centers must be Size 1. MCC's must be provided with Advanced Metering for remote monitoring. Control circuit voltage must be 120V connected ahead of each starter via a fused control transformer. Reduced-voltage starters may be used for larger motors to reduce starting kVA.

Time-delay relays must be incorporated in the starters or programmed in the BAS system to reduce inrush currents on the electrical system.

Where variable frequency drives (VFDs) are used on a project, an LCC evaluation must be conducted to determine when VFDs must be incorporated into the MCCs. If determined not appropriate, then VFDs must be powered from distribution panels installed for that purpose. See below for additional VFD requirements.

Elevator and Other Vertical Transportation Power

If two or more switchgears are available, the load of the elevator and other vertical transportation feeders must be divided among the secondary switchgears, provided that alternate elevator machines must be fed from different switchgears.

Note: One elevator in each bank must be connected to the emergency generator. Where multiple elevators are in a common bank, provide a common emergency feeder from the elevator automatic transfer switch (ATS), to allow each elevator to be operated individually during an emergency. See Section 6.12 for additional requirements.

Interlocking the ATS with the elevator group controller, programming must be made by the elevator supplier to set up a controlled return to the terminal floor and then to limit the number of elevators in that bank that can be run concurrently.

Elevator machines must be powered from circuit breakers with a shunt trip and with padlocking capability, located in the elevator machine rooms. Electrical design standards in ASME A17.1, Safety Code for Elevators and Escalators, must be followed.

United States Courthouse
Seattle, Washington

Variable Frequency Drive

Variable frequency drives must be used on all speed control motors larger than 3.7 kW (5 horsepower) to reduce the energy consumption of the project. However, VFDs generate harmonics, which are injected into the secondary power distribution system. These harmonics must be minimized through the use of filters tuned to the peak harmonic generated by the drive. All VFDs must be provided with a contactor bypass option.

VFDs must use a minimum 6-pulse width modulation (PWM) design because of their excellent power factors and high efficiencies. VFDs must be specified with passive harmonic filters and also with isolation transformers where required. Individual or simultaneous operation of the variable frequency drives must not add more than 5 percent total harmonic voltage distortion to the normal bus, nor more than 10 percent while operating from the standby generator (if applicable), per IEEE 519, latest edition. The load side of the main breaker must be the point of common coupling.

A harmonic (voltage and current) analysis must be conducted by the electrical engineer, including all calculations, and submitted in accordance with Appendix A, Sections A.3 and A.4.

Where the harmonic analysis indicates noncompliance, the application of 12-pulse, pulse width modulation, or zig-zag transformers or other approved alternate method must be used to reduce the total harmonic voltage distortion.

Thermal sensors must be specified that interlock with the VFD control circuit for additional protection for motors running at low speeds and subject to overheating. This is in addition to the standard over-current protection required.

REQUIRED

VARIABLE FREQUENCY DRIVES

VFDs must use a minimum 6-pulse width modulation design because of their excellent power factors and high efficiencies.

6.8 Interior Lighting Technologies and Controls

Careful consideration must be taken in the design of lighting and daylighting systems regarding servicing of the fixtures, replacement of lamps, and maintenance of daylighting control systems. This issue needs to be discussed with building operation staff to determine the requirements for servicing equipment.

Where lighting systems are integrated with daylight control systems, the designer must specify a testing and acceptance plan for the total system as designed. This plan will be incorporated into the commissioning specification and process. System documentation and as-built requirements for the lighting/daylighting control system must be clearly specified by the illumination designer.

Technology and Product Criteria

General lighting must comply with the following luminaire, lamp, and ballast requirements.

Luminaires

All luminaires must be appropriately selected based upon the expected application. Luminaires must be recessed, pendant, or surface mounted. Indirect/direct luminaires must have a minimum 2 percent indirect component and a maximum 50 percent direct component. Luminaires must have a minimum luminaire efficiency of 65 percent.

Where parabolic luminaires are used, louvers must be semi-specular or diffuse finishes; specular finishes must not be used.

All recessed downlights must use compact fluorescent lamps (CFL), LED, halogen, or ceramic metal halide lamps as follows:

Where a general broad distribution is required, downlights must use CFLs with a minimum fixture efficiency of 50 percent. No black baffles are allowed.

Where a narrow distribution or specific cutoff is required, downlights must use ceramic metal halide lamps with a minimum fixture efficiency of 65 percent.

LED or halogen downlights with appropriate light distributions may be substituted for CFL or ceramic metal halide where appropriate. LED lamps should *not* be used in fixtures not designed for their application.

Many fixtures have different lamp and ballast options. For ease of maintenance, all similar lighting situations must use the same lamps, ballasts, or self-contained LED luminaires where possible. Luminaires with 50,000 hour lifetime or greater as tested to IESNA LM-80 should be considered where appropriate to minimize maintenance.

Task lighting portable luminaires, such as desk lamps or task lights, and undercabinet lighting should be considered as sources to direct light to horizontal work surfaces.

Lamps

Effort must be made to minimize the number of lamp types within a facility to simplify lamp maintenance.

All linear fluorescent lamps must be SuperT8 or T5, low-mercury lamps with efficacies above 90 lumens/W. The maximum lumen depreciation must be 5 percent. The lamp color temperature must be either 3,500K or 4,100K and be consistent throughout the building. Lamps must have a CRI greater than or equal to 85. The minimum rated lamp life must be 20,000 hours.

All CFLs must have minimum efficacies of 60 lumens/W and a maximum lumen depreciation of 15 percent. The minimum rated lamp life must be 10,000 hours. The lamp color and CRI must be consistent with the linear fluorescent lamps. No CFLs below 13W may be used; these lamps typically have lower efficacy, poor power factor, and no electronic ballast options.

All ceramic metal halide lamps used in finished spaces must have a CRI greater than or equal to 80.

LED replacement modules must not be used in an existing luminaire designed for an incandescent or CFL or HID luminaire unless tested for that specified luminaire due to poor heat transfer.

High-efficiency halogen lamps and HIR lamps may be used in all incandescent fixtures.

Metal halide lamp fixtures designed to be operated with lamps rated greater than or equal to 150 watts but less than or equal to 500 watts must contain:

- a pulse-start metal halide ballast with a minimum ballast efficiency of 88 percent or;
- a magnetic probe-start ballast with a minimum ballast efficiency of 88 percent or;
- an electronic ballast with a minimum ballast efficiency of 92 percent for wattages greater than 250 watts and a minimum ballast efficiency of 90 percent for wattages less than or equal to 250 watts.

In retrofit scenarios, all fluorescent lamps must be recycled by firms that recover the mercury that is contained within the lamps. All PCB-containing ballasts must be disposed of through specialized disposal firms that destroy the PCBs.

Ballasts

Ballasts for fluorescent lamps must be “NEMA Premium” when applicable. Ballasts for other types of linear and compact fluorescent lamps and LED fixture drivers must be electronic with a minimum power factor (PF) of 0.95 and a maximum total harmonic distortion (THD) of 10 percent. Programmed start ballasts must be specified for use in linear fixtures that are frequently switched on/off, such as with occupancy controls. Continuous dimming or step-dimming ballasts must be used in special application situations. Tandem wiring must be implemented to reduce the number of ballasts, where applicable.

Electronic ballasts must be used wherever possible and have a sound rating of “A.” If EM ballasts must be used in special applications, EM ballasts must have a sound rating of “A” for 430MA (Standard Output) lamps or “B” for 800 MA lamps, and “C” for 1,500 MA lamps. Special consideration must be given to the ballast types where an electronic clock system is also specified to confirm compatibility of application.

Lighting Controls

Except for hallways, exit stairways, and lobbies, all lighting that is not intended for 24-hour operation should have automatic lighting controls. Lighting control or switching zones should follow the operation and function of the space. Proper zoning allows for better control of lighting, especially during after-hours operation, while proper circuiting can minimize the complexity and cost of the lighting control system.

For general illumination, fixtures with more than two lamps must be capable of being switched with A/B switching or dimming ballasts that allow the lighting output to be reduced to at least 50 percent. The maximum power penalty due to dimming must be no greater than 20 percent of the full power input.

Tandem wiring must be implemented to reduce the number of ballasts, where applicable.

To control large open areas, programmable relay or circuit breaker-based controls must be used. These systems typically include standard or astronomical time clocks, occupancy sensors, photosensors (light level), and override switches, but they can include myriad options such as ID card readers and individual PC-based lighting controls.

Time of Day Control

An on/off time schedule must be included in the control system for all lighting except security lighting and lighting in spaces where occupants could be in physical danger due to loss of light. This control system must incorporate lighting sweeps, warning flashes, or other methods to ensure that lighting is off in unoccupied spaces during scheduled unoccupied times.

Occupancy Controls

Occupancy sensors must be provided for the following space and occupancy types:

- Enclosed offices
- All pantries, kitchens, and conference dining rooms
- Conference rooms
- Restrooms with three or fewer flush valves
- All storage and file rooms
- Any other regularly unoccupied spaces not mentioned

Occupancy sensors must be high-frequency ultrasonic or dual-technology passive infrared/ultrasonic sensors, based on the application. Each occupancy sensor must have a manual override and must control no more than one enclosed space, though some applications may require multiple occupancy sensors to adequately control a single space. Occupancy/vacancy sensors must not false trigger or reactivate time delay due to adjacent corridor traffic. Each sensor shall allow the adding or deleting of specific fixtures or zones to the assigned sensor through handheld remotes. Occupancy sensors should allow remote control adjustments of operational parameters (sensitivity, time delay), and should be able to transmit, receive, and store system information through the remote control. Sensors shall be located, shielded or controlled by internal logic to adjust sensitivity based on ambient temperature, air temperature variations, or HVAC air movement. Each occupancy sensor must be marked/labeled identifying the panel and circuit number.

No occupancy controls must be used in mechanical or electrical rooms or other spaces where occupants could be in physical danger due to loss of light (see Section 6.8, Specific Lighting Constraints, for additional requirements).

Photo Controls

Photosensors are typically used to either control dimming ballasts for lumen maintenance or reduce lighting levels in response to available daylighting. Photo sensors must be provided for the following space and occupancy types:

- All regularly occupied perimeter spaces.
- All other spaces that are anticipated to provide daylight that will displace the installed lighting by at least 500 full-load hours per year.

Lighting systems are designed for “maintained lighting levels” so that appropriate light levels are provided as the system ages. This results in initial lighting levels approximately 20-35 percent higher than required. Lumen maintenance control strategy requires reducing the initial lighting levels to the actual target maintained lighting levels. This is accomplished via dimming ballasts and photosensor control. As the system ages, the control system monitors the artificial lighting levels and makes adjustments to provide the constant target illuminance value.

Integrated photo/occupancy sensors must be provided for perimeter offices with depth less than 15 ft. from vertical glazing and/or ceiling heights higher than 9 ft.

Photo control systems must reduce the electric lighting by simple on/off, stepped dimming, or full dimming controls.

The control strategy must be closed loop (sensing daylight and electric illumination at the same time) but must be programmed to minimize lamp cycling and occupant distraction. Daylight sensors shall allow the adding or deleting of specific fixtures or zones to the assigned sensor through handheld remotes. Sensors should allow remote control adjustments of operational parameters (set points and fade rate), and should be able to transmit, receive, and store system information through the remote control. Sensors must detect changes in ambient lighting level and provide dimming range as required by sequence of operation. The control software shall be capable of controlling multiple zones utilizing the input from a single light sensor, allowing separately adjustable settings for each control zone and shall be capable of using photosensor input to trigger preset scenes in spaces with multiple scene preset controls.

Override Controls

An easily accessible local means of temporary override must be provided in all spaces to continue operations per IBC or local energy code. This override is typically embedded in a timer switch located in the space, but PC-based and other override strategies are acceptable. However, overrides must be automatic; phone systems that depend on facility managers to control the local lighting are not permitted.

Lighting Control Applications

Unless relevant provisions of the applicable local energy codes are more stringent, provide a minimum application of lighting controls as follows:

All conference/meeting spaces shall have luminaires equipped with continuous dimming ballasts capable of dimming to 10 percent of full output or lower.

All luminaires within 15 ft. of windows or within 7 ft. of skylights (the daylighted zone) shall be separately controlled from luminaires outside of daylighted zones. Luminaires closest to the daylight aperture shall be separately controlled from luminaires farther from the daylight aperture, within the daylight zone.

Provide daylight harvesting controls for all luminaires within the daylighted zone.

Provide smooth and continuous daylight dimming for any daylighted zone with permanently seated office workers in open/enclosed office areas, conference/meeting, and all other regularly occupied spaces in the daylighted zone. Provide multilevel (or at a minimum on/off) switched daylight harvesting controls for nonwork areas or in areas where the light sources cannot dim as in HID lamps.

Provide bilevel dimming (or at a minimum switching) in stairwells, lunch room, break room, and all the regularly occupied spaces outside the daylighted zone. Daytime set points that initiate dimming shall be programmed to be not less than 125 percent of the nighttime maintained designed illumination levels.

In spaces utilizing pendant “workstation-specific” luminaires, the ambient lighting component shall be zoned and controlled as a general, space-wide lighting system. The control system shall not allow luminaires or portion of luminaires providing ambient lighting to the space and vertical surfaces to be controlled by occupant or vacancy of individual workstations. Only the downlight task-lighting component dedicated to a specific workstation can be controlled by the occupant of that workstation. Ambient lighting shall be extinguished only when all workstations in a zone are vacant.

Use occupancy/vacancy sensors with manual-on functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and automatic-on occupancy sensors are more appropriate. Provide occupancy/vacancy sensors for any enclosed office, conference room, meeting room, and training room. For spaces with multiple occupants or where line-of-sight may be obscured, provide ceiling- or corner-mounted, or luminaire-integrated sensors with manual-on switches. For workstation-specific open plans, occupancy sensors without manual-on are to be used.

Conference, meeting, training, auditoriums, and multipurpose rooms shall be provided with controls that allow for independent control of each local control channel, as well as the capability of establishing up to eight preset lighting scenes in each room. Such multiple scene controls shall include a 0-60 second fade rate option. Occupancy/vacancy sensors shall be provided to extinguish all lighting in the space. It shall not be acceptable for the system to automatically turn on the last preset selected. Such multizoned controls shall require manual selection of a preset or zone to turn on any lights in the space. In non-daylighted spaces it shall be acceptable to allow an occupancy sensor to turn on a designated preset or zone representing the lowest wattage grouping in the space.

In large meeting, training, auditoriums, or other such spaces, provide appropriate interfaces such as RS232 for audio-visual interaction, and DMX control for LED or theatrical controls, as needed for the specific project.

In meeting spaces with movable dividing partitions, provide wall stations or keypads labeled to indicate the room lighting is to be controlled in zones, or as one large room.

Security Lighting, Exit Signs, and Emergency Lighting

Security Lighting

Security lighting is lighting that remains on during unoccupied hours per applicable GSA and tenant criteria. Security lighting in daylit spaces must be controlled by photosensors. If security lighting also functions as emergency lighting, then separate circuits and emergency ballasts are required.

Exit Signs

Exit signs must meet the requirements in NFPA 101 and be energy efficient and environmentally friendly products (e.g., light emitting diodes (LED type, photoluminescent type). Tritium exit signs must not be installed.

Emergency Lighting

Emergency lighting must be provided in accordance with the requirements of NFPA 101 and the IBC. At a minimum, unswitched emergency lighting must be provided in the following areas:

- Lighting in zones covered by closed-circuit TV cameras
- Security zones
- Fire command center
- Security control center
- Where required in NFPA 101
- UPS and battery rooms

Emergency lighting may be manually switched from within in the following areas:

- Communication equipment rooms
- Electrical rooms
- Technology/server rooms
- Engineers' offices

Supplemental battery-powered emergency lighting must be provided in the following spaces to bridge the generator startup time:

- Generator rooms
- Main mechanical and electrical rooms
- Any locations where lighting cannot be interrupted for any length of time

Specific Lighting Constraints

Mechanical and Electrical Spaces

Lighting in equipment spaces or rooms must be provided by industrial-type fluorescent or metal halide fixtures. Care must be taken to locate light fixtures so that lighting is not obstructed by tall or suspended pieces of equipment. Physical protection such as wire guards and tube sleeves must be provided for light fixtures to prevent lamp or fixture damage.

High Bay Lighting

Lighting in shop, supply, or warehouse areas with ceilings above 5.0 m (16.4 ft.) must be metal halide pendant hung fixtures, LED, or high-intensity fluorescent T5HO reflectorized fixtures. Metal halide fixtures with prismatic lenses can be used only with a minimum mounting height of 7.5 m (25 ft.). No high-pressure sodium lamps are allowed. The A/E must design high bay fixtures so that lamps can be easily replaced.

Conference Rooms and Training Rooms

These spaces must have a combination of lighting options to provide multiple scenes for space flexibility. Typical scenes would be vertical illumination for facial rendering at meetings, separate light at the front for speakers' illumination, and lower light at the front for media presentations. See Section 6.3 for lighting criteria. The lighting design should be coordinated with the audiovisual requirements for these areas.

Other Special Areas

Special lighting design concepts are required in these areas. The lighting design must be an integral part of the architecture. Consideration must be taken by the certified lighting designer to integrate the design with the interior finishes and furniture arrangement to enhance the functionality of the spaces. Further consideration must be taken to adhere to the energy criteria and maintenance criteria, as well as minimizing the number of special lamp types and fixtures required. Areas generally requiring special lighting treatment are as follows:

- Main entrance lobbies
- Atriums
- Elevator lobbies
- Public corridors
- Public areas
- Auditoriums
- Conference rooms
- Training rooms
- Dining areas and serveries
- Libraries

Specific lighting criteria for courtrooms and judges chambers are referenced in Chapter 8, Design Standards for U.S. Court Facilities.

6.9 Exterior Lighting and Control Systems

Exterior luminaries and control systems must comply with all local zoning laws, and lighting levels for exterior spaces as indicated by the *IESNA Lighting Handbook*. See Section 6.3 for additional requirements.

Lighting fixtures at all entrances and exits must be connected to the emergency lighting system. Where security lighting is required and High Intensity Discharge (HID) restrike time is not acceptable, UPS backup, HID capacitive/ride-through circuitry, or instant-on lamp sources, such as fluorescents and LED are required.

Exterior lighting circuits must be controlled by the BAS or photocell and a time of day controller, with an astronomical dial, to include both all-night and part-night lighting circuits. A minimum of 30 percent of the architectural, site, and parking lighting must be switched off three hours after the building is typically unoccupied or at 11:00 pm, whichever is later.

U.S. Land Port of Entry
Raymond, Montana

A strong horizontal line projects over this structure, covering three open bays and two enclosed units which house a public lobby and offices.

6.10 Branch Wiring Distribution Systems

Lighting – Circuit Loading

120 volt circuits must be limited to a maximum of 1,400 volt-amperes.

277 volt circuits must be limited to a maximum of 3,200 volt-amperes.

Receptacles – Circuit Loading

120 volt circuits for convenience receptacles must be limited to a maximum of 1,440 volt-amperes (8 receptacles at 180 watts).

Each special purpose receptacle must be circuited on a dedicated circuit to a protective device to match the rating of the receptacle.

In GSA buildings, general wiring devices must be specification grade. Emergency receptacles must be red. Isolated grounding receptacles must be orange. Special purpose and dedicated receptacles must be gray. The color of standard receptacles and switches must be coordinated with the architectural color scheme; for example, white, not ivory, devices must be used if walls are white or light gray.

Building standard receptacles must be duplex, specification-grade NEMA 5-20R. Communication room equipment receptacles should be locking type to prevent accidental disconnection. Special purpose receptacles must be provided as required. Device plates must be plastic, colored to match the receptacles. Device plates and lighting switch plates must be labeled on the exterior with typewritten machine-made labels indicating the panel and circuit number from which they electrically feed.

Occupancy-based, time-schedule based, or building-management system based plug load controls should be considered by the designer for all office cubicles and private office workstations.

Placement of Receptacles

Corridors

Receptacles in corridors must be located 15 m (50 ft.) on center and 7.5 m (25 ft.) from corridor ends.

Office Space

Receptacles for housekeeping must be placed in exterior walls and walls around permanent cores or corridors. Where receptacles are placed on exterior walls, installation of conduits and wallboxes must minimize air infiltration and moisture incursion. See Section 5.3 and Chapter 3 for additional requirements.

Placement of receptacles in walls must be avoided where raised access floors are used. See Section 6.10, Underfloor Raceway Systems, for additional requirements. For areas where raised access floors or underfloor raceway systems are not used, placement of receptacles must comply with the project requirements.

Each office and workstation must have an isolated ground receptacle located adjacent to each convenience that could be used for powering computer based equipment. There should be a minimum of two for each office and a minimum of one for workstations. If modular furniture is to be installed, it may be necessary to connect the IG receptacle box to the convenience box with a conduit to allow wire extension to modular furniture whips.

Conference and Training Rooms

Conference rooms and training rooms must be served in the same fashion as office space, except where specifically outfitted for audio-visual equipment.

Courtrooms and Related Areas

Refer to Chapter 8 for special electrical requirements.

Maintenance Shops

Maintenance shops require plug-mold strips above work benches with duplex outlets 900 mm (36 in.) on center. Receptacles must be wired on alternating circuits. Receptacles or circuit breakers must be of the ground fault interrupt (GFI) type. Provide emergency power off stations and associated contactors for shops containing freestanding equipment.

Electrical and Communications Rooms

Electrical rooms require one emergency power receptacle that is identified as emergency power at the receptacle. Communication rooms must contain power and grounding for the passive and active devices used for the telecommunications system, including at least two dedicated 20A, 120 volt duplex electrical outlets on emergency power, and additional lock type convenience outlets at 1,800 mm (6 ft.) intervals around the walls and direct connection to the main building grounding system. If uninterruptible power is required in communications rooms, it must be furnished as part of the communications system. Larger communication rooms must be provided with ceiling-mounted locking receptacles on ceiling-hung strain relief whips.

Main Mechanical and Electrical Rooms

Main mechanical and electrical equipment rooms must each have, at a minimum, one emergency power receptacle that is identified as such at the receptacle.

Exterior Mechanical Equipment

Provide one receptacle adjacent to mechanical equipment exterior to the building, including each roof section. Receptacles must be of the weatherproof GFI type. Receptacles must be located within 7.62 m (25 ft.) of each piece of equipment in accordance with NFPA 70 210-63.

Toilet Rooms

Each toilet room must have at least one GFI receptacle at the vanity or sink. Carefully coordinate the location of the receptacles with all toilet accessories.

Underfloor Raceway Systems

Underfloor raceways fall into three categories:

Raised Access Floors

All wiring beneath a raised access floor must meet the requirements in NFPA 70 and must be routed in rigid metal or flexible conduit to underfloor distribution boxes. One distribution box per bay is recommended. Flush-mounted access floor service boxes must be attached to the underfloor distribution boxes by means of a modular, prewired system to facilitate easy relocation.

Cellular Metal Deck

In cellular metal decks that frame the concrete floor slabs in a steel building, the cells are generally fully “electrified” by the placement of steel sheets enclosing the underside of the cells. Access to the individual cells is obtained by a series of compartmented header ducts. The width of the header duct is sized according to the area served and the depth is 63 mm (2½ in).

Underfloor Duct System

A 3-cell underfloor duct system is placed in a 100 mm (4 in.) concrete fill over the concrete slab. The cells are generally located on 1,500 mm (5 ft.) to 1,800mm (6 ft.) centers. Note: This type of raceway system is frequently found in existing buildings selected for modernization.

The cell assignments in cellular metal deck systems and the 3-cell duct systems are generally designated as 1) power, 2) voice/data, and 3) signal. However, the recent increase in bandwidth required by the latest IT equipment has been accompanied by the use of CAT 6 cables and fiber optic cables. The CAT 6 cables cannot tolerate the proximity to the power cables and neither of these cables is compatible with the sharp bends from the header ducts to the cells and to the outlets, which significantly diminishes the practical use of these systems.

Panelboards

Panelboards must be constructed to comply with the requirements of UL 67 and UL 50.

All panelboard interiors must be constructed using hard-drawn copper of 98 percent conductivity, with AIC bracing greater than the calculated available fault current. The minimum short circuit rating for 208Y/120V panelboards must be 10,000 amperes symmetrical. The minimum short circuit rating for 480Y/277V panelboards must be 14,000 amperes symmetrical. A 200 percent neutral must be provided for panelboards serving office loads feed from the secondaries of K-rated transformers or harmonic canceling transformers. A full-size copper ground bus for connecting ground conductors must be bonded to the steel cabinet. Provide isolated ground bus where required.

Branch circuit breakers must be bolt-on designed for replacement without disturbing the adjacent units. Breakers must comply with the requirements of UL 489, thermal magnetic type with a short-circuit rating greater than the calculated available fault current. Panels must be specified with “door-in-door” trim.

Power Distribution Panels

Circuit breaker-type panels must be the standard of construction for Federal buildings. With the exception of lighting and receptacle panelboards, fusible switches may be considered if specific design considerations warrant their application, such as in electrical coordination of electrical over-current devices.

Lighting and Receptacle Panelboards

Lighting and receptacle panelboards must be circuit breaker type: a maximum of 30 poles for 100 amp panelboards, and a maximum of 42 poles for 225 amp panelboards.

Conduit Systems

The specification must list the various types of conduit systems that are approved for use on the project and the specific raceway applications for which they are to be used, as follows:

RSC – Rigid galvanized steel conduit – ANSI C80.1 Exposed outdoors, wet, or damp locations

RAC – Aluminum conduit (with steel elbows) Indoor feeders – exposed and/or concealed

IMC – Intermediate steel conduit – ANSI C80.6 Indoor feeders – exposed and/or concealed

EMT – Electrical metallic tubing (full compression steel fittings) – ANSI C80.3 Branch circuit wiring, exposed and/or concealed

FMC – Flexible steel conduit – connections to recessed lighting fixtures and concealed in movable and/or dry wall partitions

LFMC – Liquid flexible steel conduit with PVC jacket. Connections to vibrating equipment (motors, transformers, etc.)

PVC – Underground feeders encased in concrete envelope. Indoors and outdoors. Transition to steel or aluminum when not encased.

Conductors

Aluminum or copper conductors are acceptable for motor windings, distribution transformer windings, switchgear bussing, and switchboard bussing, where the conductor is purchased as part of the equipment. Copper conductors must be used for cables and conductors.

6.11 Voice and Data Distribution System

The configuration and type of the voice and data cabling distribution systems must be developed at the earliest stages of design, since the space requirements are so significant and widespread. System requirements are user generated and are generally translated into distribution system requirements by the design engineer in conjunction with GSA's FAS, who together develop systems in accordance with the latest edition of the *BICSI Telecommunications Distribution Methods Manual*.

Communications Raceways

Communication raceways must meet the installation requirements in NFPA 70.

Raised Access Floor

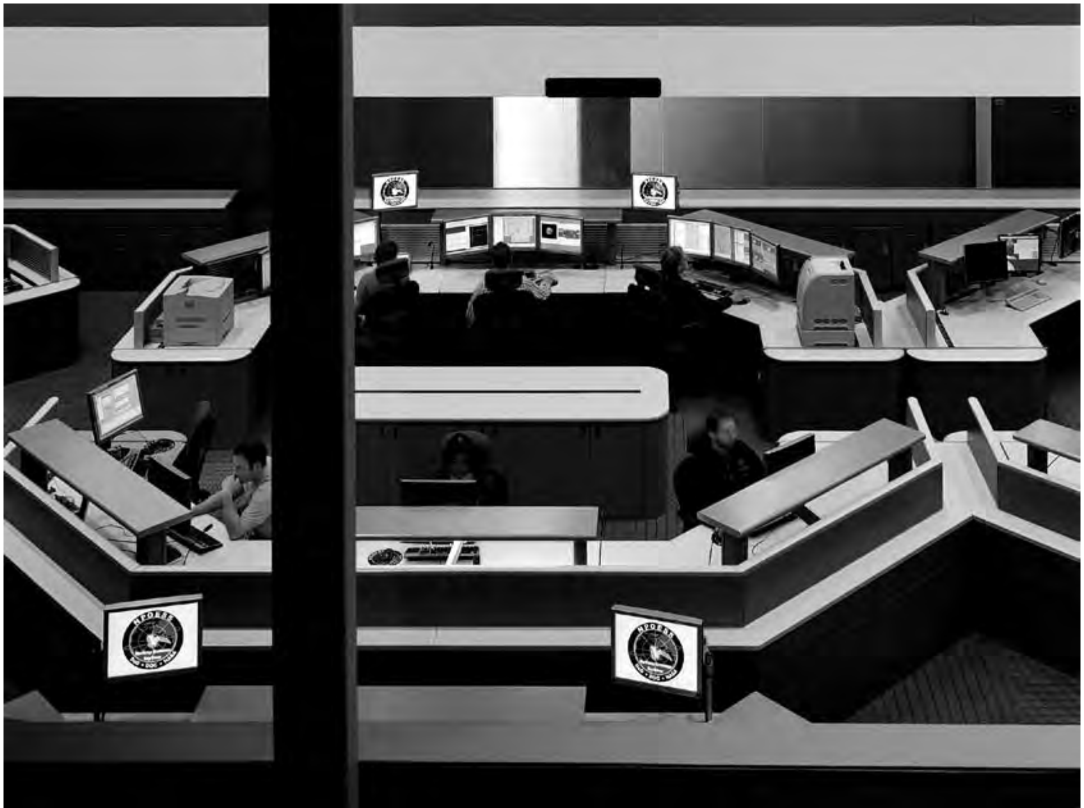
If GSA has determined that raised access floors are to be used for cable management in the project (see Section 6.10), the communications services must be installed by laying the cable in a tray for main runs and then branching directly on the floor slab below the raised access flooring system.

Cable Trays in Hung Ceilings

Since underfloor raceway systems cannot accommodate the large turning radii required by the CAT 6 and fiber optic cables, the primary alternative to a raised floor system is a series of cable trays installed above accessible hung ceilings. Cable trays must be continuously grounded.

National Oceanic and Atmospheric Administration Satellite Operations Facility Suitland, Maryland

Equipment in the mission control center monitors satellites that are used to collect weather and climate data. An entire floor of computers is housed to support these activities.



6.12 Emergency and Standby Power Systems

Emergency and standby power systems must be designed to comply with the requirements of the IBC, NFPA 110, and NFPA 111. Compliance with the electrical safety of the installation, operation, and maintenance of emergency systems is required, as addressed in Article 700 of NFPA 70. Unless otherwise specifically authorized by the contracting officer, all facilities must be provided with a standby generator to supply power to the facility in the event of a sudden loss of power.

Classification of Emergency Power Supply Systems (EPSSs)

The class and type of Emergency Power Supply Systems (EPSSs) for Federal buildings must be a minimum of Class 72, where 72 is the minimum time in hours for which the EPSS is designed to operate at its rated load without being refueled (see Chapter 4, NFPA 110). The EPSS must have a designation of Type 10, where 10 is the maximum time in seconds that the EPSS will permit the load terminals of the transfer switch to be less than 90 percent of the rated voltage.

Where the standby generator supplies a switchboard, power may be distributed from the switchboard to the emergency, legally required standby, and optional standby systems, in accordance with Figure B.1(a) and B.1(b), NFPA 110.

Emergency System

The EPSS must supply emergency loads through an automatic transfer switch upon failure of the normal supply. The transfer time limit must not exceed 10 seconds. Emergency illumination must include all required egress lighting, illuminated exit signs, and all other lights specified as necessary to provide required illumination. See Sections 6.3 and 6.8 for additional criteria and requirements.

An emergency supply source must supply equipment classified as emergency through an automatic transfer switch upon failure of the normal supply.

Emergency loads (life safety loads) must include:

- Emergency lighting
- Fire alarm system
- Exit signs
- Automatic fire detection equipment for smokeproof enclosures
- Emergency voice/alarm communication systems
- Smoke control systems
- Exit stairway pressurization systems

Other loads essential for safety to human life:

- Fire pump
- Elevators (one per bank)
- Power and lighting for fire command center and security control center

Required Standby System

This system must automatically supply power to selected loads (other than those classified as the emergency system) upon failure of the normal source. The transfer time limit must not exceed 60 seconds.

Required standby loads must include:

- Visitor screening equipment
- Telephone switches and fiber cable battery systems
- Security systems
- Mechanical control systems
- BASs
- Sump pumps
- Sewage ejection pumps
- Uninterruptible power systems serving technology/server rooms
- HVAC systems for technology/server rooms, UPS rooms, and communications rooms
- Exhaust fan in UPS battery rooms
- FAA aircraft obstruction lights
- Drinking water booster pumps (high rise buildings)

Optional Standby System

This system must supply power to the facilities or property where life safety does not depend on the performance of the system. The optional standby system must supply on-site generated power to selected loads, either automatically or by manual transfer.

Optional standby system loads may include:

- General areas of the buildings
- HVAC and refrigeration systems
- Data processing and communications systems
- Boiler, hot water pumps, perimeter HVAC units, and any other ancillary heating equipment necessary to freeze-protect the building
- Receptacles and emergency lighting in large conference rooms to facilitate command and control operations during an emergency situation

Generator System

The emergency and standby generator system must consist of one or more central engine generators and a separate distribution system with automatic transfer switches, distribution panels, lighting panels, and, where required, dry-type transformers feeding 208Y/120V panels. The electrical engineer must coordinate with the mechanical engineer and architect on the design of the generator system.

Service Conditions

If possible locate the generators outside and on grade. If installed outdoors, they must be provided with a suitable walk-in acoustic enclosure and jacket water heaters to ensure reliable starting in cold weather.

When installed at high altitudes or in areas with very high ambient temperatures, the generators must be derated in accordance with manufacturers' recommendations. Operation of starting batteries and battery chargers must also be considered in sizing calculations. In humid locations heaters can reduce moisture collection in the generator windings. Critical silencers are required for all generators. Acoustical treatment of the generator room must be provided as necessary. Temperature and ventilation must be maintained within the manufacturers' recommendations to ensure proper operation of the unit. Calculations to support the size of the intake air supply for combustion, cooling, and radiation, as well as exhaust piping and exhaust paths, must be provided by the mechanical engineer in accordance with Appendix A, Sections A.3 and A.4.

Radiators must be unit mounted if possible. If ventilation is restricted in indoor applications, remote installation is acceptable. Heat recovery and load shedding must not be considered. The remote location of radiators must be designed to avoid excess pressure on the piping seals.

A permanently installed load bank, sized at 50 percent of generator rating, must be provided. The load bank may be factory mounted to the radiator. Care should be taken in selecting materials that will tolerate the high temperatures associated with radiator-mounted load banks to include belts, flex connections, motors, sprinkler heads, and so on.

Capacity

The engine generators must be sized to serve approximately 150 percent of the design load and to run at a maximum of 60 percent to 80 percent of their rated capacities after the effect of the inrush current declines. When sizing the generators, the initial voltage drop on generator output due to starting currents of loads must not exceed 15 percent. Day tanks must be sized for a minimum capacity of four hours of generator operation. Provide direct fuel oil supply and fuel oil return piping to the on-site storage tank (see Section 5.20 for additional requirements). Piping must not be connected into the boiler transfer fuel oil delivery “loop.”

Care must be exercised in sizing fuel oil storage tanks by taking into account that the bottom 10 percent of the tank is unusable and that the tank is normally not full (normally at a 70 percent level) before the operation of the generator.

Generator Alarms

Generator alarms must be provided on the exterior wall of the generator room. All malfunctions must be transmitted to the BAS. In all buildings, with or without BAS, a generator alarm annunciator must be located within the fire command center. The generator output breaker must have a contact connected to the BAS indicating output breaker position, to allow annunciation of the open position on the BAS.

Automatic Transfer Switches

Automatic transfer switches serving motor loads must have in-phase monitors (to ensure transfer only when normal and emergency voltages are in phase) to prevent possible motor damage caused by an out-of-phase transfer. They must also have pretransfer contacts to signal time delay returns in the emergency motor control centers.

Automatic transfer switches must include a bypass isolation switch that allows manual bypass of the normal or emergency source to ensure continued power to emergency circuits in the event of a switch failure or required maintenance.

Fuel Distribution System

See Chapter 5 for additional requirements for venting, fuel oil piping, and underground fuel oil tanks.

Location

The generators and the generator control panel must be located in separate rooms or enclosures.

Load Shedding

Life safety generators should be designed to operate in parallel with the local utility, thus allowing for load shedding and smart grid and intelligent building initiatives. Before designing emergency generators for peak shaving purposes, local, State, and Federal authorities must be contacted due to the need for possible noise, air quality permitting, and additional hardware requirements.

6.13 Clean Power Systems

Uninterruptible Power Systems

In some facilities, technology/server room backup systems are designed by the tenant agency. If this is the case, shell space and utility rough-ins must be provided. In facilities where UPS systems are to be provided as part of the building construction, they must be designed as described in this section. All UPS systems are considered to be above standard for GSA space. Tenant agencies with UPS requirements should be advised that a maintenance contract is recommended.

Requirements for UPS systems must be evaluated on a case-by-case basis. If UPS is required, it may or may not require generator backup. When generator backup is unnecessary, sufficient battery capacity must be provided to allow for an orderly shutdown.

Critical Technical Loads

The nature, size, and locations of critical loads to be supplied by the UPS will be provided in the program. Noncritical loads must be served by separate distribution systems supplied from either the normal or electronic distribution system. A UPS system must be sized with at least a 25 percent spare capacity. The specification of a redundant module must depend upon the criticality of the loads.

Emergency Electrical Power Source Requirements

When the UPS is running on the site emergency generator, the amount of current to recharge the UPS batteries must be limited so as to not overload the generator. This limited battery charging load must be added to the required standby load (see Section 6.12) when sizing the standby generator.

If the UPS system is backed up by a generator to provide for continuous operation, the generator must provide power to all necessary auxiliary equipment, i.e., the lighting, ventilation, and air conditioning supplying the UPS and the critical technical area (see Section 6.12).

System Status and Control Panel

The UPS must include all instruments and controls for proper system operation. The system status panel must have an appropriate audio/visual alarm to alert operators of potential problems. It must include the following monitoring and alarm functions: system on, system bypassed, system fault, out of phase utility fault, and closed generator circuit breaker. It must have an audible alarm and alarm silencer button. Since UPS equipment rooms are usually unattended, an additional remote system status panel must be provided in the space served by the UPS. The alarms must also be transmitted to the BAS.

UPS and Battery Room Requirements

Emergency lighting must be provided in both spaces and a telephone must be provided in or adjacent to the UPS room. The battery room design must provide proper ventilation, hydrogen detection, spill containment, and working clearances. See Chapters 3, 5, and 7 for additional requirements for the UPS and battery rooms. Also, see NFPA 70.

Computer Center Power Distribution Unit

In some GSA buildings the power distribution system for computer centers is designed by the tenant agency. If this is the case, utility rough-in must be provided under the construction contract. If power distribution is to be provided under the building contract, it must be designed according to the criteria in this section.

Power Distribution Units (PDUs)

PDUs with internal or remote isolation transformers and output panelboards must be provided in all computer centers to reduce/eliminate harmonic currents generated by nonlinear loads and reflected back to the neutral service conductors. Neutral busses/conductors must be sized at 200 percent of phase busses/conductors. PDUs with internal or remote isolation transformers must be K-rated or harmonic mitigating to serve nonlinear loads. The transformer rating must take the increased neutral size into account.

**Harvey W. Wiley Federal Building FDA Laboratory
College Park, Maryland**

Computer Center Grounding

To prevent electrical noise from affecting computer system operation, a low-frequency power system grounding and a high-frequency signal reference grounding system must be provided. The design of the technology/server room grounding system must be coordinated with the computer center staff.

Low-Frequency Power System Grounding

A safe, low-frequency, single-point grounding system must be provided that complies with Article 250 of NFPA 70. The single-point ground must be established to ground the isolation transformer or its associated main service distribution panel.

A grounding conductor must be run from the PDU isolation transformer to the nearest effective earth grounding electrode as defined in NFPA 70. All circuits serving automated data processing (ADP) equipment from a PDU must have grounding conductors equal in size to the phase conductors.

High-Frequency Power System Grounding

A high-frequency signal reference grounding system for radio frequency noise may be required (with the two systems bonded together at one point) by the user agency, in addition to the low-frequency power system grounding. If this is the case, a grid made up of 600 mm (2-ft.) squares must be provided as a signal reference grounding system. If a raised floor has been provided, its grid with mechanically bolted stringers may be used. Alternatively, a grid can be constructed by laying a 600 mm mesh (2 ft. squares) of braided copper strap or 1.3 mm (16 gauge, 0.051 in.) by 50 mm (2 in.) copper strap directly on the structural floor. Data processing equipment must be connected to the reference grid by the most direct route with a braided copper strap.

Common-Mode Noise Reduction

The reduction of common-mode noise is particularly important for the proper operation of computer-based, distributed microprocessor-based systems, i.e., BASs, electronic security systems, card-access control systems, and local area networks.

The following steps must be taken to reduce common-mode noise:

- Avoid running unshielded metallic signal or data lines parallel to power feeders.
- Where metallic signal or data lines are routed in noise-prone environments, use shielded (grounded at one end) cables or install wiring in ferrous metal conduit or enclosed cable trays.
- Locate metallic signal or data lines and equipment at a safe distance from arc-producing equipment such as line voltage regulators, transformers, battery chargers, motors, generators, and switching devices.
- Provide isolation transformers, electronic power distribution panelboards, or power conditioners to serve critical electronics equipment loads.
- Provide isolated grounding service on dedicated circuits to critical data terminating or communicating equipment.
- Replace metallic data and signal conductors with fiber optic cables where practical.

Harmonic Generation, K-Rated and HMT Transformers, Sizing of Neutrals

Harmonic frequencies are introduced into the branch circuit distribution system by the power supplies of the following equipment:

- Electronic ballasts
- Variable frequency drives
- PCs
- Laser printers
- File servers
- Fax machines
- Copiers
- Telecommunication equipment

Harmonic distortion will create overheating and power quality problems such as overheating in transformer and conductor neutrals, motor failure, false tripping of protective devices, computer operational problems, and hardware component failures. To correct these problems, the electrical design engineer must investigate the use of K-Rated transformers (K-13 or higher) with a 200 percent neutral, must feed branch circuit panelboards with 200 percent neutrals, and/or the use of harmonic mitigating transformers (HMT). HMT are preferred since they actually cancel the harmonic frequency distortion.

All isolated ground, computer room, and communication room transformers should have these features specified.

ATF National Laboratory Center
Beltsville, Maryland

The structural framing of this building follows a simple and efficient matrix that allows for operational flexibility. Laboratory spaces that require natural daylight are located at the outer perimeter; laboratory support functions that require no natural daylight occupy the middle zone.

6.14 Grounding Systems

Grounding systems must be designed to coordinate with the specific type and size of the electrical distribution system, including the following applicable generic types of grounding systems or grounding components.

Separate equipment ground conductors

The types, sizes, and quantities of equipment grounding conductors must comply with NFPA 70, Article 250, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

Insulated equipment grounding conductors must be installed with circuit conductors for the following items, in addition to those required by NFPA 70:

- Feeders and branch circuits
- Lighting circuits
- Receptacle circuits
- Single-phase motor and appliance branch circuits
- Three-phase motor and appliance branch circuits
- Flexible raceway runs
- Metal clad cable runs
- Cabletrays (bond each individual section)

Busway Supply Circuits

Insulated equipment grounding conductors must be installed from the grounding bus in the switchgear, switchboard, or distribution panel to the equipment grounding bar terminal on the busway.

Separately Derived Grounds

To minimize extraneous “noise” on certain systems, particularly those in which harmonics are generated, the specific system grounds must be separated before grounding at the service grounding electrode or counterpoise.

Isolated Grounds

Isolated grounds must be applied where the equipment served may be particularly sensitive to external interference from sources generating third harmonics and higher. In these instances the grounds, beginning from the panelboard ground and the grounding conductor from the raceway to the grounding terminal at the receptacle or outlet box, must be electrically isolated from the main grounding system. The isolated grounds must terminate at a common ground or counterpoise.

In buildings where a 208Y/120V service is supplied by the power company and there is no intermediate transformer isolating the utilization voltages from the various harmonic generators previously mentioned, the use of isolated ground panels serving the office power requirements must be installed.

Raised Floors

All access floors must be grounded. A grounding conductor must be bonded to every other floor pedestal and must be extended to the technology/server room common ground bus.

Counterpoise

Where feasible, a grounding conductor (counterpoise) must be provided in an isosceles triangle configuration with sides greater than or equal to 3 meters (10 ft.). The conductor must be tinned copper not less than No. 4/0 AWG and must be electrically connected to the incoming domestic water services (provided the piping for the water service is a conducting material) on either side of the building as well as the various clusters of three ground rods spaced at intervals. Ground rods must be 15 mm (5⁄8 in.) diameter by 2,400 mm (96 in.) long and must be tin coated copper. The counterpoise loop will involve direct burial in earth 600 mm (24 in.) below grade. The following items must be connected to the counterpoise loop. All ground rod and grounding connections must be exothermically welded:

- Lightning protection system “down conductors”
- Transformers in substations
- Emergency generator ground
- Telecom and data room grounds
- Separately derived grounds
- Isolated ground panels
- Main switchgears
- Normal and emergency distribution systems
- Flagpoles

Common Ground System

Consideration should be given to providing a common ground bus throughout the building. Conceptually a common ground bus would originate from the main service entrance and run up through stacked electrical rooms, where an insulated wall-mounted copper ground plate would be installed for connecting any equipment needing a common ground. Where conditions might prohibit an isosceles triangle counterpoise ground, consideration should be given to installing chemical ground rods in trenches or borings supplemented with conductivity-enhancing soil conditioners such as Bentonite clay or conductive concrete.

Calexico West Land Port of Entry
Calexico, California

A rendering of the proposed expansion, which includes new pedestrian processing and privately owned vehicle (POV) inspection facilities, and new administration offices.

**Wilkie D. Ferguson, Jr.
United States Courthouse
Miami, Florida**

The site's perimeter has been planted with a grove of lush trees—inviting people to stroll the grounds and providing shelter from the tropical sun.

6.15 Safety Systems, Equipment, and Personal Protection

Lightning Protection Systems

Lightning protection systems are important safety features in the design of electrical distribution systems. Their application on any specific project is a function of its geographic location, height, proximity of taller adjacent structures, regional ground resistance, and the architectural configuration of the building. The decision to provide a lightning protection system must be made at the earliest stages of design and must be supported by a study, as prescribed by NFPA 780.

If a decision is made to provide a lightning protection system, specify that it be installed in compliance with NFPA 780 and the components meet the requirements of UL 96.

Alternate Systems

The requirement of a UL certification imposes certain restrictions or limitations on the design of the system, which may be in conflict with the architectural design, particularly if the facade includes large curved surfaces that preclude the installation of air terminals and where the spacing of down conductors is limited. In those instances, the electrical engineer may appeal to the contracting officer to waive the UL certification requirement on the basis that the design generally follows the Faraday Cage principle of lightning protection.

Grounding

The down conductors must follow direct paths from the air terminals to the ground connections or to the counterpoise loop. Lightning ground conductors should have long sweeping bends and not hard 90 degree bends forcing them to conform to architectural building features.

Security Systems

Every government building, virtually without exception, whether new or existing, large or small, recent vintage or historic, must have provisions for a security system. The type and level of security system must be determined by GSA, FPS, and the client agency. The security requirements must be integrated into the design for the project. The systems must be integrated with the emergency and standby power systems.

Short Circuit and Coordination Study

The electrical engineer must submit a preliminary short circuit analysis on all projects in accordance with Appendix A, Sections A.3 and A.4. The final coordination and analysis must be completed by the electrical contractor's testing agency or by an independent agency employed by GSA, and a report must be submitted as part of the commissioning process (see Chapter 1 for commissioning requirements). This language must be written into the design specifications.

Arc Flash

The design engineer must submit a computer-generated arc flash analysis for the entire building electrical distribution system. The data from the arc flash calculations for individual pieces of electrical equipment must be transposed to NFPA 70E-approved labels and all panelboards, motor control centers, switchgear, and major electrical equipment must be appropriately labeled and protection boundaries delineated per OSHA 1910 Subpart and NFPA 70E requirements.

6.16 Alterations in Existing Buildings and Historic Structures

The goal of alteration projects is to meet the same standards described in this document for new projects. The prospectus will describe the extent of the replacement and upgrade of existing systems and equipment. Equipment that is unsafe or beyond the useful service life must be demolished and new systems designed to meet the current and future usage of the facility. Renovation and rehabilitation designs must satisfy the immediate occupancy needs and anticipate additional future changes. Remodeling must make building systems more flexible. Parameters of reuse and disruption of service must be clearly specified in construction documents.

All replacement and upgrades must comply with the requirements of this chapter. The result of these projects should be enhanced performance, not just equipment replacement.

Lighting – Historic Buildings

Historic fixtures may be upgraded with energy efficient lamps, ballasts, reflectors, or other means to achieve required light levels, if changes can be made without affecting the appearance of the fixture. Energy-efficient light sources should match incandescent light or daylight as closely as possible in regards to temperature (color rendering) and the surrounding lighting. In restoration zones, opportunities should be sought to replace unsympathetic contemporary lighting with replicas of original historic fixtures. Replica fixtures in which light sources are not exposed should incorporate high-output, energy efficient lamps as necessary to achieve required light levels and meet energy conservation standards. Supplemental lighting, if required, should be designed and placed to minimize penetration of ornamental wall and ceiling surfaces and to avoid competing visually with historic lighting. Freestanding torchieres, task lighting, and discrete accent lighting are recommended for increasing light levels in ceremonial spaces containing historic chandeliers, pendant lights, or sconces.

U.S. Post Office and Courthouse
New Bern, North Carolina

In 2004, GSA assumed ownership and started renovation of this historic property. The restored postal lobby features massive bronze octagonal light fixtures.

6.17 Lighting Design Criteria for Specific Areas

This section's purpose is a guideline to determine the requirements for the design criteria for interior office lighting and bilevel stairwell lighting.

Indoor Office Lighting

This section pertains to the design and installation of luminaires to save energy by reducing the installed power density of equipment below code by using a combination of high performance equipment, design strategies, daylighting, and the integration of lighting controls. The following paragraphs will provide performance criteria for the following luminaires provided and installed by the contractor:

Primary luminaires are to be installed in enclosed offices, open plan offices, meeting spaces, and ancillary spaces, including lamps, ballasts, shielding, electrical components, wiring, and luminaire-mounted lighting controls for lighting in open-plan and private offices. Other luminaire types may be needed to achieve proper lighting quality criteria, including downlights, wall washers, and wall sconces.

Workstation-specific lighting associated with bidirectional pendant luminaires must be composed of a task-lighting component controllable by the occupant of that workstation and an ambient lighting component controlled on a space-wide basis.

Lighting Quantity and Quality Requirements

The electric lighting installation must provide a minimum maintained average illuminance of 484 lux (45 fc) utilizing both task and ambient sources at the viewed plane (30 in. AFF in open-plan and enclosed offices). Additionally, the minimum maintained average ambient illuminance from permanently fixed luminaires must be no less than 323 lux (30 fc) across the viewed plane.

Room surface brightness should not be neglected in attempts to meet the required horizontal illuminance. Incorporate design principles in IESNA DG-18 to provide adequate balance of lighting on the ceiling, walls, and work surfaces.

Energy Conservation

At a minimum, the entire lighting system including accent and decorative lighting must reduce lighting energy consumption by 20 percent below ANSI/ASHRAE/IESNA Standard 90.1-2007. If stricter Federal energy criteria become mandated, they must supersede this requirement.

Luminaires

Direct-Indirect pendants are the preferred means of meeting the lighting standards and requirements. Recessed fixtures should only be considered in open offices for spaces with ceiling heights ≤ 9 ft.-6 in. AFF or in cases where the existing ceiling cannot be disturbed due to asbestos or other OSHA-identified hazard. Recessed fixtures may be acceptable in private offices.

Pendant-Mounted Direct/Indirect Fluorescent Luminaire

A light defined as a linear-shaped luminaire utilizing linear fluorescent light sources, directing illumination directly downward and indirectly upward. The pendant-mounted direct/indirect linear fluorescent luminaire must be suspended below the finished ceiling, with a stem length of 18 in. or longer and a total luminaire efficiency of 85 percent or higher. Direct component (0-90 degree zone) must be 25 percent of total fixture lumens or higher, not to exceed 50 percent. For ceiling heights lower than 9 ft.-6 in., or applications where the stem length must be shorter than 18 in., provide a luminaire specifically designed for low ceiling mounting. Luminaire should use either two T8 HP fluorescent lamps (high performance with 3,100 lumen) or T5 fluorescent lamps. T5HO lamps are acceptable in well-shielded pendant luminaries or cove details. Adequately shield all bare lamps with baffles or lenses. Baffles must be semi-specular, diffuse, or high-reflectance white.

Workstation-Specific Pendant-Mounted Direct/Indirect Linear Fluorescent Luminaires

A light defined as a linear-shaped luminaire utilizing linear fluorescent light sources, directing illumination directly downward and indirectly upward. Suspend the workstation-specific pendant direct/indirect linear fluorescent luminaire below the finished ceiling a minimum stem length of 16 in. The lighting system must provide both "ambient uplighting" and general "downlight" or dedicated "task lighting" for the workstation. Lamps designated for each function must be separately controlled and compartmentalized as necessary to reduce distraction of lamps operating at different output. Luminaire must use either Super T8 fluorescent lamps or T5 fluorescent lamps. Adequately shield bare lamps with baffles or lenses. Baffles must be semispecular diffuse, or high-reflectance white. Specular materials must not be visible from any viewing angles below the luminaire. Luminaire should have an efficiency of 60 percent or higher.

Non Planar-Lensed Recessed Fluorescent Troffers

A light defined as a rectangular or square-shaped recessed luminaire utilizing fluorescent light sources and a nonplanar lens (e.g., curved, multi-angled lens) that redirects the light from the lamps to increase the amount of light leaving in high vertical angles (i.e., greater than 60°) compared to a traditional troffer with a flat lens or parabolic louver. Luminaire must use either T8 fluorescent lamps or T5 fluorescent lamps. Luminaire should have a total luminaire efficiency of 80 percent or higher for 2 ft. x 4 ft. troffers.

Lamps

Effort must be made to minimize the number of lamp types within a facility to simplify lamp maintenance.

All linear fluorescent lamps must be Super T8 or T5, low-mercury lamps with efficacies above 90 lumens/W. The maximum lumen depreciation must be 92 percent or higher. Lower wattage, high-performance lamps may be used if dimming capacity and temperature sensitivity are appropriate for the application. The lamp color temperature must be either 3,500K or 4,100K and be consistent throughout the building. Lamps must have a CRI greater than or equal to 80. The minimum rated lamp life must be 24,000 hours.

Ballasts are described in Section 6.8, Interior Lighting Technologies and Controls.

Lighting Controls

Control the downlight and uplight components separately. Private offices may be controlled with ceiling or wall-mounted occupancy sensors. If DALI control systems are installed the occupant should be able to set their preferred light level for their workstation's "task component" either through a computer-based solution, a handheld personal digital assistant (PDA), or a wireless remote. If the fixtures are located in the daylighted area then an automatic photosensor must be integrated into the fixture's design and operation. The control photosensor must be capable of automatically regulating the light intensity of at least the "ambient" component.

Bilevel Stairwell Lighting

The intent here is to design the bilevel stairwell/corridor fixture to reduce energy consumption while still providing appropriate illuminance levels during occupied periods and emergency egress. The key components in the product are ultrasonic occupancy sensor technology, bilevel dimming controls, programmed-start electronic ballast, and a lamp conditioning circuit. When spaces are unoccupied, the lighting operates at a low level. This can be either preset or adjusted by the user/contractor.

Lighting Quantity and Quality Requirements

Provide an average of 10 footcandles on stairwell landings.

Illuminance uniformity must be 20:1 max:min.

Energy Conservation

At a minimum, design the entire lighting system to be 20 percent below ASHRAE Standard 90.1-2007. Use lighting controls to reduce the energy usage (kwh) of the luminaires when the space is vacant by a minimum of 50 percent.

Luminaires

Use bilevel linear fluorescent luminaires controlled by an integral ultrasonic motion sensor in stairwells and similar low-occupancy spaces. The luminaire must operate at a low standby light level during vacancy and instantly switch to full light output upon occupancy.

Lamps

To minimize maintenance and frequent re-lamping it is recommended to use 32 W (nominal) 4 ft. T8 lamps (F32T8), preferably Super T8 with 3,100 initial lumen. Energy-saving T8 lamps should not be used as they are not dimmable yet. The lamp color temperature must be either 3,500K or 4,100K and be consistent throughout the building. Lamps must have a CRI greater than or equal to 80. The minimum rated lamp life must be 24,000 hours.

Ballasts

Ballasts for fluorescent lamps must be class P, electronic high frequency programmed, rapid start type ballasts with a normal ballast factor of 0.88 (nominal) and a minimum PF of 0.90. Ballast must have a maximum THD of 20 percent and have a sound rating of “A.”

Lighting Controls

Install and aim sensors in locations to achieve coverage of areas indicated. Coverage patterns must be derated as recommended by manufacturer based on mounting height of sensor, furniture and partitions locations, obstructions, and finish of interior surfaces. Occupancy sensor should be a ceiling-mounted ultrasonic type or dual technology (ultrasonic and passive infrared). Sensor should incorporate a failsafe feature such that lamps fail “on” in the event of sensor failure.

6.18 Photovoltaic Systems

REQUIRED
PV SYSTEM APPROVAL

Before PV system installation, the GSA project manager must ensure the proposed PV system design and layout is acceptable to all parties:

GSA Property Manager

GSA Fire Protection Engineer

GSA Safety Specialist

Local fire officials

The installation of photovoltaic systems (PV) presents concerns for safety (energized equipment, trip hazards, etc.) and fire fighting operations (restricting venting locations, limiting walking surfaces on roof structures, etc.). The intent of the requirements below is to address these issues while embracing the environmental advantages of this technology. The majority of the information noted below is based on a solar photovoltaic installation guideline (April 22, 2008) developed in partnership by representatives of the California Department of Forestry and Fire Protection – Office of State Fire Marshal, local fire officials, local building officials, and the solar photovoltaic industry.

Be cognizant that because of the growing demand for photovoltaic system products, manufacturers are developing new products and methods daily and therefore GSA may encounter photovoltaic systems that will require an alternative means of compliance. Please note that it is not intended to prohibit the use of alternative systems, methods, or devices not specifically prescribed, provided GSA approves all proposed alternatives. In addition, all fire protection and safety issues must be reviewed and approved by the GSA regional fire protection engineer that may include consultation with the local fire department.

Before the PV system installation, the GSA project manager must meet with the contractor, GSA property manager, GSA fire protection engineer, GSA safety specialist, and local fire official to ensure the proposed PV system design and layout is acceptable to all parties.

Before the acceptance of the PV system, the GSA project manager must confirm that the PV system has been tested. All testing must be witnessed and documented by a qualified independent third party test entity. The third party test entity must have an advanced understanding of the installation, operation, and maintenance of the PV system installed. Third party test entities must be licensed (certified) where required by applicable codes and standards. At completion of witnessing the PV system testing, the third party test entity must provide to the GSA project manager documentation verifying that the PV system is in compliance with the design and specifications and all applicable codes and standards.

Requirements

The installation of PV systems at GSA Federal buildings must comply with the requirements in the International Building Code and National Fire Protection Association (NFPA) 70, National Electrical Code.

Marking

PV systems must be marked in accordance with NFPA 70, Article 690, and the following:

Marking Direct Current (DC) Circuits

All interior and exterior DC conduits, raceways, enclosures, cable assemblies, and junction boxes associated with the PV system must be marked to alert individuals that DC power is present. The marking must be placed every 10 feet or fraction thereof, at turns and above and below penetrations, and on all DC combiner and junction boxes.

The marking must contain the text "CAUTION: PV CIRCUIT ENERGIZED" in capital letters a minimum of 3⁄8 inches in height with white letters on a red background. The materials used for marking must be reflective and weather resistant in accordance with UL 969 that is suitable for the environment.

Marking Stairway Access to Roofs

Signage is required on all stairway doors providing access to the roof where PV systems are installed. Each stairway door providing access to the roof must have a sign affixed to the interior side of the stairway door.

The signage must contain the text "CAUTION PHOTOVOLTAIC SYSTEM INSTALLED ON ROOF." The sign must consist of letters having a principal stroke of not less than ¾ inch wide and be at least 6 inches high on a contrasting background.

Guidance on Fire Department Access and Pathways

Until code requirements are established, the following is provided as guidance for placement of PVs on roofs to allow for fire department access. The A/E must verify PV placement with the local authorities.

See Figures 6-1 to 6-4 for PV Array placement examples. These examples were developed by the Orange County Fire Chief's Association with guidance from the California State Fire Marshall.

Access

There must be a minimum 6 foot wide clear perimeter around the edges of the roof.

Exception: If either axis of the building is 250 feet or less, there must be a minimum 4 foot wide clear perimeter around the edges of the roof.

Ground Ladder Access

In low-rise buildings, ground ladder roof access must correspond with roof pathways and must not be located over an opening (e.g., windows or doors). Ground ladder access points must be located at strong points of the building construction and not conflict with overhead obstructions (i.e., tree limbs, wires, or signs).

Pathways

The PV system must be designed such that designated pathways are provided on the roof. The pathways must meet the following requirements:

The pathway must be located over structural roof members.

The center line axis pathways must be provided in both axes of the roof and must be located on structural members or located on the next closest structural member nearest to the center lines of the roof.

Each pathway must be a straight line and not less than 4 feet in clear width to each roof standpipe outlet, and to skylights and/or ventilation hatches.

Each pathway must provide not less than 4 feet of clear width around each roof access hatch with at least one pathway not having less than 4 feet of clear width to the parapet or roof edge.

Smoke Ventilation

The PV system must be designed such that smoke ventilation opportunity areas are provided on the roof and meet the following requirements:

Each array must be no greater than 150 x 150 feet in distance in either axis.

Ventilation options between array sections must meet one of the following:

- a pathway 8 feet or greater in width;
- a pathway 4 feet or greater in width that borders on existing roof skylights or ventilation hatches; or
- a pathway 4 feet or greater in width bordering 4 ft. x 8 ft. "venting cutouts" every 20 feet on alternating sides of the pathway.

REQUIRED
PV SYSTEMS ON ROOFS

The A/E must verify PV placement with the local authorities.

These examples were developed by the Orange County Fire Chief's Association with guidance from the California State Fire Marshall.

Figure 6-1

PV Array Example Large Commercial Building (Axis >250 ft.) 8 ft. Walkways

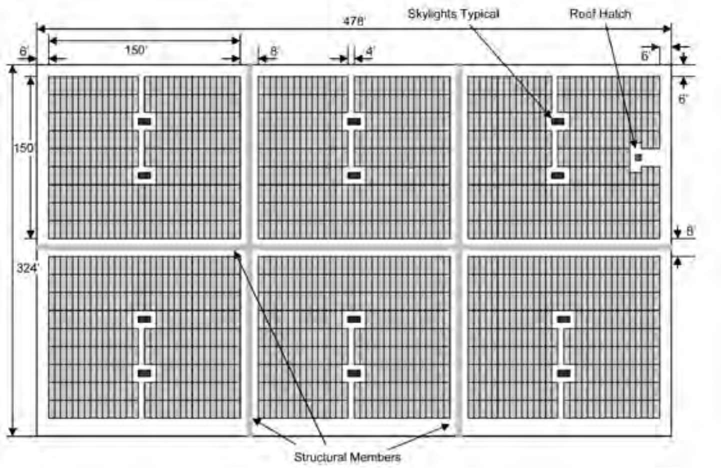
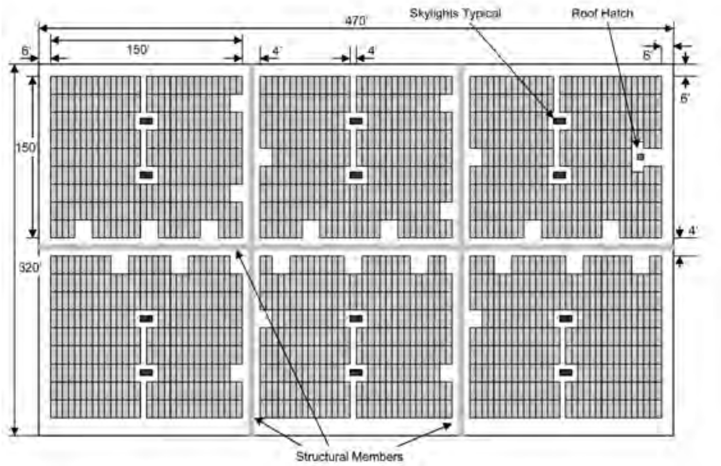


Figure 6-2

PV Array Example Large Commercial Building (Axis >250 ft.) 4 ft. Walkways with Venting 8 ft. x 4 ft. Venting Opportunities Every 20 ft. along Walkway



These examples were developed by the Orange County Fire Chief's Association with guidance from the California State Fire Marshall.

Figure 6-3

PV Array Example Small Commercial Building (Axis <250 ft.) 8 ft. Walkways

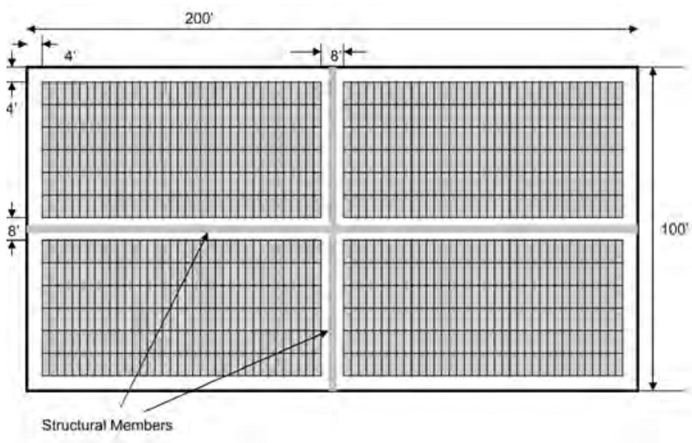
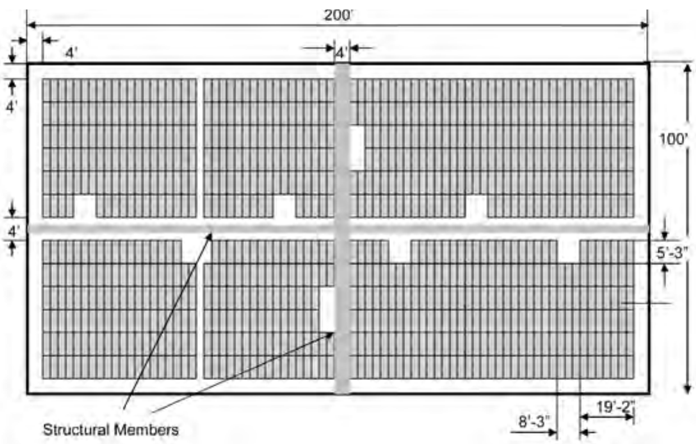


Figure 6-4

PV Array Example Small Commercial Building (Axis <250 ft) 4 ft. Walkways with Venting 8 ft. x 4 ft. Venting Opportunities Every 20 ft. along Walkway



Location of DC Conductors

Exposed conduit, wiring systems, and raceways for PV circuits must be located as close as possible to the ridge or hip or valley on the roof to reduce trip hazards and maximize ventilation opportunities.

Conduit runs between subarrays and conduit runs to DC combiner boxes must be designed in a manner that minimizes total amount of conduit on the roof. The DC combiner boxes must be located such that conduit runs are minimized in the pathways between arrays.

To limit the hazard of cutting live conduit in fire department venting operations, DC wiring must be run in metallic conduit or raceways when located within enclosed spaces in a building and must be run, to the maximum extent possible, along the bottom load-bearing members.

Ground-Mounted PV Arrays

Ground-mounted PV arrays must also comply with the above applicable requirements. Setback requirements do not apply to ground-mounted, free-standing PV arrays, however, a clear brush area of 10 feet on all sides is required for ground-mounted PV arrays.

Roof Clearance Requirements

The PV system, including supports and power conductors, must not interfere with roof drains, expansion joints, air intakes, existing electrical and mechanical equipment, existing antennas, and planned areas for future installation of equipment.

Rooftop installation must coordinate with the building rigging plan associated with powered platforms, boatswain chairs, etc., and address the relocation or incorporation of the davits.

In addition to the pathway requirements noted above, a 3-foot clear path of travel must be maintained to and around all rooftop equipment.

Roof Mounting Requirements

Mounting systems must be either fully ballasted or must limit penetrations of the roofing system. All roof penetrations must be designed and constructed in collaboration with the roofing professional or manufacturer responsible for the roof and roofing material warranty for the specific site. The number and size of the penetrations necessary to extend the power and control cable into the building must be kept to a minimum and grouped in a single location when practicable. All weather-proofing of penetrations must be compatible with the roof warranty.

Equipment and Components

All PV hardware and structural components must be either stainless steel or aluminum.

All interconnecting wires must be copper. Power provided must be compatible with on-site electric distribution systems.

Safety

Provide detailed Lock Out/Tag Out instructions for all equipment.

Provide lightning protection meeting UL 96 and NFPA 780.

The design must meet the local, State and Federal criteria for wind, snow, and seismic loads.

PV Modules must be UL Listed and must be properly installed according to manufacturer's instructions, NFPA 70, and as specified herein.

LAND PORT OF ENTRY
RAYMOND, MONTANA

ARCHITECTS: HAMMOND BEEBY RUPERT AINGE ARCHITECTS
PROJECT MANAGER: SCOTT MCCOLLOUGH

7 Fire Protection and Life Safety

Chapter 7 Fire Protection and Life Safety

7.1 Goals and Objectives

The goal of GSA's fire protection and life safety program is to incorporate into all projects fire protection and life safety systems that are effective in detecting, extinguishing, or controlling a fire event, thereby improving overall building safety to an acceptable level. The primary goal is to protect human life from fire and products of combustion. The secondary goals are to reduce Federal Government and taxpayers' potential losses from fire (i.e., protect Federal real and personal property, maintain client agency mission continuity, and control environmental impact).

Scope

This chapter provides the fire protection and life safety requirements for GSA facilities to meet the goals identified above. Areas where GSA's requirements differ from the referenced national codes and standards are delineated in Chapter 1. The provisions located in the introduction and in Chapter 1 within this document also apply to this chapter. All other text is mandatory.

Applicability

Where work areas consist of portions of a building, the requirements within this chapter must be limited to the work area in which work is being performed, unless specified otherwise by the GSA regional fire protection engineer.

Responsibilities

Design Team Fire Protection Engineer

A fire protection engineer must be a full participant of the design team for each phase of the project from concept through design, construction, and occupancy. The design team fire protection engineer must be licensed and have at least six years' experience, of which at least three consecutive years are directly involved in fire protection engineering life safety applicable to the specific project as determined by the GSA regional fire protection engineer, and which can be verified by documentation. (Please note that GSA does not require the design professional to be licensed in the State where the project is being constructed, so the design team fire protection engineer may be licensed in any State that formally recognizes a professional fire protection engineer.) The design team fire protection engineer must perform the following:

Analysis of:

- Building construction
- Occupancy classification
- Means of egress
- Fire alarm system
- Water-based fire extinguishing system(s)
- Non-water-based fire extinguishing system(s)
- Smoke control system(s)

Calculations for:

- Egress
- Water supply
- Smoke control (fire dynamics) and timed egress
- Audibility for fire alarm system

Design of all fire protection and life safety systems, including, but not limited to:

- Fire alarm system
- Water-based fire extinguishing system(s)
- Smoke control systems and stair pressurization systems

The design team fire protection engineer must also establish and maintain a dialog with the GSA regional fire protection engineer to ensure that all fire protection and life safety issues are addressed throughout each phase of the project.

See the Appendices for New Construction and Modernizations and for Alteration Projects for specific submission requirements.

GSA Regional Fire Protection Engineer

The GSA regional fire protection engineer will participate in each phase of the project from concept through design, construction, final acceptance, and occupancy to ensure fire protection and life safety requirements are incorporated into the project. The GSA regional fire protection engineer will review design plans, specifications, and related information; review contractors' submittals for compliance with contract documents; witness acceptance testing and commissioning of fire protection and life safety systems; and upon successful completion of commissioning and acceptance of tested systems, will issue certificates of occupancy (or temporary certificates of occupancy) before occupancy.

The GSA regional fire protection engineer is the authority having jurisdiction (AHJ) for technical requirements in this chapter, including all fire protection and life safety code interpretations and code enforcement requirements. As the AHJ, the GSA regional fire protection engineer has the right to revise the specific requirements within this chapter based on a technical evaluation and analysis and the project's specific needs.

Alternative Designs

The design team fire protection engineer may propose alternative designs to that prescribed herein, but the GSA regional fire protection engineer must approve the alternative design. Such review must determine if the proposed alternative is deemed equivalent or superior to the intent of the prescribed requirements in this chapter. See Chapter 1 for additional information.

Certificate of Occupancy

No portion of a project may be occupied until the GSA regional fire protection engineer has issued a certificate of occupancy to the GSA project manager. Issuance of a certificate of occupancy must not be construed as an approval of any violation of a national code or GSA design standard or criterion.

The GSA regional fire protection engineer is required to issue a certificate of occupancy to the GSA project manager once the GSA regional fire protection engineer has determined that to the best of his or her knowledge all fire protection and life safety systems have been completed, inspected, successfully tested, and approved, and all outstanding fire and life safety deficiencies have been corrected to afford a reasonable degree of safety to the building occupants from fire and similar emergencies.

The GSA regional fire protection engineer is authorized to issue a temporary certificate of occupancy that allows partial occupancy of the building in a specific area(s) before completion of the project. The temporary certificate of occupancy identifies the specific area(s) of the project where occupancy is permitted and will be issued only if all life safety and fire protection systems serving the areas proposed for occupancy and all the floors below it have been completed, inspected, successfully tested, and approved by the GSA regional fire protection engineer. Following the issuance of a temporary certificate of occupancy, the GSA regional fire protection engineer is required to set a time frame for the completion of all remaining life safety and fire protection systems and the correction of any outstanding life safety and fire protection deficiencies. The GSA regional fire protection engineer will issue a (final) certificate of occupancy to the GSA project manager once the GSA regional fire protection engineer has determined that to the best of his or her knowledge all fire protection and life safety systems have been completed, inspected, successfully tested, and approved, and all outstanding fire and life safety deficiencies have been corrected.

7.2 References

The national codes and standards adopted by GSA are discussed in Chapter 1. Additional codes and standards for the design of fire protection and life safety systems are included in the text of this chapter and listed in Appendix B, References.

Wayne Lyman Morse U.S. Courthouse
Eugene, Oregon

Shown underway, the project has been honored for construction excellence. Completed at one of the lowest per-square-foot costs of any federal courthouse, the building attained LEED Gold on its completion in 2006.

7.3 General Design Requirements

Fire Safety During Construction and Renovation Projects

Fire safety during construction must comply with the requirements in the IBC, IFC, and NFPA 241.

Fire Protection Systems

Disruptions to fire alarm and sprinkler systems must be kept to a minimum or avoided. The design team fire protection engineer must delineate phasing of construction to ensure that installations of new systems are expedited and existing systems are kept in service until the replacement system is operational. If fire protection systems are to be disrupted, procedures must be incorporated into the design to maintain equivalent levels of fire protection and provide formal notification to the facility while systems are down.

The GSA regional fire protection engineer must make the final determination of the adequacy of proposed equivalent levels of fire protection before the disruption of any fire protection system. For example, the provision of a 24-hour fire watch by qualified individuals may provide an equivalent level of fire protection during system disruption in some circumstances.

Building Construction

For each construction type, fire-resistive ratings of structural members, building height, area, separation, and requirements for rated exterior walls and openings for protection from exposure by adjacent buildings or hazards must comply with the requirements in the IBC.

Occupancy Classifications

Occupancy classifications must meet the requirements in the IBC.

7.4 Means of Egress

The means of egress requirements for the building must meet the requirements in NFPA 101. The technical egress requirements in NFPA 101 must be used in place of the technical egress requirements in the IBC.

Special Requirements

The following requirements take precedence over the requirements in NFPA 101:

- In buildings that are protected throughout by an automatic sprinkler system, one-hour fire-rated corridors are not required.
- Interlocking (scissor) stairs must count as only one exit stair. A minimum of two exit stairs are required for any multistory building.
- For common paths of travel and dead-end corridors, GSA permits the NFPA 101 exceptions for sprinkler protection to apply to individual floors protected throughout by sprinklers, even if the other floors of the building do not have sprinkler protection.
- Fire escapes, as defined in the NFPA 101, are not considered approved exits.
- In addition to meeting the arrangement of egress requirements, where the building has an occupied floor surface located more than 22.8 m (75 ft.) above the lowest level of fire department vehicle access, the exit stair enclosures must be separated by a distance not less than 9.1 m (30 ft.) or not less than one fourth of the length of the overall diagonal dimension of the building or area served, whichever is less. The distance must be measured in a straight line between the nearest point of the exit stair enclosure.
- Where the building has an occupied floor surface located more than 22.8 m (75 ft.) above the lowest level of fire department vehicle access, or more than 9.1 m (30 ft.) below the level of exit discharge serving such floor levels, exit stairways must be pressurized in accordance with the requirements in the IBC.

Exit Stair Path Markings and Identification Signs

Where the building has an occupied floor surface located more than 22.8 m (75 ft.) above the lowest level of fire department vehicle access, exit enclosures must be equipped with exit stair path markings and exit stair identification signs made of a material having a luminescent background.

Special Requirements

The following requirements take precedence over the requirements in NFPA 101:

Materials. Exit stair path markings and identification signs must be made of any material, including paint, provided that an electrical charge is not required to maintain the required luminescence. Such materials must include, but are not limited to, self-luminous materials and photoluminescent materials. Materials must comply with one of the following:

- ASTM E 2072, Standard Specification for Photoluminescent (Phosphorescent) Safety Markings; except that the charging source must be 10.8 lux (1 footcandle) of fluorescent illumination for 60 minutes, and the minimum luminance must be 5 mcd/m^2 (0.46 mcd/ft^2) after 90 minutes.

- UL 1994, Standard for Luminous Egress Path Marking Systems.
- An alternative standard deemed equivalent and approved by the GSA regional fire protection engineer.

Exit Stair Illumination. Where photoluminescent materials are installed in exit enclosures, such exit enclosures must be continuously illuminated for at least 60 minutes before the building is occupied. Lighting control devices (e.g., motion sensors) that automatically turn exit enclosure lighting on and off based on occupant movement are not permitted. However, a lighting control device that dims the level of lighting and continues to provide a charging source of a minimum of 10.8 lux (1 footcandle) of fluorescent illumination is permitted, if approved by the GSA regional fire protection engineer.

Exit Stair Handrails. All handrails and handrail extensions must be marked with a solid and continuous marking stripe and meet the following requirements:

- The marking stripe must be applied to the upper surface of the handrail or be a material integral with the upper surface of the handrail for the entire length of the handrail, including extensions.
- Where handrails and handrail extensions turn a corner or bend, a gap in the marking stripe is permitted, but must be as small as practicable and in no case greater than 102 mm (4 in.).
- The marking stripe must have a minimum horizontal width of 25 mm (1 in.).
- The dimensions and placement of the marking stripe must be uniform and consistent on each handrail throughout the exit enclosure.

Emergency Exit Symbol. An emergency exit symbol with a luminescent background must be affixed on all doors that swing out from the exit enclosure in the direction of egress travel. The emergency exit symbol must also meet the following requirements:

- The emergency exit symbol must meet the requirements of NFPA 170, Standard for Fire Safety and Emergency Symbols.
- The emergency exit symbol must be a minimum of 102 mm (4 in.) in height.
- The emergency exit symbol shall be affixed to the door, centered horizontally, with the top of the symbol no higher than 457 mm (18 in.) above the finished floor.

William J. Nealon Federal Building and U.S. Courthouse Scranton, Pennsylvania

A stairway within the glass-and-steel atrium that connects the 1931 building to the 1999 annex.

7.5 Interior Finishes

The interior finish requirements for walls, ceilings, floors, draperies, curtains, and movable partitions must meet the requirements in the IBC.

Special Requirements

The following requirements take precedence over the requirements in the IBC:

- Adhesives and other materials used for the installation of carpets must be limited to those having a flash point of 60° C (140° F) or higher.
- Wood used in construction that is required to be fire retardant must be treated with fire retardant chemicals by a pressure impregnation process or other method that treats the materials throughout (as opposed to surface treatment).

Sam Gilliam, Artist
Census

U.S. Census Headquarters
Suitland, MD

The library is designed as a freestanding pavilion to make it easily available to the public. *Census*, a colorful painted and sculpted artwork by Sam Gilliam is a focal point of the walnut panelled reading room.

7.6 Fire Alarm and Emergency Communication Systems

Fire alarm and emergency communication systems must be installed in accordance with the requirements in NFPA 72, the IBC, and the appropriate GSA fire alarm system specification.

Special Requirements

The following requirements take precedence over the requirements in NFPA 72 and the IBC:

- All fire alarm systems installed in buildings must be an emergency communication system when any one of the following conditions exist:
  - The building is two or more stories in height above the level of exit discharge.
  - The total calculated occupant load of the building is 300 or more occupants.
  - The building is subject to 100 or more occupants above or below the level of exit discharge.
- The emergency communication system must provide an automatic voice message in response to the receipt of a signal indicative of a fire emergency. Manual control with the capability of making live voice announcements must also be furnished to provide occupants notification on either a selective or all-call basis.
- With the exception of mass notification, a fire alarm and emergency communication system are not permitted to be integrated with other building systems such as building automation, energy management, security, and so on. Fire alarm and emergency communication systems must be self-contained, standalone systems able to function independently of other building systems.
- Fire alarm and emergency communication system control equipment that is installed in non-high-rise buildings must be located within a room separated from the remainder of the building by not less than a one-hour fire resistance-rated fire barrier. The room must be provided in a location approved by the GSA fire protection engineer after consultation with the local fire department. The room must be a minimum of 9.3 m^2 (100 sq. ft.) with a minimum dimension of 2.4 m (8 ft.).
- Fire alarm and emergency communication system control equipment that is installed in U.S. Courthouses must include redundant functionality installed within the U.S. Marshals Service (USMS) Command and Control Center. The redundant controls must have the same capabilities and operation as the main fire alarm and emergency communication system control unit, including annunciation, except there must be no capability to initiate “Signal Silence” (turning notification appliances off), “Acknowledge” (of any signal), and “Reset” (resetting the system to normal) operations. In addition, the control unit’s alarm, supervisory, and trouble audible signals must be capable of being silenced. Subsequent alarm, supervisory, and trouble conditions must cause the local audible signal to resound. The master microphone located at the main fire alarm and emergency communication system control unit must be arranged to take priority over the redundant microphone located in the USMS Command and Control Center.
- All fire alarm signals (i.e., alarm, supervisory, and trouble signals) must be automatically transmitted via a digital alarm communicator over leased phone lines to a UL-listed central station service. Operation of a duct smoke detector must initiate a supervisory signal.

Manual Fire Alarm Boxes

Manual fire alarm boxes must be installed in accordance with the requirements in NFPA 72 and the IBC.

Special Requirements

The following requirement takes precedence over the requirements in NFPA 72 and the IBC:

- Manual fire alarm boxes must be installed in all new fire alarm system projects in accordance with the spacing and location requirements in NFPA 72.

Waterflow Switches

Waterflow switch(es) must be installed in accordance with the requirements in NFPA 13, NFPA 72, and the IBC.

Special Requirements

The following requirements take precedence over the requirements in NFPA 13, NFPA 72, and the IBC:

- Waterflow switch(es) must be installed on each floor or fire area protected by sprinkler systems.
- Each waterflow switch must be separately annunciated at the main fire alarm control unit and all required annunciators.

Smoke Detectors

Smoke detectors must be installed in accordance with the requirements in NFPA 72 and the IBC.

Special Requirements

The following requirements take precedence over the requirements in NFPA 72 and the IBC:

- Area smoke detectors must not be installed in any of the following rooms: mechanical equipment rooms, electrical closets, telephone closets, and emergency generator rooms.
- Smoke detectors specifically for the protection of the fire control unit(s), notification appliance circuit power extenders, and supervising station transmitting equipment must not be installed in a building protected throughout by an automatic sprinkler system.
- Smoke detection appropriate for the application must be installed in each of the following: uninterruptible power service rooms, electrical switch gear rooms, transformer vaults, telephone exchanges, and information technology equipment as specified in this chapter. When smoke detection is installed in rooms having high voltage equipment, the smoke detection must not be installed directly above the high voltage equipment.
- Duct smoke detectors must meet the requirements in NFPA 90A.

Audible Notification Appliances

Performance, location, and mounting of audible notification appliances must be in accordance with the requirements in NFPA 72.

Special Requirements

The following requirements take precedence over the requirements in NFPA 72:

- The design for achieving the required minimum dBA levels must take into consideration all building construction materials such as carpeting, hard surfaces, walls, doors, etc., and any other materials that can cause sound level attenuation and/or clarity problems in the placement and location of all audible notification appliances.
- Where emergency communication systems are provided, fire alarm speakers must be installed in elevator cars and exit stairways; however, they must only be activated to broadcast live voice messages (e.g., manual announcements). The automatic voice messages must be broadcast through the fire alarm speakers on the appropriate floors, but not in stairs or elevator cars.
- To prevent external tapping of the audio/speaker circuit(s) serving a sensitive compartmented information facility, any of the following methods are permitted to be used:
  – Self-amplified speakers
  – Remote dedicated amplification
  – Remote signal modules

Visible Notification Appliances

Placement and spacing of visible notification appliances must be in accordance with the requirements in NFPA 72.

Special Requirements

The following requirements take precedence over the requirements in NFPA 72:

- Unless the project includes a new fire alarm system or a complete replacement of an existing fire alarm system, visible notification appliances are not required to be installed in areas where visible notification appliances do not currently exist or where noncompliant existing visible notification appliances currently exist. This requirement does not preclude the addition of new visible notification appliances to existing fire alarm systems that contain existing compliant visible notification appliances.

- Visible notification appliances must be installed only in public and common areas. For the purposes of this requirement, visible notification appliances are not required to be installed in individual offices. Public and common areas include public rest rooms, reception areas, building core areas, conference rooms, open office areas, and so on.

- Visible notification appliances are not permitted to be installed in exit enclosures (e.g., exit stairs).

Occupant Notification

Transmission of an alarm signal from any fire alarm system initiation device to notify the occupants throughout the building must be in accordance with the requirements in NFPA 72 and the IBC.

Special Requirements

The following requirement takes precedence over the requirements in NFPA 72 and the IBC:

- All alarm signals transmitted from any fire alarm system initiation device must activate the respective building audible and visible notification appliances to notify the occupants.

- Duct smoke detectors must not activate the fire alarm system notification appliances.

Fire Alarm Notification Strategies for High-Rise Buildings

In high-rise buildings, the fire alarm and emergency communication system must be designed for selective evacuation, unless specifically approved otherwise by the GSA regional fire protection engineer. The GSA regional fire protection engineer must establish a dialogue with the design team fire protection engineer to determine specific evacuation strategies for the building and subsequent operational features of the fire alarm system. This includes, but is not limited to, determining how and where the “fire zone” and “safe area zone” messages are used. The visible alarm notification appliance circuits must not be activated on floors designated as safe area zones.

Survivability

The fire alarm and emergency communication system must meet the survivability requirements in NFPA 72.

Special Requirements

The following requirements take precedence over the requirements in NFPA 72:

- Two vertical risers (e.g., supply and return inter-connected network circuits Style 7– Class X) must be installed as far from each other as practicable so that a single fire does not impact both risers.

- The two vertical risers must be protected by a minimum two-hour rated enclosure or an approved two-hour rated cable or system that is not common to both vertical risers. (Pathway Survivability Level 2 or 3)

- The horizontal interconnection between the two vertical risers at the top and bottom must be protected by a minimum two-hour rated enclosure, or an approved two-hour rated cable or system, or an approved construction material having a two-hour fire resistance rating. (Pathway Survivability Level 2 or 3)

- All circuits (speaker/audio, SLC, network, and/or power) necessary for the operation of the notification appliances must be protected until they enter the evacuation signaling zone (usually a floor) by a minimum two-hour rated enclosure, or an approved two-hour cable or system, or an approved construction material having a two-hour fire resistance rating. (Pathway Survivability Level 2 or 3)

- A minimum of two distinct fire alarm audible notification appliance circuits and a minimum of two distinct visible notification appliance circuits must be provided on each floor.

- Circuit integrity cable, if used, must be installed in EMT, IMT, or rigid metal conduit for mechanical protection.

- Provide a minimum of three Class B Signaling Line Circuits (SLC) per floor if the gross floor area is greater than 2,415 m^2 (26,000 sq. ft.) but less than 4,830 m^2 (52,000 sq. ft.) gross area. Provide a minimum of four Class B Signaling Line Circuits (SLC) for all floors where the aforementioned areas are exceeded. The floor SLC's must be isolated from the SLC risers and network. The system must be designed and installed so that a single wire to wire short or any other single Style 4 (Class B) impairment on an SLC does not affect more than one half of the area of the floor or 1,207 m^2 (13,000 sq. ft.), whichever is less.

Fire Command Center

The fire command center must meet the requirements in the IBC.

Special Requirements

The following requirements take precedence over the requirements in the IBC:

- Each fire command center must be provided in a location approved by the GSA regional fire protection engineer after consultation with the local fire department.

- Each fire command center must be provided with appropriate lighting, ventilation, and emergency lighting.

- Each fire command center must have a way to provide the responding fire department with the ability to operate the building's lighting system from the fire command center.

Annunciator

All fire alarm systems must have at least one annunciator located in plain view within 7.6 m (25 ft.) of the primary fire department entrance to the building.

7.7 Water Supply for Fire Protection

The design team fire protection engineer must assess the adequacy of the existing water supply. The design team fire protection engineer must perform water supply flow testing of fire hydrants and/or fire pumps. If the hydraulic data is less than one year old and is available from the local jurisdiction, the design team fire protection engineer must verify the locations involved as well as the quality and accuracy of the data. The required fire water flows and pressures for buildings must comply with the requirements in NFPA 13, 14, and 20. In addition, a secondary on-site water supply equal to the hydraulically calculated sprinkler demand must be provided for high-rise buildings assigned to Seismic Design Category C, D, E, or F as determined by the IBC.

Fire Pumps

When a fire pump is necessary to supplement fire water flow and pressure, the size and the installation of the fire pump must be in accordance with the requirements of NFPA 13, 14, and 20.

Special Requirements

The following requirements take precedence over the requirements in NFPA 13, 14, and 20:

- The building's fire pump must be sized for the sprinkler system requirements only if the local responding fire department can provide the necessary flow and pressure for manual fire fighting operations (i.e., hose stations), through fire department Siamese connections. Where fire pumps are provided to supply other fire suppression activities, they must be sized in accordance with the appropriate NFPA standard.
- A fire pump must start automatically at 69 kPa (10 psi) below pressure maintenance pump (jockey pump) start pressure. The fire pump must be manually shut down.
- The fire pump installation must include a test header and a flow meter.
- Emergency power must be provided in accordance with the requirements in Chapter 6.
- The power transfer switch and the fire pump controller must be factory assembled and packaged as a single unit. Separate transfer switches are not permitted. The fire pump controller must be monitored by the fire alarm system.

Pressure Maintenance Pump (Jockey Pump)

A pressure maintenance pump must be used to maintain a uniform or relatively high pressure on the fire protection system. A jockey pump must be sized to make up the allowable leakage rate within 10 minutes or 3.8 lpm (1 gpm), whichever is larger. The pressure maintenance pump must be equipped with emergency power.

Fire Hydrants

New fire hydrants must be installed in accordance with the requirements in NFPA 24 and the IFC unless the locations of the existing fire hydrants provide adequate coverage for the subject project. The local fire department must be consulted with regard to the location of the fire hydrants and thread types for hydrant outlets.

Post Indicator Valve

In a campus setting a post indicator valve is required on the fire protection service for each building.

7.8 Automatic Sprinkler and Standpipe Systems

Automatic sprinkler systems must be installed in accordance with the requirements in NFPA 13, the IBC, and the appropriate GSA sprinkler system specification.

Special Requirements

The following requirements take precedence over the requirements in NFPA 13 and the IBC:

- Automatic sprinklers must be installed throughout all new construction and renovation projects where the building has a sufficient municipal water supply system for the design and installation of a sprinkler system at the site.
- Automatic sprinklers must be installed throughout the designated work area for all alteration projects where the building has a sufficient municipal water supply system for the design and installation of a sprinkler system at the site.
- Where project sites are located in remote or isolated areas having insufficient or nonexistent water supplies in close proximity, design the fire sprinkler system in accordance with NFPA 13. See Automatic Sprinkler Systems for Remote or Isolated Facilities for additional information regarding automatic sprinkler system requirements.
- Where automatic sprinklers are required to be installed, they must be installed throughout all locations unless the subject locations are specifically exempted by NFPA 13 or the IBC. Where sprinklers are exempted from rooms or areas, such rooms or areas must be separated from adjacent sprinklered rooms or areas by fire barriers having a two-hour fire-resistance rating.
- All sprinkler systems must be wet-pipe sprinkler systems, unless installed in areas subject to freezing.
- In areas subject to freezing, dry-pipe sprinkler systems, dry pendent sprinklers, heating the space, or rerouting sprinkler piping to heated areas is required. Heat tape is not permitted on sprinkler piping.
- Seismic protection must be installed where required in the IBC.
- Sprinkler systems must be designed using a minimum system design area of 139 m^2 (1,500 sq.ft.). No decreases are permitted.
- Where floor openings are not classified as atriums, the sprinklers at the ceiling must be zoned with the lower level if it is enclosed on the upper level (the enclosure is effectively creating a high ceiling). Otherwise, sprinklers must be zoned with the upper level.
- Sprinkler system control valves must be located in accessible spaces. Sprinkler system control valves are not permitted in above-ceiling spaces.
- Antifreeze sprinkler systems are not permitted to be installed.
- Pre-action-type sprinkler systems are not permitted to be installed.
- Sprinkler guards must be provided in the following locations:
  - Sprinklers installed less than 2.1 m (7 ft.) above the floor
  - Sprinklers installed within elevator machine rooms and elevator pits
  - Sprinklers installed within electrical closets
  - Sprinklers installed within electrical equipment rooms

- Sprinklers installed in electrical switchgear rooms and transformer vaults must be provided with separate manual isolation valves and a separate water flow switch located outside the room in an accessible location. Tamper switches must be provided on all such valves.

Types of Sprinklers

Sprinklers must be selected based on the associated hazards within the occupancy to be protected in accordance with the requirements in NFPA 13 and the IBC.

Special Requirements

The following requirements take precedence over the requirements in NFPA 13 and the IBC:

- Sprinklers equipped with “O-ring” water seals are not permitted to be installed.

Sprinkler Piping

Sprinkler piping, fittings, control valves, check valves, and drain assemblies must meet the requirements in NFPA 13.

Special Requirements

The following requirements take precedence over the requirements in NFPA 13:

- Black steel piping and copper tubing must be used for all wet-pipe sprinkler piping. Chlorinated polyvinyl chloride sprinkler piping is not to be installed unless specifically approved for installation by the GSA regional fire protection engineer.
- Galvanized (internal and external) sprinkler piping must be used for all dry-pipe sprinkler systems.
- Steel pipe sizes 51 mm (2 in.) and smaller must be Schedule 40 and must be threaded.
- Steel pipe sizes larger than 51 mm (2 in.) must be minimum Schedule 10. Piping less than Schedule 40 must be roll grooved.
- Threadable lightwall pipe is not permitted be installed.
- Steel piping having a corrosion-resistant ratio less than 1 is not permitted to be installed.
- Plain-end fittings are not permitted to be installed.

Automatic Sprinkler Systems for Remote or Isolated Facilities

The requirements below apply to facilities located in remote or isolated areas having insufficient or nonexistent water supply sources for the design and installation of a fire sprinkler system in accordance with the requirements in NFPA 13. These facilities must also meet the criteria set forth below to determine when it is not economically feasible to install automatic fire sprinkler protection in accordance with NFPA 13.

If the following conditions exist, the sprinkler system must be designed in accordance with the requirements in NFPA 13D:

- The costs associated with the installation of the interior NFPA 13 fire sprinkler system (which include all costs such as labor, materials, the adequate water supply source, pumps, etc.) exceed $10.00 per square foot; and

- The costs associated with connecting the interior NFPA 13 fire sprinkler system to the adequate water supply source (which include all costs such as labor, materials, the adequate water supply source, pumps, etc.) are greater than 50 percent of the cost for the installation of the interior NFPA 13 fire sprinkler system.

Special Requirements

The following requirements take precedence over the requirements in NFPA 13D:

- The water supply source for the sprinkler system must be a minimum of 3,785.4 liters (1,000 gallons) and must be capable of meeting system demands for at least 30 minutes.
- Antifreeze sprinkler systems are not permitted to be installed.

Fire Department Connections

Fire department connections must meet the requirements in the IBC.

Special Requirements

The following requirement takes precedence over the requirements in the IBC:

- UL-listed locking fire department connection caps must be installed on all fire department connections where the local fire department has a program and the hardware to accommodate locking fire department caps.

Standpipes

Standpipes must be installed in buildings where required in the IBC.

Special Requirements

The following requirements take precedence over the requirements in the IBC:

- All standpipes must be connected to the fire protection water supply, permanently pressurized, and installed in accordance with the requirements in NFPA 14. The standpipe water supply must be in accordance with the requirements specified within this chapter.
- Dry standpipes must be permitted to be installed only in spaces subject to freezing.
- Where standpipe and sprinkler systems are required, a combination sprinkler/standpipe system design must be provided.

Fire Department Hose Outlets

Fire department hose outlets must be installed in buildings where required in the IBC.

Special Requirements

The following requirements take precedence over the requirements in the IBC:

- Each fire main riser must be provided with 63 mm (2½ in.) fire department hose outlets.
- Each outlet must be located in the stair shaft and have a removable 38 mm (1½ in.) adapter and cap. Threads and valves must be compatible with the local fire department requirements.

7.9 Non-Water-Based Fire Extinguishing Systems

Wet Chemical Extinguishing Systems

Wet chemical extinguishing systems must be installed to protect commercial food heat-processing appliances required to have a Type 1 hood in accordance with the requirements in NFPA 17A.

Dry Chemical Extinguishing Systems

Dry chemical extinguishing systems are not permitted to be installed to protect any commercial cooking equipment installations.

Clean Agent Extinguishing Systems

Clean agent extinguishing systems are not permitted to be installed, unless specifically approved for installation by the GSA regional fire protection engineer. The approved clean agent extinguishing system is considered a supplemental fire extinguishing system and is not to be installed in place of a wet-pipe sprinkler system.

Carbon Dioxide Fire Extinguishing Systems

Carbon dioxide fire extinguishing systems are not permitted to be installed.

ATF National Laboratory Center
Beltsville, Maryland

The world's first forensic fire testing and research laboratory needed to simulate both an indoor and an outdoor environment that would allow a fire to burn freely. Engineering challenges included accommodating for airflow and protection from heat damage.

Portable Fire Extinguishers and Cabinets

Portable fire extinguishers and cabinets must be installed in accordance with the requirements of the IBC.

Special Requirements

The following requirements take precedence over the requirements in the IBC:

- In office buildings protected throughout with quick-response sprinklers, portable fire extinguishers must only be installed in areas such as mechanical and elevator equipment areas, computer rooms, UPS rooms, generator rooms, kitchen areas, special hazard areas, and so on.

7.10 Elevator Systems

Elevator systems must be designed and installed in accordance with the requirements in ASME Standard A17.1/CSA B44 and the IBC.

Special Requirements

The following requirements take precedence over the requirements in the IBC:

- In sprinklered buildings, each elevator machine room must be protected by a wet-pipe sprinkler system using standard response sprinklers having an intermediate-temperature rating, unless the GSA regional fire protection engineer permits the elimination of the sprinklers in the elevator machine room.
- The sprinkler system for the elevator machine room must be provided with separate manual isolation valves and a separate water flow switch located outside the room in an accessible location. Tamper switches must be provided on all such valves.
- Sprinkler protected elevator machine rooms containing elevator control equipment must be provided with a means to disconnect automatically the main line power supply to the affected elevator before the application of water in accordance with the requirements in NFPA 72.
- Enclosed elevator lobbies are not required to be installed in buildings protected throughout by an automatic sprinkler system.

Fire Service Access Elevators

Fire service access elevators must be designed and installed in accordance with the requirements in the IBC and ASME Standard A17.1/CSA B44.

Special Requirements

The following requirements take precedence over the requirements in the IBC and ASME Standard A17.1/CSA B44:

General. Where fire service access elevators are required, a minimum of two elevators each having a minimum 1,588 kilograms (3,500 pounds) capacity or one elevator having a minimum 1,814 kilograms (4,000 pounds) capacity serving every floor must be provided. At least one fire service access elevator must be sized to accommodate a stretcher in accordance with the requirements in the IBC. These fire service access elevators are not intended to be for exclusive use of the fire department and may be available for public use under nonemergency conditions.

Phase I Emergency Recall Operation. Actuation of any building fire alarm initiating device must initiate Phase I emergency recall operation on all fire service access elevators in accordance with the requirements in ASME Standard A17.1/CSA B44. In addition, an independent, three-position, key-operated “Fire Recall” switch conforming to the applicable requirements in ASME A17.1/CSA B44 shall be provided at the designated level for each fire service access elevator. All other elevators must remain in normal service unless Phase I emergency recall operation is manually initiated by the required three-position key-operated “Fire Recall” switch or automatically initiated by the associated elevator lobby, hoistway, or elevator machine room smoke detectors.

Water Protection. The fire service access elevator hoistway and associated elevator landings must be designed to prevent water from infiltrating into the hoistway from the operation of the automatic sprinkler system outside the enclosed fire service access elevator lobby.

Elevator Machine Rooms and Machinery Spaces. Plumbing systems and automatic sprinklers must not be installed in the fire service access elevator machine rooms and machinery spaces.

Fire Service Access Elevator Symbol. A pictorial symbol of a standardized design designating which elevators are fire service access elevators must be installed on each side of the hoistway door frame on the portion of the frame at right angles to the fire service access elevator lobby. The fire service access elevator symbol must be designed as shown in Figure 7-1, and must also meet the following requirements:

- The fire service access elevator symbol must be a minimum of 76 mm (3 in.) in height.
- The vertical center line of the fire service access elevator symbol must be centered on the hoistway door frame. Each symbol must not be less than 78 inches, and not more than 84 inches above the finished floor at the threshold.

Occupant Evacuation Elevators

Occupant evacuation elevators must be designed and installed in accordance with the requirements in the IBC and ASME Standard A17.1.

Special Requirements

The following requirements take precedence over the requirements in the IBC and ASME Standard A17.1:

General. In any new construction project, when the building has an occupied floor more than 36.5 m (120 ft.) above the lowest level of fire department vehicle access, occupant evacuation elevators must be installed. All passenger elevators for general public use, except for those designated as fire service access elevators, must be designated as occupant evacuation elevators in accordance with this section.

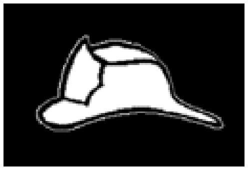
Phase I Emergency Recall Operation. An independent three-position key-operated “Fire Recall” switch conforming to the applicable requirements in ASME A17.1/CSA B44 must be provided at the designated level for each occupant evacuation elevator.

Water Protection. The occupant evacuation elevator hoistway and associated elevator landings must be designed to prevent water from infiltrating into the hoistway from the operation of the automatic sprinkler system outside the enclosed occupant evacuation elevator lobby.

Elevator Machine Rooms and Machinery Spaces. Plumbing systems and automatic sprinklers must not be installed in the occupant evacuation elevator machine rooms and machinery spaces.

Figure 7-1

Fire Service Access Elevator Symbol



7.11 Special Fire Protection Requirements

Air Distribution Systems

Fire dampers and smoke dampers installed in air distribution systems must be installed in accordance with the requirements in NFPA 90A.

Special Requirements

The following requirements take precedence over the requirements in NFPA 90A:

- In buildings protected throughout by an automatic sprinkler system, smoke dampers are not required to be installed at penetrations of shafts unless smoke dampers are used as part of a smoke control system.

Information Technology Equipment Rooms

Information technology equipment rooms containing high-value or mission-essential electrical equipment (such as mainframe computers) with the potential for high dollar loss or business interruption must be designed in accordance with the requirements in NFPA 75 and the appropriate GSA computer room fire alarm system specification.

Special Requirements

The following requirements take precedence over the requirements in NFPA 75:

- A wet-pipe sprinkler system must be provided throughout the area, including data storage areas.
- Quick-response sprinklers must be installed throughout the area, including data storage areas.
- The sprinkler system must have a separate isolation valve and a separate water flow switch located outside of each protected area in an accessible location. Each valve must be provided with a tamper switch that is connected to the building's fire alarm system.
- Activation of the sprinkler water flow switch must disconnect power to the information technology equipment and to the HVAC systems with no time delay.
- The activation of one intelligent analog/addressable photoelectric smoke detector utilizing early warning smoke detection technology (e.g., smoke detectors having enhanced algorithms, fire alarm control panel having capability to program individual smoke detector response parameters, or smoke detectors using air sampling technology for use in information technology equipment rooms) within a single protected area must disconnect power to the information technology equipment and to the HVAC system after a preset time delay.
- Clean agent fire extinguishing systems are not permitted to be installed in information technology equipment rooms, unless warranted by risk and specifically approved by the GSA regional fire protection engineer.
- Underfloor spaces within information technology equipment rooms must be protected with a fire suppression system only where the risk warrants this protection and when approved by the GSA regional fire protection engineer. If underfloor fire suppression is to be installed in an underfloor space that is 457 mm (18 in.) or greater in height, an automatic sprinkler system must be installed. If underfloor fire suppression is to be installed in an underfloor space that is less than 457 mm (18 in.) in height, use of a clean agent extinguishing system is permitted provided the design is specifically approved by the GSA regional fire protection engineer.

Places of Confinement (Holding Areas)

Places of confinement must be designed in accordance with the IBC.

Special Requirements

The following requirements pertaining to places of confinement take precedence over the requirements in the IBC when the aggregate number of detainees within each holding area is not more than 50 detainees, and where no individual is detained for more than 24 hours.

- Places of confinement must be designed in accordance with the requirements in NFPA 101 for lock-ups.
- Sprinklers must be installed within all places of confinement, including, but not limited to, prisoner holding cells, the main prisoner detention cell block, and prisoner attorney interview rooms.
- The sprinklers installed must be institutional quick-response flush pendent sprinklers designed for standard and extended coverage applications.
- The institutional sprinklers must have a solder-link-type fusible element, a tamper-resistant escutcheon, and a retaining flange that prevents sprinkler movement away from walls and ceilings.

Atriums

Atriums must be designed in accordance with the requirements in the IBC.

Special Requirements

The following requirements take precedence over the requirements in the IBC:

- The atrium sprinkler system must be designed as a separate sprinkler zone. In addition, a separate manual isolation valve and a separate water flow switch must be located in an accessible location. A tamper switch must be provided on all such valves.
- Atrium smoke control systems must be installed using the exhaust method in accordance with the requirements in the IBC.

Cooling Towers

Cooling towers must meet the requirements in NFPA 214.

Special Requirements

The following requirements take precedence over the requirements in NFPA 214:

- Cooling towers that are more than 57 m^3 (2,000 cu. ft.) in size and have combustible fill must be protected with an automatic deluge sprinkler system.
- Automatic sprinkler protection is not required to be installed in cooling towers that are over 57 m^3 (2,000 cu. ft.) in size, constructed of noncombustible materials, and have noncombustible components (including piping) and noncombustible decks.
- Automatic sprinkler protection must be installed in cooling towers that are constructed of combustible materials, have combustible components (such as PVC fill, louvers, drift eliminators, etc.), or have a combustible deck.

Residential Housing Units

Residential housing units must meet the requirements in the International Residential Code (IRC).

Special Requirements

The following requirements take precedence over the requirements in the IRC:

- Stairways in residential housing units must have a maximum riser height of 178 mm (7 in.) and a minimum tread depth of 279 mm (11 in.).

- Residential housing units are required to be protected by an automatic sprinkler system. The design of the automatic sprinkler system for the residential housing unit must be based on the design and installation requirements in NFPA 13D. Each residential housing unit must be provided with a local waterflow switch that will initiate a local alarm. The sprinkler waterflow alarm must be arranged so that the operation of the waterflow switch must produce an alarm signal that is audible throughout all inhabited areas of the individual housing unit. The sprinkler system waterflow switch and control valve must be monitored for alarm, supervisory, and trouble conditions.

- Residential housing units must be provided with approved multiple-station smoke alarms in all of the following locations:
  – In all sleeping rooms
  – Outside of each separate sleeping area in the immediate vicinity of the sleeping rooms
  – On each level of the dwelling unit, including basements

- All smoke alarms must be designed and installed in accordance with the requirements in the NFPA 72. All smoke alarms within the residential housing unit must be interconnected in such a manner that the activation of any single smoke alarm will activate all the smoke alarms within the individual residential housing unit and produce an alarm signal that is audible throughout all inhabited areas of the individual residential housing unit.

- Manual fire alarm stations must not be installed in the residential housing unit.

Chemical Laboratories

Laboratories must meet the design requirements in NFPA 45 and the IBC.

Special Requirements

The following requirements take precedence over the requirements in NFPA 45:

- Laboratories handling or storing hazardous chemicals, flammable gases, flammable liquids, explosives, and biological laboratories must not be expanded in existing office buildings.

- All chemical laboratories must be equipped with sprinklers, regardless of size. Sprinkler protection must be calculated to provide a density of 6.1 (L/min)/m^2 (0.15 gpm/ft.^{2}) over 279 m^2 (3,000 ft.^{2}).

Record Storage Facilities

Record storage facilities that have a storage volume of records exceeding 1,416 m^3 (50,000 cu. ft.) must meet the requirements in NFPA 232.

Special Requirements

The following requirements take precedence over the requirements in NFPA 232:

- Record storage facilities that store Federal records must meet the requirements in the National Archives and Records Administration (NARA) guidelines published in the NARA Code of Federal Regulations–36 CFR Part 1234, Appendix B– Alternative Certified Fire-safety Detection and Suppression System(s) and, when specified by NARA, the archival storage standards published in NARA Directive 1571.

Flammable and Combustible Liquid Storage Arrangements

The storage arrangements and protection of a flammable and combustible liquid storage area must meet the requirements in NFPA 30 and the applicable factory mutual data sheets.

Track Files

A track file uses a single aisle to give access to an otherwise solid group of open-shelf files. Access is gained by moving shelf units on rollers along a track until the proper unit is exposed.

Special Requirements

Track files must meet the following requirements:

- The track file system must be protected by an automatic sprinkler system designed in accordance with the requirements in NFPA 13.
- A minimum clearance of 457 mm (18 in.) must be maintained between the top of the track file system and the sprinkler deflector.
- The track file system must be no more than 2.4 m (8 ft.) in height.
- The track file system must be constructed entirely of steel. At least 1.4 mm (.055 in.), 18-gauge sheet metal must be used for all parts of the shelving unit.
- The back cover of stationary end files must be solid sheet metal.
- For floor loading requirements, refer to Chapter 4.

Harvey W. Wiley Federal Building for FDA College Park, Maryland

Each laboratory is designed with fume hood connections, point exhaust connections, and gas manifold towers at the bench.

7.12 Required Design Guides and Manuals

U.S. Court Facilities

For special fire protection and life safety requirements for U.S. Court facilities refer to Chapter 9 and the *U.S. Courts Design Guide.*

U.S. Marshal Service Space

For special fire protection and life safety requirements for U.S. Marshals Service space, refer to the *USMS Requirements and Specifications for Special Purpose and Support Space,* Volumes I, II, and III.

Land Port of Entry Facilities

For special fire protection and life safety requirements for land port of entry facilities, refer to the *Land Port of Entry Design Guide.*

GSA Child Care Centers

For special fire protection and life safety requirements for GSA child care centers, refer to the *GSA Child Care Center Design Guide* (PBS-140).

Pacific Highway Land Port of Entry Blaine, Washington

This port of entry is steel frame construction infilled with galvanized, corrugated steel.

7.13 ISC Physical Security Criteria for Federal Facilities

Important Note: The following criteria do *not* apply to all projects. Follow each criterion only if so instructed by the project-specific risk assessment.

The continued operation of the building's fire protection systems during an unwanted event is essential to ensuring overall building safety. The primary goal is to protect human life from fire and the products of combustion during an unwanted event. The secondary goals are to reduce potential loss from fire during an unwanted event. The design of a building must be such that life safety does not solely depend on any single safeguard. Therefore, an additional safeguard(s) must be considered for life safety in case any single safeguard is ineffective due to an unwanted event.

Fire Protection Risk Assessment

For buildings assigned a high-protection risk level (determined by the risk assessment), the design team must perform a fire protection risk assessment of the building. The fire protection risk assessment is a technical evaluation, based on professional rationale and judgment, of potential risks involved in achieving desired objective(s) (e.g., protection of life, the property, and the mission). It involves the measurement and complete documentation of conditions and features relevant to determination and adjustment of the level of building safety and the adequacy of the protection provided. The overall combined effect of all positive features and negative conditions must be considered in the evaluation rather than the effects of a single item or concern. The result will be a logical and reliable determination of whether equivalent or alternative solutions exist for any or all negative conditions caused by an unwanted event.

Water Supply for Fire Protection

For buildings assigned a high-protection risk level (determined by the risk assessment), the design team must consider the risks associated with a single point failure of the incoming water supply for fire protection due to an unwanted event. To address this concern, the design team must consider alternative solutions to reduce the unwanted event probability, hazard severity, or a combination of both to achieve an acceptable level of risk. Possible solutions include, but are not limited to, requiring the incoming water supply line to be encased, buried, or located 15 m (50 ft.) away from high-threat areas and/or requiring redundant fire pumps.

Combination Standpipe-Sprinkler Risers

For buildings assigned a high-protection risk level (determined by the risk assessment), the design team must consider the risks associated with a single point failure of the combination standpipe-sprinkler risers due to an unwanted event. To address this concern, the design team must consider alternative solutions to reduce the unwanted event probability, hazard severity, or a combination of both to achieve an acceptable level of risk. Possible solutions include, but are not limited to, providing two standpipe-sprinkler risers with connections to each riser on alternate floors, and locating the combination standpipe-sprinkler risers away from exterior walls on floors less than 6.0 m (20 ft.) above grade.

Occupant Notification

For low-rise buildings assigned a high-protection risk level (determined by the risk assessment), the design team must consider the risks associated with the fire alarm system not providing adequate occupant notification via live voice announcements due to an unwanted event. To address this concern, the design team must consider alternative solutions to reduce the unwanted event probability, hazard severity, or a combination of both to achieve an acceptable level of risk. One possible solution would be to require the fire alarm system installed in the building to be an emergency voice/alarm communication system. The emergency voice alarm communication system would provide an automatic response to receipt of a signal indicative of a fire emergency. In addition, the emergency voice/alarm communication system would provide manual control with the capability of making live voice announcements to provide occupant notification either on a selective or all-call basis. Another solution would be to install redundant circuitry to reduce the risk of notification circuit failure.

Occupant Evacuation Elevators

For facilities assigned a high-protection risk level (determined by risk assessment), the design team must consider the risks associated with not all occupants being able to safely exit the facility. To address this concern, the design team must consider alternative solutions to reduce the unwanted event probability, hazard severity, or a combination of both to achieve an acceptable level of risk. One possible solution may be to incorporate occupant evacuation elevators within the facility for persons who may not be able to safely exit the facility.

If occupant evacuation elevators are provided, the building's occupant evacuation plan (OEP) must specifically cover the purpose and use of occupant evacuation elevators during an emergency.

Egress Door Locks

For all buildings, the design team must ensure that all security locking arrangements on doors used for egress comply with requirements of NFPA 101, Life Safety Code.

Exit Stairways

For buildings assigned a high-protection risk level (determined by risk assessment), the design team must consider the risks associated with occupants evacuating a building with the loss of an exit stairway due to an unwanted event. To address this concern, the design team must consider alternative solutions to reduce the unwanted event probability, hazard severity, or a combination of both to achieve an acceptable level of risk. Possible solutions include, but are not limited to, increasing the number of exit stairways; hardening the exit stairways; increasing the travel distance between each exit stairway; and ensuring exit stairways do not discharge into lobbies, parking, or loading areas; incorporating horizontal exits.

Smokeproof Exit Enclosures

For buildings assigned a medium- and high-protection risk level (determined by the risk assessment), the design team must consider the risks associated with occupants utilizing exit stairways that are infiltrated by heat, smoke, and fire gases due to an unwanted event. To address this concern, the design team must consider alternative solutions to reduce the unwanted event probability, hazard severity, or a combination of both to achieve an acceptable level of risk. One possible solution may be to incorporate smokeproof enclosures within the facility to limit the infiltration of heat, smoke, and fire gases from a fire in any part of the building. The smokeproof enclosures may be permitted to be created by using natural ventilation, by using mechanical ventilation incorporating a vestibule, or by pressurizing the exit stairway enclosure.

Ventilation Systems

Ventilation systems and equipment must be located away from high-risk areas such as loading docks and garages and protect the system controls and power wiring to the equipment. The ventilation system must be connected to emergency power to provide the ability to selectively run one or several air-handling units for smoke removal.

Blast Resistant Windows

Fire safety is an important consideration in window design. The facility's multidisciplinary security team, including a fire protection engineer, must evaluate the performance requirements for all security-glazing materials proposed for the project. The multidisciplinary team must ensure that normal tools carried by firefighters, such as a pick head axe, halligan tool, or similar device, can readily overcome glazing barriers. If the use of more specialized tools, such as a rabbit tool, a k-tool, circular saws, rams, or similar devices, is necessary to break through the glazing barrier or if the glazing itself is hardened so that high pressures may not blow out the windows, alternative methods or systems are to be designed to ensure that smoke from an incident is not trapped inside the building.

Oklahoma City Federal Building
Oklahoma City, Oklahoma

In event of an explosion, the windows are designed to allow the glass to push inward and transfer vibrations to the concrete building frame.

7.14 Historic Structures

For an overall fire protection plan and to emphasize the design team's responsibility to address fire protection and to preserve the historic integrity of historic structures, the design team must explore alternative approaches outlined in State rehabilitation codes, International Existing Building Code, and national performance-based codes to resolve conflicts between prescriptive code requirements and preservation goals. In addition, the requirements and recommendations in NFPA 914 must be considered for rehabilitation projects in historic structures. The design team must also evaluate the U.S. Department of Housing and Urban Development Guideline on Fire Ratings of Archaic Materials and Assemblies, which provides test data on the fire resistance of a variety of historic materials, and the GSA publication titled *Fire Safety Retrofitting in Historic Buildings.*

Responsibility

The GSA regional fire protection engineer is the AHJ for all fire protection and life safety requirements who must exercise professional judgment to assess the acceptability of alternative compliance solutions. Early and frequent coordination between the architects, State historic preservation officer, regional historic preservation officer, preservation specialists, external review groups, and the design team's fire protection engineer is needed for timely resolution of conflicts between fire safety and preservation goals.

Impact on Historic Fabric

Before the design development submission for a project in a historic building, the design team fire protection engineer must consult with the GSA regional historic preservation officer and the GSA regional fire protection engineer regarding the impact of the fire protection design features as required within this chapter on the historic fabric.

Fire Protection Alternatives for Consideration

Listed below are fire protection alternatives for the design team's fire protection engineer to consider when designing a project in a historic building:

- New stair enclosures in historic buildings should be designed to minimize visual impact on significant spaces, including historic lobbies and corridors. Cross-corridor doors should be designed to provide maximum height and width clearance and avoid visually truncating the corridor. Oversized hold-open doors will achieve this end in most circumstances. For more ornamental spaces, accordion-rated doors may be used. Transparent treatments, such as rated glass assemblies or historic doors modified to incorporate rated glass, should be considered when barriers should be kept closed to maintain a rated enclosure. Nonprescriptive compliance solutions, such as modification of historic door assemblies, should be approved by GSA's regional fire protection engineer.
- New fire-rated doors in preservation zones should be designed to resemble historic doors in panel detailing and finish. True-paneled fire doors are preferred for replacement of original paneled stair or corridor doors.

- In historically significant spaces, sprinklers should be carefully placed to minimize damage to ornamental materials. Develop detailed drawings for architecturally sensitive areas, showing precise sprinkler locations and finishing notes as necessary to ensure proper installation. Sprinklers should be centered and placed symmetrically in relation to ornamental patterns and architectural features defining the space, such as arched openings.

- Sprinklers and escutcheons should match original architectural surfaces or hardware. Oxidized brass or bronze heads are recommended for use in deeply colored (unpainted) woodwork. In elaborately decorated ceilings, heads should be camouflaged by custom coating and omitting escutcheon plates. In such cases, low-profile, quick-response sprinklers are preferred.

- In historically significant spaces, smoke detectors should be placed to minimize destruction of ornamental surfaces. Where ceilings are elaborately embellished, explore alternative detection products and approaches such as air sampling detection, projected beams, low-profile spot detectors, recessed installation, or custom-coating detector housings to blend with ornamental finishes. Application of special finish treatments outside of the standard factory process should be coordinated with, and approved in writing by, the manufacturer to ensure that UL labels and detector performance are not compromised. Smoke detector housings should be removed before application of special finishes.

United States Courthouse
Tallahassee, Florida

Built in 1935-36, the courthouse retains its original stair with iron balusters and bronze newel posts. In 1979, the courthouse was listed in the National Register of Historic Places.

7.15 Mass Notification Systems

Mass notifications systems are emergency voice communications systems that can be used to broadcast nonfire emergencies such as severe weather, biological/chemical spills, terrorist acts, etc. to occupants within a single building, to multiple buildings, or throughout a campus. Mass notification systems use audible and visible notification appliances, similar to fire alarm and emergency communication systems, however, the appliances may be used to direct occupants to remain in the building for their safety, rather than evacuate or relocate as they would normally do in a fire emergency.

Mass notification systems may merely be simple extensions to fire alarm and emergency communication systems, involving additional audible and visible devices. This would typically be for systems installed within a single building. Mass notification systems become more costly and complex when installed to serve multiple buildings or a campus, as these installations involve additional wiring, multiple command centers and the possibility of exterior audio and visual devices. Because of these variances, every mass notification system project needs to be evaluated individually, and involve the GSA regional fire protection engineer. It should also be noted that a good time to install a mass notification system is when a new fire alarm system is being installed, since mass notification systems generally use the same equipment contained in a fire alarm and emergency communication system.

Regardless of the scope, a mass notification system must be designed in accordance with NFPA 72. However, the following special requirements take precedence over the requirements in NFPA 72:

- Mass notification system control equipment must be integrated with the fire alarm and emergency communication system control equipment.
- Occupant emergency notification must use fire alarm audio-visual appliances (e.g., speakers and strobes).
- Nonfire alarm notification appliances are permitted to be used for exterior building broadcasting announcements.
- Mass notification systems must have the capability of generating both automatic prerecorded and manual (live voice) emergency messages via the audible notification appliances, including speakers that are installed in elevator cars and exit stairways.
- Live voice emergency messages must override any automatic prerecorded message.
- Mass notification messages are permitted to over-ride the fire alarm and emergency communication system if approved by the GSA regional fire protection engineer.
- Visible notification appliances must be the same type as used for the fire alarm system visible notification appliances; however, they must not be identified by the word “fire.”
- Additional means for notifying occupants of a nonfire emergency (e.g., such as emergency message displays, scrolling text message displays, video displays, or text messaging, etc.) are permitted provided they are approved by the GSA regional fire protection engineer.
- The building fire alarm and emergency communication system must have manual over-ride capabilities at the main fire alarm and emergency communication control equipment and USMS Command and Control Center where appropriate. Additional locations are permitted if approved by the GSA fire protection engineer.
- An abnormal condition of a mass notification system component must not adversely affect the performance of the fire alarm and emergency communication system and vice versa.

7.16 Performance-Based Design

GSA encourages the use of performance-based design for new construction and major renovation and alteration projects. Performance-based design is an engineering approach to fire protection design based on established fire safety objectives and functional statements, analysis of fire scenarios, and assessment of designs based on those objectives and functional statements. Performance-based design differs from traditional prescriptive design in that specific methods for achieving compliance with the design intent are established by the design team, subject to the GSA regional fire protection engineer's concurrence, and a life safety solution is developed that is tailored to the specific building, fire, and occupant characteristics contained within the building being assessed. Information on performance-based designs can be found in the International Code Council Performance Code, *Society of Fire Protection Engineers (SFPE) Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings,* and the *SFPE Handbook of Fire Protection Engineering.*

United States Courthouse
Phoenix, Arizona

The atrium smoke exhaust system was designed using a performance-based approach.

7.17 Commissioning Fire Protection and Life Safety Systems

When total building commissioning is required as part of the project, the commissioning process must ensure that the fire protection and life safety systems and equipment installed in a building are in compliance with the owner's project requirements and design intent documents.

The commissioning team must include a fire commissioning agent (FCxA) to perform all fire protection and life safety commissioning activities. The FCxA must be separate, both by contract and employment, from the A/E design team.

The FCxA must prepare a written commissioning plan that identifies the processes, procedures, methods, and documentation for each phase of the commissioning process for all types of active and passive fire protection and life safety systems from concept through post-occupancy. The completed commissioning plan, including all appendixes, must form the commissioning record turned over at the end of the construction phase. The commissioning plan must be continuously updated by the FCxA throughout the predesign, design, construction, and occupancy phases of the building life cycle. At a minimum, the commissioning plan must include:

- Commissioning scope and overview specific to the project
- General project information
- Commissioning team members, roles, and responsibilities
- General communication plan and protocol
- Commissioning process tasks and activities through all phases
- Commissioning schedule
- Required commissioning process documentation and deliverables
- Required testing procedures
- Recommended training

The following materials must be added, as applicable, to the appendix of the completed commissioning plan:

- Owner's project requirements
- Basis of design
- Commissioning specifications
- Design review
- Submittal review
- Issues log
- Construction checklists
- Site visit and commissioning meeting minutes
- Systems manual review
- Training
- Functional performance and seasonal testing procedures
- Warranty review
- Test data reports
- Sequence of operation (matrix)

The FCxA must assist the design team fire protection engineer in the development of the construction contract specifications to align the actions of the construction contractor with the commissioning plan, addressing all involved tests, special inspections, and certifications.

All active and passive fire protection and life safety systems must be commissioned including, but not limited to:

- Infrastructure supporting the fire protection and life safety systems within the boundaries of the project
- Fixed fire suppression and control systems
- Fire alarm systems
- Emergency communications systems
- Smoke control and management systems
- Normal and emergency power and lighting systems
- Explosion prevention and control systems
- Fire doors, windows, walls, and other fire- and smoke-resistant assemblies
- Commercial cooking operations
- Elevator systems
- Fire extinguishers
- Means of egress systems and components
- Other passive and active fire and life safety systems and equipment
- Other systems or installations integrated or connected to a fire or life safety system, such as, but not limited to access control, critical processes, and hazardous operations.
- Fire and smoke dampers
- Fire and smoke doors
- Through penetration fire stops
- Fire walls, barriers, and partitions
- Smoke barriers and partitions

For more information on commissioning requirements, see the *Building Commissioning Guide,* available at **http://www.wbdg.org/ccb/GSAMAN/building commissioningguide.pdf.**

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Design Standards for
U.S. Court Facilities

Chapter 8 Design Standards for U.S. Court Facilities

8.1 Goals and Objectives

This chapter refers to program and design issues in an effort to relate the design intent directly to the technical requirements for the building systems and finishes.

This chapter does not cover issues related to selection of audiovisual, data, or telecommunications systems. (These criteria are developed in the *U.S. Courts Courtroom Technology Manual.)* Reference is made to these systems in Chapter 8 only with regard to the electrical service requirements in the areas where they are being installed.

The following complementary documents provide comprehensive programming and design criteria for U.S. Court facilities.

Design Guidance

U.S. Courts Design Guide (USCDG)

This publication focuses on the functional program requirements, Court and court-related adjacency relationships, finish materials, and specific performance criteria for acoustics, environmental systems, including special heating, cooling, and lighting requirements. The USCDG also addresses security, telecommunications, and audio-visual design requirements.

The USCDG includes a tabular comparison of funding responsibilities for all components of the courthouse and court functional space. (This information is organized into budget requirements for GSA, judiciary, and the judiciary-related executive branch agencies.)

The USCDG refers to technical information related to performance criteria to help illustrate the rationale for the requirements and to establish the standard for level of quality.

U.S. Marshals Service Criteria

Criteria for space controlled by the U.S. Marshals Service (USMS) is found in *Requirements and Specifications for Special Purpose and Support Space Manual* (USMS Publication 64). Use the latest version including all volumes and addenda. This publication provides the finish criteria for USMS functional program requirements, spatial relationships, electronic and physical security, and hardware standards and special HVAC requirements within the U.S. Courts and court-related spaces.

The USCDG and USMS Publication 64 speak directly to the functional requirements of the user and tenant. Chapter 8 presents the most cost-effective and efficient building systems and materials to achieve the appropriate environment from the perspective of the building owner (GSA) by reference to applicable technical standards, security standards, and life safety and accessibility requirements.

The USMS Publication 64 standards are complementary documents to both the USCDG and this chapter. These documents establish, in detail, the environmental, security, functional, and technical requirements for the USMS spatial accommodations within U.S. courthouses. They include information regarding secure environments for prisoners being held in preparation for a court appearance, USMS staff facilities, and general building security requirements. GSA is responsible for power to the electronic security devices, but the design consultants should understand that the USMS security contractor provides detailing and environmental requirements related to security within the functional area dedicated to the courts. Chapter 8 indicates general requirements, but the USMS Publication 64 is the standard the A/E must follow.

8.2 General Requirements

Planning for Future Requirements

The master plan for each courthouse facility is intended to accommodate 30 years of growth, and the design of the initial phase of construction must provide the spatial requirements for 10 years.

The conversion of general office or other support spaces to courtroom use will potentially put greater demands on the HVAC, electrical, and communications systems. These systems will require expansion capacity and space for additional equipment related to the future courts in the initial building design. Historic courthouses require special considerations. For guidance on renovation of historic courthouses, consult with the regional historic preservation officer. Accessibility ramps should be installed in historic buildings, unless such ramps will result in substantial loss of historic material. Under exceptional conditions, an application for a waiver may be made for a temporary ramp.

Planning for Accessibility

All U.S. Court facilities must be accessible to persons with physical challenges.

The detailed functional aspects of each courtroom component include an integrated reference to accessibility accommodation within the description of Courtroom Requirements in chapter 4 of the USCDG.

The following information is intended only as a summary of the basic circulation, change in elevation, and spatial requirements that must be addressed at each respective component with regard to accessibility for individuals with physical challenges.

Design for accessibility must comply with the requirements of the Architectural Barriers Act Accessibility Standard (ABAAS).

GSA and judiciary policy requires all Federal courtrooms have the lectern, counsel tables, witness stands, and jury boxes accessible in the original design, and the judge's bench, clerk's station, and other court personnel workstations adaptable for accessibility, regardless of local or State code.

ABAAS requires a totally accessible interior route from the point of entry to all areas of a building used by the public. The design elements affected by this requirement include:

- Vestibule configuration
- Door sizes and pressure of operation
- Corridor widths
- Elevator access and control
- Toilet room and stall dimensions
- Telephone and TTY (text telephone) provisions
- Drinking fountain location and dimensions
- Visual and audible alarm accommodations
- Signage design and location
- Quantity of accessible seating
- Ramps or platform lift access to all raised seating

Access to all raised areas in courtrooms must be by platform lifts or permanent ramps. If platform lifts are provided, they must be an integral part of the architecture of the courtroom. Bench areas must be designed to accommodate this equipment, including structural slabs with a shallow pit for the lift platform.

U.S. Court facilities have several conditions that are unique to Federal building planning and design. There are provisions within the courtroom for fixed millwork to include elevated platforms for judges, witnesses, clerk staff, reporters, and jurors. In addition, design of spectator seating areas must consider visitors with physical challenges, including individuals with sight and hearing difficulties. (All areas of the courtrooms must accommodate listening systems for the hearing impaired, and translators, note takers, and interpreters for the visually disabled.)

Table 8-1 outlines the accessible standards that apply specifically to courts and highlights instances where policy or preferences developed by GSA, in conjunction with the Judicial Conference of the United States, differ from ABAAS. Adaptability requires that dimensional consideration be included in the original design to incorporate accessible elements at a later time. Wherever ramps or platform lifts are provided for access to a raised area, railings must be provided as required.

Infrastructure

Electrical outlets, wiring, conduit, or raceways to support sound and visual communication equipment for persons with physical challenges will be provided by GSA. Electrical service may be required for transcription services, telephone handset amplifiers, telephones compatible with hearing aids, closed caption decoders, text telephones (TTYs), or other devices to assist those with hearing or visual impairments.

Acoustic Planning Requirements

Acoustical performance is of the utmost importance in courthouse design. The A/E must include an acoustic consultant who must develop the appropriate information at each stage of the design process to assure the courts and GSA that sound and vibration issues have been properly addressed. Chapter 14 of the USCDG has specific guidance and requirements for the acoustic performance of each courthouse facility space. The design must provide these acoustic requirements. The finished space performance will be tested against these specific requirements. Where detailed criteria are not provided in the USCDG the requirements of P100 will be followed.

William B. Bryant Annex, E. Barrett Prettyman Courthouse Washington, DC

Elegantly finished in four-square paneling, the new courtrooms within the Annex are larger to allow for multi-defendant trials and a variety of furniture layouts.

Table 8-1

Accessibility Requirements

Space	Accommodation
Courtroom	
Circulation routes	Clearance and turning radius for wheelchairs throughout the courtroom.
Public seating	Number of wheelchair spaces and location are set by ABAAS.
Litigant and counsel tables	Height clearance at table(s) and circulation space requirements of ABAAS.
Jury box	One wheelchair space along the general circulation path at the box. (If located on a tier, provide a ramp or lift.)
Witness stand	Comply with clear floor space and maneuvering requirements of ABAAS. Permanent ramp or platform lift to provide access. (Adjacent space is required for an interpreter.)
Judge's bench	Comply with clear floor space and maneuvering requirements of ABAAS. Adaptable for future inclusion of ramp or platform lift. (Electrical service, space, and floor depression must be included in the initial design for future platform lift.)
Courtroom clerk, bailiff, and court reporter stations	Comply with clear floor space and maneuvering requirements of ABAAS. Adaptable for future inclusion of ramp or platform lift. (Electrical service, space, and floor depression must be included in the initial design for a future platform lift.)
Lectern	Include an adjustable platform with a height variation between 710 mm and 760 mm (28 in. and 30 in.) above the floor. Knee space at least 685 mm (27 in.) high. The lectern must be at least 760 mm (30 in.) wide and 480 mm (19 in.) deep.
Jury & Ancillary Facilities	
Jury assembly room	Must be located on accessible route. Refer to ABAAS for number of wheelchair spaces. ABAAS also determines requirements for listening devices, kitchenette-type service units, and associated vending and seating areas.
Jury deliberation rooms	One space at tables. Clearance provided at coat storage and dedicated toilet rooms. Portable assistive listening system (provided by judiciary) may be used if there is more than one deliberation room.
Attorney/witness rooms, attorney work rooms, and conference rooms	Provide proper clearance for circulation and height at tables for wheelchairs.
Grand jury suite	Refer to ABAAS for the number of wheelchair spaces and listening devices. Clearance provided at coat storage, service unit, and toilet rooms. Witness stand with wheelchair turning radius clearance.
USMS Facilities	
Court holding areas	Each classification of holding must have one holding cell accommodating wheelchair clearances and an appropriate toilet plus lavatory in accordance with ABAAS.
Visitor booths and attorney/prisoner areas	At least 5 percent, but no less than 1 percent, of booth/areas must provide clear floor space, maneuvering clearances and counter height dimensions for a wheelchair on both sides in accordance with ABAAS.

8.3 Architectural and Interior Design

This section addresses technical requirements for architectural materials and systems in buildings designed to serve the U.S. Courts. Specific requirements are presented for all special or unique court spaces and court-related agencies, including those to accommodate the U.S. Marshals Service.

General building design concepts for GSA-owned structures are based on an overall "systems" approach, utilizing all design elements of the building, including ceiling cavities, floor cavities created by use of access flooring, stacked vertical distribution cores, and centrally located support areas to increase functionality, improve flexibility for future modifications, and provide buildings that are efficient regarding construction, operation, and maintenance costs.

Building Enclosure Systems

The baseline standard of exterior materials for U.S. Court facilities is precast concrete with limited stone, brick, or other durable materials. Fundamental construction standards for the majority of the exterior building systems are discussed in Chapter 3.

Specific additional provisions for U.S. Court facilities include:

- Vehicular sallyport doors that meet USMS requirements
- Appropriate (ballistic-resistant) glazing at various levels of a facility
- Physical and electronic security design features at vulnerable areas that will decrease risk of attack to occupants or escape of prisoners
- Level of facility as determined by the ISC Facility Security Level Determination of Federal Facilities dated February 21, 2008

Floor Systems

An important issue in the design of GSA-owned structures has been the evaluation and selection of an appropriate floor system, especially with the potential of using the cavity below for the horizontal distribution of power, data, telecommunications, and low-voltage system cabling, and the flexibility to position connections above the floor. Accessible flooring systems can be defined as a suspended floor plane above the structural slab with relocatable modular components. Raised access floor systems for Federal facilities must use a minimum of 150 mm (6 in.) above the concrete deck to allow adequate space for wire management systems and the crossing of large conduits. The requirement for raised access flooring in courthouses is described in Chapter 15 of USCDG.

The height of the accessible floor system must be included in the determination of floor-to-floor dimensions.

Select standard floor finishes within each function of the court facility primarily based on acoustic enhancement, general durability, and ease of access to underfloor electrical, telecommunication, and data distribution systems.

The USCDG contains detailed information on specific requirements for the use of carpet and other floor finish materials under each category of functional space. See Chapter 12 of the USCDG. The USMS Publication 64 contains very stringent requirements for the USMS in all detention-related areas of its facilities.

Interior Wall Systems

Most interior wall partitions will be composed of gypsum board on metal studs, with the exception of USMS detention spaces. There may be instances in the general building construction where concrete masonry is used if building elements, including elevator or plumbing shafts, are stacked systematically floor upon floor.

Ceiling Systems

The USCDG outlines all of the appropriate interior finishes for U.S. Court-related spaces.

Chapter 3 of this document outlines the general parameters for selection of a ceiling system in typical office spaces. There are several types of spaces with custom ceiling system requirements, which may include courtrooms, public spaces, office and conference spaces of the courts or other agencies, and detainee areas. In historic buildings, acoustical requirements should be satisfied using removable finishes and features so that original ornamental surfaces may be maintained.

Office and Conference Spaces

In office and conference spaces, flexibility and durability are also the main considerations in the selection of a ceiling system that must accommodate change and accessibility above the ceiling plane. The ceiling material must absorb sound to provide speech privacy and control transfer of noise from machines, computers, light ballasts, and other sources within adjacent office areas.

The use of a standard 600 mm by 600 mm (2 ft. by 2 ft.) suspension system with a commercial-quality acoustic ceiling tile is recommended. The use of this system allows future flexibility in partition arrangement and corresponding relocation of mechanical diffusers, lights, sprinklers, and components of other systems such as speakers and fire alarm notification appliances.

Courtrooms

In courtrooms, acoustic characteristics and aesthetics are the main considerations in the selection of a ceiling system. The ceiling design and materials must enhance the acoustic performance of the well area. (Ideal reverberation time in a courtroom is 0.6 to 0.7 seconds. See Chapter 14 of the USCDG.) This will involve the use of reflective and absorptive materials in the space. At no point in the ceiling design must the highest point exceed the maximum ceiling height requirements in the USCDG.

Public Spaces

In public spaces, the ceiling system must accommodate future changes to the layout of the space and allow access for maintenance of the building systems above and within the ceiling plane, including mechanical systems, diffuser locations, communication devices, lights, and fire protection systems. Acoustic tile in a suspended ceiling grid is typically provided in these areas, along with supplemental use of gypsum wallboard in soffits, perimeter coves, recesses, and reveals.

Detainee Areas

In detainee areas, security and durability are the main considerations in the selection of a ceiling system. Refer to USMS Publication 64 for suggested ceiling materials in these spaces.

Fixed and Movable Furniture

Components to be provided by GSA in U.S. Court facilities include fixed and limited movable furniture and millwork required for the operations of the courts in courtrooms, grand jury rooms, hearing rooms, jury assembly rooms, and public transaction counters. See Chapter 12 of the USCDG.

In general, built-in furniture must be designed with integral cable raceways plus conduits sized for future expansion and change. Built-in furnishings must also include access panels to permit easy cable and wiring changes. Provisions for power, data, and telecommunications outlets and inputs, and sound and other systems must be confirmed during the design development phase of the project on a position-by-position basis. Courthouse furniture must meet a variety of needs, and selection must consider function, cost, availability, and aesthetic criteria. The selection and design of fixed and limited movable furniture must be carefully coordinated to achieve a consistent image, proper function, and required clearances.

The movable furniture provided by GSA in the U.S. Court facilities are lecterns and counsel tables for courtrooms.

Typical provisions for movable furnishings in U.S. Courts are indicated in tables provided for each category of space use in the USCDG. All items to be provided by GSA within the baseline rent charges are assumed to be included within the anticipated construction budget.

Refer to USMS Publication 64 for a detailed description of USMS fixed and movable furniture requirements in U.S. Court facilities.

Table 8-2 outlines the basic fixed furniture elements that are provided for all court-related functions.

Wayne Lyman Morse U.S. Courthouse
Eugene, Oregon

The seating in this courtroom consists of minimalist armless wood benches.

Table 8-2

Typical Interior Fixed Furniture Elements

Space	Type of Furniture Element	Space	Type of Furniture Element
Courtroom	Judge's bench (See AO publication *U.S. Courts Design Reference Manual* 2007) Deputy clerk desk (Adaptable for computer and printer) Court reporter/Recorder desk Witness box Fixed base chairs for jury and one not fixed Spectator rail and seating Jury box Spectator benches	Library Spaces	Standup counter and stacks
		Probation and Pretrial Services Entrance and Urinalysis Testing Toilets and Lab	Standup counter (break resistant windows) Toilet with mirror
		Bankruptcy Appellate Panel Clerk	Intake counters
		District and Bankruptcy Public Areas	Public counters and workstation
Grand Jury Room	Bench Witness stand Jury rails	USMS Detention Cells	Benches Modesty screen
Judge's Chambers Suite	Kitchenette-type serving unit with sink (cabinets above and below) Built-in book shelves	USMS Prisoner/Attorney Interview Room	Counter Stool (Prisoner side)
Judge's Robing Room	Lockers for robes	USMS Reception/ Cashier Area	Service counter
Judge's Private Toilet and Judge's Robing Room Toilet	Vanity, mirror, and medicine cabinet	USMS Staff Locker Rooms (Men's and Women's)	Lockers and benches Grooming shelf and mirrors Metal lockers Hooks or open closet rod and shelf for coats
Jury Assembly	Check-in counter Coat closet with rods Kitchenette-type serving unit (cabinets above and below)	USMS and CSO Work/Mail Room	Base cabinets Work surface Shelving
Jury Areas	Toilets with vanity and mirror Kitchenette-type serving unit Coat closet with rods	Central Mail Facilities	Personal protection equipment storage, counter sink with eye wash

Signage and Graphics

Many Federal courthouses are large, complex structures requiring clear and coordinated systems of signage and way-finding that allow first-time users to locate their destination as quickly and directly as possible.

A standardized system of signage, with interchangeable components, must be provided throughout the courthouse. ABAAS guidelines are specific about parameters of design, including location, size, color, and tactile qualities of signage and use of graphic symbols to assist nonreaders.

In addition to providing all general building identification and way-finding signage, GSA supplies all court-related signs in public corridors of the building. Signage requirements within the courts' dedicated space, related to their function, are provided by the courts. See Chapter 13 of the USCDG. GSA supplies signs for life safety and public convenience (restrooms) within the functional areas of the courts. The A/E is responsible for designing all GSA-supplied signage and graphics.

For installation of signage in historic buildings, the A/E must consult with the regional historic preservation officer regarding the integration of signage in the historic facility or district.

The following signage must be furnished by GSA under the A/E design contract, and any remaining requirements will be determined and provided by the courts:

Identification and Information Signage

- Building identification/seal/cornerstone
- Division/department, tenant agency identification
- Courtroom/room/area identification
- Special function identification—library, media center, cafeteria, etc.

Directional Signage

- Main directory at building entrance—graphic plan
- Floor directory on each floor—graphic plan
- Directory of building occupants with suite locations
- Directional signage for building access by persons with physical challenges
- Directional signage for parking/restricted entrances
- Directional signage for service vehicles

Regulatory/Security Signage

- Signage for core functions—restrooms, stairs, telephones, and other elements on ABAAS-accessible path to building services
- Signage for controlled access areas—judicial and staff areas; if admission to controlled areas is based on acceptable identification, instructions for operating the call button/camera must be provided at the controlled door
- Signage for dedicated systems/facilities—elevators, stairs, staff restrooms (identification as dedicated and regulations for use must be stated)
- Signage for special locking arrangements

8.4 Structural Systems

General Requirements

The selection of the primary structural system for a new U.S. Court facility must be based on a variety of functional, technical, and load criteria. Whatever system is selected, the building must be planned with the longest logical clear spans (spacing between columns) consistent with design to prevent progressive collapse, and simplified structural framing to provide flexibility for modification/adaptation to accommodate areas of special use, including future courtrooms. (If space is dedicated to future courts, the column layout must not disrupt internal sightlines of the courtrooms.)

Design of the courtrooms and court-area structural configuration must respond to the needs for electrical and data/telecommunications systems and their related horizontal/vertical distribution network.

An important consideration for a structural design is the number and size of floor slab penetrations required in court areas for initial and future renovation.

Other Structural Design Requirements

Floor-to-floor heights must provide adequate space under raised access floors to allow for all systems within the floor cavity to be placed without interference with each other and to have adequate access for maintenance.

Floor-to-floor heights must be designed to provide sufficient space above the ceiling assembly to allow for all systems within the ceiling cavity to be placed without interference with each other and to have adequate access for maintenance.

Floor-loading capacities must be planned to accommodate initial and planned future loads, particularly in areas near building cores that can serve as special high-service zones.

Adequate floor structural capacity must be provided to accommodate the secure, solid-filled, reinforced security walls wherever they may occur in the dedicated USMS space.

Adequate roof structure must be provided to carry general personnel and equipment loads, and to accommodate additional loads for antennas, satellite dishes, and window washing equipment.

Special structural capacity must also be provided in the following areas of U.S. Court facilities:

- Court library stack areas (headquarters, satellite, and unstaffed): 7.2 kPa (150 lb/sf) live load capacity.
- Moveable shelving live loads must be determined by reference to International Building Code requirements in the location where construction is taking place. The minimum loading for these areas is 14.4 kPa (300 lbs/sf).
- Design floor loads of the USMS space as required by USMS Publication 64.
- Clerk of the Court file storage area must be designed to accommodate high-density file storage as identified by the court.

8.5 Mechanical Systems

This section focuses on technical requirements for the mechanical engineering systems that should be provided in buildings designed to serve the U.S. Courts. Specific requirements are presented for all special or unique spaces used by the U.S. Courts and court-related agencies, including spaces designed to accommodate the U.S. Marshals Service.

Federal court facilities must be designed to take advantage of integrated systems and controls to provide better building performance through energy conservation, economy of operations, maintenance, and flexibility for changes. Opportunities for system integration must be evaluated throughout the design process.

U.S. Court facilities require a variety of space types, each with its own set of specific requirements. In addition, court functions require flexibility in the time of operation and control of dedicated HVAC systems. See Chapter 15 of the USCDG.

System Selection and Design

All criteria in this section are mandatory.

HVAC Specific Design Criteria

- Outdoor winter temperature equal to ASHRAE 1-percent design dry bulb and coincident wet bulb.
- Outdoor summer temperatures equal to ASHRAE 99-percent design dry bulb/97.5 percent wet bulb.
- Indoor air in courtrooms: 24° +/- 1°C (75° +/- 2°F) in summer and 22° +/- 1°C (72° +/- 2°F) in winter.
- Maintain 45 to 50 percent relative humidity for summer conditions and 25 to 35 percent relative humidity for winter conditions.
- All materials and methods of construction used to protect through penetrations and membrane penetrations of horizontal assemblies and fire-resistance-rated wall assemblies must meet the requirements of the International Building Code.
- Do not use duct lining. Ductwork must be acoustically designed as described in Chapter 5 of the P100 and Chapter 15 of the *Courts Design Guide.*
- HVAC systems must be designed to provide optimum flexibility in scheduling the use of courtrooms and chamber areas.

General Criteria

The selection of the HVAC systems, equipment, and source of energy must be in accordance with the guidelines and procedures established in Chapter 5. A life cycle cost (LCC) analysis must be conducted to ensure selection of the most cost-effective alternative environmental considerations.

The HVAC system must be designed to provide 23.4°C (74°F) in judges' chambers, courtrooms, and trial jury suites on average. The courtroom HVAC system must be designed so that courtroom thermostats can be reset from the building automation system to precool the courtrooms to 21.1°C (70°F) before scheduled occupancy.

Trial jury suites (when located adjacent to a courtroom), judges' chamber suites (when located adjacent to a courtroom), attorney/witness rooms, attorney work room, and courtrooms must be placed on the same system with separate zones having related thermostats and the design must account for variation in occupancy load.

Humidification must be provided as specified in Chapter 5. See Chapter 15 of the USCDG.

Mechanical systems will provide 5.7 cubic meters (20 cubic feet) per minute as a minimum per person in all occupiable areas of U.S. Court facilities.

The HVAC systems must be zoned in such a manner that the requirements of the special areas can be satisfied by efficient use of the systems and equipment.

To allow flexible and efficient use of the HVAC systems for hours of activity occurring at times other than standard building operations and to satisfy specific requirements in a U.S. Court facility, the central plant equipment (chillers, boilers, cooling towers, pumps, air handling units (AHUs), etc.) must be designed using redundant equipment of various sizes to satisfy the requirements of differing number and sizes of zones. (The goal is to service no more than two courtrooms per air handling unit.)

Piping systems must allow arrangements to permit changing courtroom HVAC systems from primary to secondary chilled water for off hours.

The HVAC design must allow submetering of utilities and equipment to permit the facility manager to allocate cost of operation beyond standard hours of operation.

The HVAC system design for the courtroom, judge's chamber suite, and the jury deliberation room, which compose a single "court set," must be designed to allow the HVAC system to operate after standard building operations hours in an efficient manner.

The design must include winter humidification for areas in the building with custom millwork.

Courtrooms/Chambers

Temperature and Systems Control

The HVAC system serving judges' chambers, courtrooms, and trial jury suites must provide an average temperature of 23.4° (74°F). The courtroom system zone must be designed to allow thermostats to be reset from the building automation system to precool to 21.1°C (70°F) before scheduled occupancy.

Air Distribution (See Chapter 15 of the USCDG)

Three HVAC zones must be provided: one for the judge and attorney areas; a second for the jury areas; and a third for the spectator area.

The diffusers serving the spectator areas must be sized to serve the allowable seating capacity, plus 25 percent, to accommodate extra seating. The diffusers must be selected to meet minimum ventilation requirements at no loads, with no appreciable increase in system noise during load changes.

A minimum air exchange per hour: Appellate Judges' EnBanc and Panel, Special Proceeding Courtrooms 6-8; District, Magistrate and Bankruptcy Judge's courtrooms 8-10 (See Chapter 14 of the USCDG). Six air changes per hour must be provided for rooms with a ceiling height up to 4.6 meters (15 ft.) and eight air changes per hour for rooms with a ceiling height greater than 4.6 meters

(15 ft.). Systems must be designed to meet these requirements when spaces are fully occupied, unless otherwise noted.

The maximum percentage of recirculated air must not exceed 85 percent.

If the courtroom is served by a fan system dedicated to more than one courtroom, the return air from each courtroom and its associated areas must be ducted directly to the unit.

Return air from the chamber suites must be ducted directly toward the return air shaft for a minimum distance of 4.5 meters (15 ft.). Ductwork will be treated to meet the acoustical courtrooms/chambers design criteria.

Jury Facilities

System Description and Control

Trial jury suites should be served from the same system as the associated courtrooms. A separate thermostat for each trial jury room is desirable.

Air Distribution

Air distribution systems in the jury facilities must provide separate temperature control and a high degree of acoustical isolation, particularly in the grand jury and trial jury rooms. Ductwork will be treated to meet the acoustical deliberation room design criteria.

Air Changes

In the jury assembly suites, trial jury suites, grand jury suites, and libraries, the system must provide 10 air changes per hour (ACH) with 80-85 percent return.

Refer to USMS Publication 64 for all detention requirements.

Expansion Capability

Since U.S. Court facilities should be expected to have a long, useful life, new construction and renovation projects must be planned to provide adequate mechanical and electrical capability to the site and building(s) to support future additions. It is particularly important to design the systems for specialized areas of the building (lobby, food service, mechanical rooms, electrical rooms) to support the anticipated 30-year needs of the occupants.

This can be accomplished by building additional space for future growth of the HVAC systems during initial construction and temporarily allocating it to building or tenant storage.

The A/E must locate equipment adjacent to the building perimeter wall that will abut future expansion for orderly tie-in to new system components.

Acoustic Performance

Acoustic performance must be a major consideration in the selection of HVAC equipment. Systems serving the courtrooms and auxiliary spaces must be designed with sound attenuation to provide consistent and acceptable sound levels. This is particularly critical in the design of court facilities that require extensive use of sound and audiovisual equipment for recording and presentations.

To control noise during all modes of operation and for all load conditions, the HVAC system should be provided with one or more of the following:

- Sound traps
- Low-velocity, low static-pressure fan systems
- Special low-noise diffusers

If air is returned by the ceiling plenum, special attention should be given to the location of any partitions extending to the floor structure above and to the acoustical treatment of the required penetration of these partitions for return air.

HVAC equipment, including AHUs and variable air volume (VAV) boxes, must not be located in close proximity to courtrooms, jury rooms, and chambers. The minimum distance should be 7.6 meters (25 ft.) between AHU and courtrooms. (Refer to Chapter 5, Theaters and Auditoriums, for criteria regarding maximum duct velocity.) General system design must provide appropriate treatment of mechanical supply/return ducts to minimize sound and voice transfer from courtrooms, chambers, jury deliberation spaces, and witness rooms to surrounding areas.

Noise criteria (NC) (the limits that the octave band spectrum of noise source must not exceed) must range from 25 to 30 in courtrooms. (See Chapter 14 of the USCDG). For sound level maintenance, the courtroom must be served by constant volume air supply. The system must also support variable outside air requirements and variable cooling loads. Air ducts serving the trial jury and grand jury suites must be double-walled sound-attenuating ducts for a length of at least 3.7 meters (12 ft.) from the diffuser or return air intake.

Mechanical System Diffusers and Vents

Mechanical system diffusers and grills in public and staff areas must be secure from tampering, particularly in areas that provide some degree of seclusion and privacy (restrooms, attorney-client visitation rooms, etc.). Maximum-security detention-type grilles, secured with tamper-proof fasteners, must be provided at all areas accessible to prisoners. (Refer to USMS Publication 64 for more information.)

Changes in Building Envelope to Meet Energy Guidelines

Due to the energy load requirements of court facilities, designers must use the alternative design processes of ASHRAE 90.1R to meet Federal energy guidelines for overall building energy usage. Increases in building envelope energy resistance must be used to compensate for higher-than-average load requirements resulting from court functions. Total building energy usage must be established according to calculations using mandatory design standards contained in Chapter 5. To demonstrate the same total energy usage, a new calculation must be done, incorporating factors for energy reduction strategies to offset increased lighting, cooling, and heating energy loads.

Information Technology System Loads

Information technology systems are not the largest source of heat within the office spaces, but may be the largest sources in other areas. Information technology systems may be the most uncertain source of heat flows during design phases; therefore, the HVAC system must be planned with capacity and control to accommodate the need for constant temperature and humidity environments 24 hours a day, where systems hardware could be placed.

The design of the HVAC systems must take into consideration provisions for separate units for critical areas such as computer rooms, USMS control room, elevator machine rooms, etc., which generate additional heat loads. The HVAC design for these areas must have redundancy and be connected to the emergency power system.

8.6 Fire Protection and Security Systems

Refer to Chapter 7, Fire Protection and Life Safety, for all fire protection and life safety system requirements.

All security systems must be connected to emergency power. In addition, any security hardware (e.g., electronic locks, card readers, magnetic locks, etc.) that is installed on exit doors and exit access doors must meet the requirements of the National Fire Protection Association 101, with regard to function, design, operation, and maintenance. This includes, but is not limited to, any security hardware being installed on exit stair doors, building perimeter exit doors, and elevator lobby enclosure doors, as well as any door in the means of egress.

Pioneer Courthouse
Portland, Oregon

Completed in 1875, the Pioneer Courthouse is the oldest extant Federal building in the Pacific Northwest and is designated a National Historic Landmark.

In 2002, GSA undertook a major rehabilitation to modernize its systems and to restore and maintain the elegant features of the original building design.

8.7 Electrical Systems

GSA will provide emergency and secondary power distribution as a basic requirement.

Normal building distribution systems must be designed to comply with Chapter 6. They must include a special electrical distribution system consisting of an isolation transformer with associated branch circuit distribution equipment, and must be designed to serve the data network system and associated equipment supporting nonlinear loads.

Uninterruptible power systems (UPS) must be provided to serve security, emergency smoke evacuation, and any other critical systems and be connected to the emergency power distribution system. Additional systems must be provided by the tenants for any specific tenant related requirements.

Spare Capacity

General design requirements for office and courtroom areas must be based on anticipated loads and requirements as outlined in Chapter 6. The capacity of the feeders serving all areas of the building must accommodate growth to the extent shown in the 30-year long-range plan for the facility.

Number of Outlets

The number of outlets provided in U.S. Court facilities must be in accordance with Table 8-3, electrical codes, and good practice.

Lewis F. Powell U.S. Courthouse
Richmond, Virginia

Visitors to the building follow a carefully orchestrated entry sequence and circulation pattern that fosters a sense of ritual suited to the country's highest courts. The experience is accentuated by the arrival into a soaring, seven-story atrium.

Table 8-3

Electrical Power Requirements/Outlets*

Location	Equipment/Outlets	Notes
Courtrooms		
Judge's Bench	Isolated ground quadriplex receptacle for general purpose use; Duplex receptacle for computer, monitor; additional duplex receptacle for video arraignment.	
Courtroom Lobby	Duplex outlet with dedicated circuit for portable magnetometer. Branch circuits will be provided for additional loads dictated by the courts.	
Court Deputy Clerk Workstation	One isolated ground quadriplex receptacle (general use) and one duplex receptacle for PC and monitor per clerk position.	Printers as a group.
Court Reporter/ Recorder's Workstation	One quadriplex receptacle (general use), one duplex receptacle for reporter's computer/CRT.	Provide additional duplex receptacle(s) at alternate CR position(s) in the courtroom.
Witness Box	One duplex receptacle and one dedicated outlet.	
Jury Box	One quadriplex receptacle for general purpose use.	Mounted on inside of jury box enclosure.
Attorney Tables	One quadriplex receptacle (general use). Recessed floor box.	Per attorney table position.
Appellate Judge's Courtroom Clerk	One isolated ground quadriplex receptacle (general use) and one duplex receptacle for PC and monitor.	Printer.
Spectator Seating	One isolated ground duplex outlet at front rail ("bar") for computer/monitor for CRT or other use.	Mounted on spectator side of rail enclosure.
Equipment Room/Area	Multiple outlets (as required) for sound, assisted listening system (ALS), data, telecommunications, and video recording and presentation equipment.	
Other	Duplex outlets at 20 ft. intervals along the walls of courtroom. Duplex outlets at two locations (minimum) in front of bench millwork. Additional outlets at appropriate locations for ceiling-mounted screen, fixed or movable positions for slide projector, video monitor, video recorder, interactive white-board and image copier, and x-ray viewer equipment. Locate underfloor boxes for multiple possible locations of a lectern and alternative locations for attorney tables. Provide additional outlets for initial/future location of video cameras. Provide outlet for wall-mounted clock. Provide outlet(s) for ALS unit(s). Provide outlets as required for video conferencing/arraignment equipment, video monitors/VCR equipment, security, and so on.	The courtroom well will have a suspended access floor system for flexible location of outlets.

*This table is comprehensive, but may not be complete as needs and systems change over time and from court to court. These requirements are in addition to those in Chapter 6.

Table 8-3

Electrical Power Requirements/Outlets (continued)

Location	Equipment/Outlets	Notes
Court Support		
Witness Waiting Rooms	Distributed convenience outlets, including provisions for cleaning and housekeeping.	
Attorney/Witness Conference	Distributed convenience outlets, including provisions for cleaning and housekeeping, and for audiovisual equipment (monitor/VCR).	
Public Waiting Areas	Distributed convenience outlets, including provisions for cleaning/housekeeping. Provide outlets for clock. Duplex outlet with dedicated circuit for magnetometer outside sound lock.	
Media Room(s)	Distributed convenience outlets, including provisions for cleaning equipment and motor loads. Provide separately metered power outlets for news agencies telecast equipment.	
Court Reporter Office	One isolated ground quadriplex receptacle (general use). Duplex outlet(s), two minimum, for PC, monitor, printer, FAX.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Judges Shared Conference/Reference Room(s)	Distributed convenience outlets. Provide isolated ground outlets as required for video conferencing/arraignment equipment, video monitors/DVR equipment, security, sound-system, ALS and other equipment, based on anticipated locations of equipment.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Judicial Chambers		
Judge's Chambers	Quadriplex receptacle for general purpose use. Two duplex receptacles for miscellaneous uses (TV monitor, slide projector use, etc.). Two isolated ground duplex receptacles for PC, monitor, printer and other computer equipment. Additional duplex receptacle for video arraignment and FAX equipment where required (initial/future use).	Duplex outlets for PC and monitor positions to be located in multiple positions (based on likely furniture placement). Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Secretary/ Judicial Assistant	One quadriplex receptacle (general use). Duplex isolated ground outlets, two minimum, for PC, monitor, printer, FAX.	
Law Clerk Office	One quadriplex receptacle (general use). Duplex isolated ground outlet(s), two minimum, for PC, monitor, printer, FAX.	Computer and office equipment (PC, monitor, printer) not in FF&E budget
Work Area	Quadriplex receptacle for general purpose use. Duplex outlets for coffee machine, microwave unit, refrigerator, based on equipment/furniture layouts. Additional outlet(s) for copier.	Equipment not included in base building budget. Refrigerator included in FF&E budget. Other equipment (PC, monitor, printer, FAX, copier, etc.) not in FF&E budget.

Location	Equipment/Outlets	Notes
Conference/Reference General	Provide isolated ground outlets for video conferencing, TV monitor, projectors. Distributed convenience outlets in reception/waiting and general office areas. Provide outlets for outlets for floor-cleaning equipment and motor loads. Provide outlets as required for video conferencing/arraignment equipment, security, sound-system, ALS or other equipment, based on anticipated locations of equipment.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Service Unit	Distributed convenience outlets.	Coffee maker, microwave, refrigerator
Trial Jury Suite(s)		
Jury Deliberation Room	Distributed convenience outlets, including provisions for cleaning/housekeeping. Outlets (GFI) on separate circuit for kitchen type service unit equipment (microwave, coffee maker). Isolated ground outlets for film/slide projection equipment, TV monitor and DVR, audio tape recorder/player. Outlet for wall-mounted clock.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Other areas	Distributed convenience outlets, including provisions for cleaning/housekeeping.	GFI in toilet areas, per codes.
Grand Jury		
Witness Box	Duplex receptacle.	
Jury Seating	Convenience outlets, including provisions for cleaning equipment and motor loads.	
Court Reporter's Workstation	One quadriplex receptacle (general use), one isolated ground duplex receptacle for reporter's computer/CRT.	Provide additional duplex receptacle(s) at alternate court reporter position(s), if applicable.
Attorney Tables	One quadriplex receptacle (general use). Recessed floor box, if appropriate. Foreperson: one quadriplex receptacle (general use).	Recessed floor box, if appropriate.
Other areas	Distributed convenience outlets, including provisions for cleaning/housekeeping.	GFI in toilet areas, per codes.
General	Distributed convenience outlets, including provisions for cleaning/housekeeping. Outlets (GFI) on separate circuit for kitchen type service unit equipment (microwave, coffee maker). Outlets for film/slide projection equipment, TV monitor and VCR, audio tape recorder/player. Outlet for wall-mounted clock. Power for sound, video system, if any.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.

Table 8-3

Electrical Power Requirements/Outlets (continued)

Location	Equipment/Outlets	Notes
Jury Assembly		
Jury Assembly Room	Distributed convenience outlets. Provide isolated ground outlets as required for video conferencing equipment, video monitors/DVR equipment, security, sound-system, ALS, and other equipment, based on anticipated locations. Provide outlets for use at carrels and tables for jurors for personal use.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Jury Clerk Workstation(s)	One quadriplex receptacle (general use). Duplex isolated ground outlet(s), two minimum, for PC, monitor, printer, FAX.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Other Area(s)	Distributed convenience outlets, including provisions for cleaning equipment/motor loads.	
Law Library		
Circulation Desk	Isolated ground outlets for PC, other equipment. Distributed convenience outlets.	
Public Waiting Areas	Distributed convenience outlets, including provisions for cleaning/housekeeping.	
Entry Control	Isolated ground outlets for security equipment. Distributed convenience outlets, including provisions for cleaning/housekeeping.	Recessed floor box, if/as required.
Staff Offices	One quadriplex receptacle (general use). Duplex isolated ground outlet(s), two minimum (for PC, monitor, printer, FAX) per workstation.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Staff Work Areas	Distributed convenience outlets; quadriplex receptacle(s) for general purpose use. Additional outlet(s) for copier.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
CALR Areas	Duplex isolated ground outlet(s), two minimum (for PC, monitor, printer, FAX) per workstation.	Recessed floor box, if/as required.
Carrel/Casual Seating Areas	Distributed convenience outlets. Provide outlets for use at carrels and tables.	
Conference/Group Study/Work Rooms	Multiple outlets (as required) for sound, ALS, data, telecommunication and video recording and presentation equipment. Duplex outlet for microfiche machine.	

Location	Equipment/Outlets	Notes
Clerk of Court Areas		
Public Counter and Workstations	One quadriplex receptacle (general use); duplex isolated ground outlet(s), two minimum, for PC, monitor, printer, FAX, per workstation. Provide additional outlet(s) for cash registers, additional printers, shared-access PCs, printers.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Records Exam Areas	Provide duplex outlet(s) for public access PCs, monitor, printer, and FAX equipment. Provide outlet(s) on separate circuits for public access copier(s).	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Other Staff Workstations	One quadriplex receptacle (general use). Duplex isolated ground outlet(s), two minimum, for PC, monitor, printer, FAX.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Shared Staff Work Areas	Distributed convenience outlets; quadriplex receptacle(s) for general purpose use. Additional outlet(s) for copier(s), FAX equipment, etc.	Computer and office equipment (PC, monitor, printer) not in FF&E budget.
Staff Break Rooms	Distributed convenience outlets, including provisions for cleaning/housekeeping. Outlets (GFI) on separate circuit for kitchen type service unit equipment (microwave, coffee maker).	Equipment not included in base building or FF&E budget.
Court-Related Agencies/Spaces		
	Similar to Court Clerk/Court Administrative areas above.	

Notes

1. For all electrical power and outlet requirements in USMS dedicated spaces, refer to USMS Publication 64.
2. The power outlet requirements for each project should be verified.

Areas that require battery backup to maintain camera and direct visual surveillance in the event of power failure include:

Vehicular sallyports

Prisoner sallyports and secured circulation

Detention cell block areas

Communications centers

Prisoner processing areas

Squad rooms

Public reception rooms

Prisoner-attorney interview rooms

Court holding cell areas

Judges' chambers

Interconnecting doors from public corridors to controlled corridors

Command and control centers

Courtrooms

Witness/Attorney rooms

Restricted circulation

Grounding

Provide grounding as indicated in Chapter 6.

Isolated Ground Circuits

Most courthouse computers and data/telecommunication equipment will not be connected to the building backup emergency generators or UPS system. To minimize this type of equipment operational and performance problem, it is necessary to mitigate the amount of electrical disturbance that this type of equipment will be subjected to. All courthouse desks and work areas should be provided with regular power receptacles as well as an isolated ground (IG) power receptacle. IG power systems are especially designed to minimize electrical disturbances, thus only computers and data/telecommunication should be connected. All other types of equipment including task lighting, heaters, radios, photocopiers, and vacuum cleaners should be connected to the regular power receptacles.

Below-Floor Electrical Distribution

Most areas of the courthouse incorporate below-floor horizontal distribution systems. Final horizontal distribution plans must be designed considering potential EMI/RFI sources. (Access floor areas must comply with Chapter 6.)

Emergency and UPS Power Systems

In addition to the emergency power systems required in Chapter 6, provide backup power to systems described in Chapter 15 of the *Courts Design Guide.*

Service and Distribution

Emergency and normal electrical panels, conduits, and switchgear must be installed separately at different locations. Electrical distribution must also run at separate locations.

Exterior Connection

Conduit and feeders must be installed on the exterior of the building to allow use of a trailer-mounted generator to connect to the building's electrical system. This must be regarded as a tertiary source of power for systems in the building where operational continuity is critical. (An operational plan must be in place to provide this service quickly when needed.)

Emergency power must be derived from generators sized to carry the required loads. Generators must be synchronized to serve a common distribution board which, in turn, serves appropriate automatic transfer switches (ATSs) and the fire pump. Separate ATSs must be provided for the life safety/security system, UPS system, and essential systems. Essential systems will serve the ventilation and equipment loads required for personnel and building protection in the event of a commercial power failure or other catastrophic event.

Coordination with Telecommunications System Design

Electrical IG power distribution for the various areas of U.S. Court facilities must be coordinated with the design of the telecommunications powering/grounding systems to improve the overall integrity of the telecommunications utility. See Chapter 15 of the USCDG.

As technology continues to increase in speed/performance, better distribution coordination becomes necessary. If this is not done, the grounding systems will not operate efficiently at the higher frequency ground currents, reducing the integrity of the telecommunications utility, creating errors in transmission, etc.

A secure, air-conditioned data/telecommunications closet must be located near the judges' chambers, courtrooms, and court offices to contain network equipment. The use of cable trays rather than conduits must be considered.

Lighting Systems

Illumination levels, lighting types, and lighting controls in specific court functional areas are provided in the USCDG. See Chapter 15 of the USCDG. In all other spaces, illumination levels and lighting controls must be provided as specified in Chapter 6. Task lighting must be variable to 100 FTC (1100 lx).

The lighting system should have good color rendition and avoid bright spots on the ceiling plane. Modulation of lighting should be used to distinguish the courtroom well and spectator areas. The A/E must provide fixtures with accurate color rendition and avoid the use of metal halide fixtures. The use of indirect pendant-mounted fluorescent fixtures provides good, soft diffuse general lighting in a courtroom, complemented with recessed concentrated light sources at the judge's bench, the witness box, and attorneys' tables. Lighting levels must consider the impact on courtroom finishes.

An override switch will be located at the judge's bench and at the courtroom deputy clerk station to allow an instantaneous override of all dimming controls in an emergency.

The following lighting controls can be specified depending on the size of the courtroom, lighting arrangements, and lamp types:

- A more complex lighting installation consisting of local, wall, box-type, electronic, silicon-controlled rectifier dimmers; or
- Remote electronic dimmers with preset lighting arrangements, for large courtrooms with high ceilings.

Control of lighting is the responsibility of the courtroom deputy clerk or another designated court officer and must be operated with a key. Light switches must not be accessible from the spectator seating area or witness box. Provision of integrated electronic controls must be considered with preset lighting schemes having integrated controls for shading devices at windows and skylights, plus controls for presentation screens (if provided by the courts). The controls must allow varying levels of light to suit the needs and desires of the courtroom participants.

Electronic ballasts for fluorescent lamps must not be used in areas that contain sensitive security devices or special equipment that is sensitive to electronic interference, such as ALD infrared emitters.

Guidelines for site illumination are specified in Chapter 6. Lighting in parking areas must allow for identification of vehicle color, and the design should avoid the use of low-pressure sodium fixtures.

Emergency lighting for courtrooms and security areas, to include USMS detention facilities, must have built-in batteries plus emergency generator service.

Audiovisual Requirements in U.S. Court Facilities

All audiovisual design and technical infrastructure requirements are indicated in the Administrative Office of the United States Courts publication, *Courtroom Technology Manual.* These requirements are provided and funded by the tenant.

8.8 Security Design: Agency Responsibilities

Courthouse security is the joint responsibility of the judiciary, Department of Homeland Security, Federal Protective Service, and USMS. The USMS has the primary role in security decisions. Decisions regarding security planning and design are made by individual agencies and the local Court Security Committee (CSC), or for multitenant buildings, the Facility Security Committee (FSC). See Chapter 16 of the USCDG.

The CSC is responsible for identifying a court's specific security requirements and developing a security plan for judicial facilities and operations throughout the district.

All security systems and equipment must be consistent with requirements in ISC Physical Security Criteria for Federal Facilities and the ISC Security Level Determination of Federal Facilities dated February 21, 2008; USCDG; and *Requirements and Specifications for Special Purpose and Support Space Manual* Volumes 1-3, USMS Publication 64. The CSC must be informed about and have the opportunity to review all security-related design decisions.

The USMS Central Courthouse Management Group's (CCMG) facilities management team is responsible for design considerations involving secure prisoner movement, holding cell and interview facility requirements, and USMS-occupied office and support space. The Judicial Security Systems Team within the CCMG is responsible for the planning, design, and installation of security systems in spaces occupied by the judiciary. The USMS coordinates the work of the security system and security construction contractors.

In addition, the CCMG often acts as security engineer for court buildings, designing and integrating security systems for building perimeters in conjunction with GSA and FPS.

Refer to the USCDG and USMS Publication 64 for a more detailed explanation of security design responsibilities.

Once the functional planning criteria including security-related issues, as outlined in the USCDG and USMS Publication 64, are implemented into the conceptual design for the new or renovated court facility, they are intended to help in the development of the technical drawings, specifications, and other information to incorporate the security components into the project.

A

JOHN M. SHAW U.S. COURTHOUSE
LAFAYETTE, LOUISIANA

ARTIST: DIANA MOORE
ARTWORK: *URNS OF JUSTICE*

Appendix

Appendix Submission Requirements and Resources

A.1 General Requirements

These design submission requirements have been developed to ensure a rational, well-documented design process and to facilitate reviews by GSA staff, tenant agencies, and local regulatory agencies or review boards as the design develops. The submission requirements listed here apply to all projects where design services are performed by architects and engineers under contract to GSA.

These requirements are the minimum standards and the specific A/E scope of work will take precedence on each project.

In each phase of work, project documents must be submitted to GSA in electronic and hard copy format as determined by the GSA project manager.

Drawings

Drawing Size

All drawings of a single project must be a uniform standard size, as designated by the American National Standards Institute (ANSI) below. International Organization for Standardization (ISO) or architectural-sized sheets may also be approved for use.

Designation	Size (in)	Size (mm)
ANSI A	8.5 x 11	216 x 279
ANSI B	11 x 17	279 x 432
ANSI C	17 x 22	432 x 559
ANSI D	22 x 34	559 x 864
ANSI E	34 x 44	864 x 1118

Drawing Lettering

Lettering on drawings must be legible when drawings are reduced to half size and when they are microfilmed. This applies to concept and design development drawings as well as construction documents.

Drawing Scale

All drawings are to be created at full scale and plotted at a selected scale. The drawings or views (such as details) should include numeric and graphic scales. The scale selected should be appropriate for high resolution and legibility to include reduced copies (such as half-sized).

There are nine preferred metric scales: 1:1 (full size), 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, and 1:1000. Other scales may be used as needed (such as 1:2 half full size). Floor plan drawings should be plotted at 1:100 (close to 1⁄8 inch scale).

Architectural floor plans must be dual dimensioned with English units and contain English scales so that spatial data management coordinators can reconcile the drawings with the program requirements.

CAD Standards

The National CAD/CIFM Standards should be obtained from GSA's **www.gsa.gov/cifm** website. These guidelines should be followed for all CAD drawing formatting. Regional CAD standards are available through the Spatial Data Management (SDM) Coordinators and are considered supplements to the national standards. (Refer to the base scale examples in the previous paragraph.)

A north arrow must be included on all site drawings and plan view drawings.

Dimensioning

The millimeter is the only unit of measurement to appear on construction documents for building plans and details for all disciplines except civil engineering, which must be stated in meters. However, building elevation references are stated in meters. Use of millimeters is consistent with how dimensions are specified in major codes. No dimension requires the "mm" label. On the drawings the unit symbol is eliminated and only an explanatory note such as: "All dimensions are shown in millimeters" or "All dimensions are shown in meters," is provided. Whole numbers always indicate millimeters; decimal numbers taken to three places always indicate meters. Centimeters will not be used for dimensioning.

If dual dimensioning is utilized on drawings, SI units must be primary, with English units secondary and in parentheses.

Seals

Each sheet of the construction documents must bear the seal and signature of the responsible design professional. (Specification and calculations cover page only.) Electronic plans may have digital signatures and seals.

Cover Sheet

Provide code certification statement for compliance with specified codes and standards by each discipline with the professional seal and signature. The intent is to formally recognize the responsibility for compliance.

Document Security Requirements

All sensitive but unclassified (SBU) building information must be handled as described in GSA Order PBS 3490.1A, Document Security for Sensitive But Unclassified Building Information, 06/01/2009.

Within any electronic or printed document, pages containing SBU building information must have the following mark imprinted or affixed:

SENSITIVE BUT UNCLASSIFIED (SBU)
PROPERTY OF THE UNITED STATES GOVERNMENT
FOR OFFICIAL USE ONLY
Do not remove this notice
Properly destroy or return documents
when no longer needed

The following mark must be affixed to the cover or first page of any document (such as the cover page on a set of construction drawings) containing pages marked as required by the paragraph above:

SENSITIVE BUT UNCLASSIFIED (SBU)
PROPERTY OF THE UNITED STATES GOVERNMENT
COPYING, DISSEMINATION, OR DISTRIBUTION OF
THIS DOCUMENT TO UNAUTHORIZED RECIPIENTS
IS PROHIBITED
Do not remove this notice
Properly destroy or return documents
when no longer needed

The previous two statements must be prominently labeled in bold type in a size appropriate for the document or portable electronic data storage device or both, if applicable. On a set of construction drawings, for example, the statements must be in a minimum of 14 point bold type or equivalent. The SBU markings must be used regardless of the medium through which the information appears or is conveyed.

The construction drawings, plans, and specifications are to be disseminated only to those requiring the information necessary for design, construction bidding, construction coordination, or other GSA procurement competition processes.

Building Information Model

GSA requires the use of interoperable Building Information Models (BIM) on all projects. During the initial phase, and in support of design reviews during the concept design stage for new construction and modernization projects, BIM models must be a supplement to all existing submission requirements, including PBS CAD Standards. BIM models must be delivered in both native and IFC file formats. For questions or feedback, please email bim@gsa.gov or visit **www.gsa.gov/bim**.

Specifications

Format

Specifications should be produced according to the 2004 edition Construction Specification Institute (CSI) division format. Each page should be numbered. Specifications should be bound and include a table of contents. The specifications must include instructions to bidders and Division 1, edited to GSA requirements.

Editing of Specifications

The A/E is responsible for the editing of all specification sections, including any Government-furnished guide sections, to reflect the project design intent, GSA policy requirements, and Federal law. Technical specifications must be carefully coordinated with drawings to ensure that everything shown on the drawings is specified. Specification language that is not applicable to the project must be deleted.

Dimensioning in Specifications

Domestically produced hard metric products must be specified when they meet GSA guidelines regarding cost and availability; see Chapter 1, General Requirements, Metric Standards, in this document. In the event a product is not available domestically in hard metric sizes, a nonmetric sized product may be specified, and its data will be soft converted to a metric equivalent.

Turnover Documents

Electronic and hard copy documentation on all building systems should be provided for the guidance of the building engineering staff and long-term asset management. Documents should show the actual elements that have been installed, how they performed during testing, and how they operate as a system in the completed facility. Examples are as follows:

- Contractor “redline” as-built drawings and specifications (including building/site actual measurements, changes to details, actual panel schedules, etc.) as required by the construction contract.
- Architect/engineer’s final “record” drawings to include final changes to design and contractor noted as-built conditions.
- Operating manuals with a schematic diagram, sequence of operation, and system operating criteria for each system installed. Custom-written operating manuals; minimum standard should be submission of Word documents.
- Training materials and videos.
- Equipment maintenance manuals with complete information for all major components.

In addition, asset data and documentation, including special data and documentation as to engineering, calculations, record drawing information, and visual media, should be provided to document the configuration, engineering assumptions, actual material/sizes installed for future maintenance, repairs, and improvements. Prior to acceptance for design completion or substantial completion, all required submittals and deliverables must be verified by a Government representative as received and complete, such as:

- Drawings: design, redline, and record drawings
- Submittals, fabrication, and shop drawings, including:
  - Equipment schedules;
  - Equipment (or other) data sheets, product literature, minimum standard should be submission of PDFs, allows for regional supplementation;
  - Equipment inventories, testing, adjusting, and balancing (TAB) reports, and Commissioning functional performance test (FPT) results to be submitted as electronic data tables (Excel or Access files are acceptable), including fields specified in the specifications;
  - BAS point and device data must be submitted as electronic data tables, to include necessary unique identification information such as point numbers, device ID numbers, network numbers, etc., as well as English-language descriptions and location information.
- All test records
- Fire Sprinkler and Alarm Systems: Calculations (including energy, structural, lighting, fire alarm system voltage drops and battery requirements, fire sprinkler hydraulics, etc.)

All electronic media must be in the latest versions and optimum file sizes of desktop media, such as Acrobat, Microsoft, CAD ".dwg" format, video media, electronic photo (e.g., ".jpg"), and Webcam archive data. Electronic data should be provided to the Government on CD-Rom unless otherwise specified.

For all software installed in support of installed equipment, provide backup CDs with all files necessary to reinstall, all user and programming support manuals, and all files produced for the specific installation (e.g., graphics files, DDC program files, etc.).

Note that specification section 01781, Project Record Documents, should be edited to reflect Electronic Final Submittals and Data as noted above.

Design Narratives and Calculations

Format

Typed, bound narratives should be produced for each design discipline.

Content

Narratives serve to explain the design intent and to document decisions made during the design process. Like drawings and specifications, narratives are an important permanent record of the building design. Drawings and specifications are a record of *what* systems, materials, and components the building contains; narratives should record *why* they were chosen. The narrative of each submittal may be based on the previous submittal, but it must be revised and expanded at each stage to reflect the current state of the design.

Calculations

Manual and/or computer based calculations should accompany narratives where required to support technical analysis. Each set of calculations should start with a summary sheet, which shows all assumptions, references applicable codes and standards, and lists the conclusions. Calculations should include engineering sketches as an aid to understanding by reviewers. The calculations for each submittal should be cumulative, so that the final submittal contains all calculations for the project. Calculations submitted at early stages of the project must be revised later to reflect the final design. Calculations must refer to code, paragraph of code used, standards, and text books used for specific portion of calculation. Refer to drawing number where the results of the calculations have been used. Example: number and sizes of re-bars used in reinforced concrete members.

Performance Criteria

As part of the development of concepts through construction documents there must be a check of building performance criteria as noted in Section A.2.

Design Quality Reviews

Design Quality Reviews will be performed by an independent third-party review team at three stages of project design: Final Concepts (FC), Design Development (DD), and Construction Documents (CD). These reviews are sponsored by the Office of Design and Construction and are diagnostic in nature. Using a predefined review process and random sampling techniques, the review teams will evaluate each project for applications of best practices, conformance with criteria, building and systems performance, efficient and effective design, cost drivers, risk factors for successful execution, and customer satisfaction, as well as several other indicators of overall project suitability and readiness to move to the next phase in execution. At each design stage, the design A/E will be required to complete the Design Quality Review Questionnaire and submit it to GSA Central Office along with one complete set of design submittal documents including drawings, specifications, and design narratives. These submittals may be made in electronic form as agreed with GSA on a case-by-case basis.

Energy Analysis

In addition to GSA's goal of USGBC LEED Gold Certification for all new construction and major modernizations, the release of Executive Order 13524 on October 5, 2009, increased the importance of Federal energy goals. An energy analysis must be submitted at the preconcept phase of design and updated throughout the development of the project to continually look for creative ways to reduce energy use. Many opportunities exist for the reduction, recycling, or production of new energy in site, architectural, and building systems design. An energy analysis as described in Section A.6 and in Section 5.3 (Energy Analysis Criteria) is required for each project.

Cost Management Requirements

Cost estimates and market studies must be provided at various stages of the design process in compliance with GSA document P120, Project Estimating Requirements, and the estimating requirements outlined below, with the technical clarification from the GSA estimating staff.

General Requirements

The Government requires that the design team prepare cost estimates at a minimum for the following stages of design:

- Preliminary concept design stage with multiple schemes of design
- Final concept design preceding value engineering
- Final concept design
- Design development documents preceding value engineering
- Final design development documents
- 75% Construction documents
- 90% Construction documents
- 100% Construction documents
- Postaward bid analysis

The cost management services required by GSA are summarized in Table A-1.

Independent Cost Estimates

In order to aid in effective project controls and assist in tracking the budget, GSA will develop two separate independent government estimates (IGE)— one in the Region and another in the Central Office, at a minimum for the following phases of design:

- Final concept design
- Final design development
- 90% Construction development
- 100% Construction development

The design team must provide all necessary documentation for these estimates and be available to support this activity.

Development of the multiple estimates may include the requirement for estimate reviews and reconciliation efforts, as identified in Table A-1.

Cost Estimate Reporting

Cost estimates must be reported in an electronic spreadsheet format. Each of the cost estimate submissions must contain the following, at a minimum:

1. Executive summary
2. Basis of estimate, rationale, assumptions and market analysis, as required in P120
3. GSA Report 3474
4. GSA Report 3473
5. Summary Reports (ASTM UNIFORMAT II and CSI MasterFormat formats as applicable)
6. Detailed line item cost reports

Warm Lit Shell and Tenant Improvements Cost Estimates

The organization of the cost elements must be in accordance with the GSA pricing policy, which calls for a separate tenant improvement (TI) breakdown of all tenant space fit-out identified by the agency.

The estimate must be broken down into 1) Warm-Lit Shell, and 2) Tenant Agency Fit-Out, as defined by the agency in the housing plan and the supporting floor plans. The amortized capital security costs, (i.e., vehicular barriers, secure doors and locks, progressive collapse, blast mitigation and window glazing costs) must be broken down per tenant, as applicable.

Estimates for Campus Development Projects

Projects that reflect campus developments or multiple buildings require cost estimates be developed for each of the individual building or campus components, as reflected in the design documents. The reporting requirements must reflect the individual estimates, as well as a campus summary estimate report.

Postaward Bid Analysis

After award of the construction contract, GSA will provide the A/E 1) the abstract of bids received with an indication of the award amount, 2) a breakdown or verification of contractor prices in the course of contract award, and 3) the contract's approved progress payment schedule.

The A/E must perform an analysis of the contractor planned payment schedule and the independent cost estimate, which reflects the design upon which the construction award is based. The A/E must complete the GSA Form 3472 and submit the form to the GSA Regional Office and Central Office. The GSA Form 3472 must report the construction costs, as awarded, based on the UNIFORMAT Level III subsystem parameters for use in contributing to the GSA, PBS Construction Cost Database, as spelled out in the PBS P120.

Table A-1

Cost Management Matrix

Project Sub-Phase	Estimate Tree Structure: WBS	Detail Level	Summary Level	Estimate Methodology	Notes
Preliminary Concept Submission	UNIFORMAT II	III	II	Parameter	1, 2, 3, 4
Draft Final Concept Submission—Before VE	UNIFORMAT II	IV	II	Parameter and Quantification	1, 2, 3, 4
Final Concept Submission—After VE Implementation	UNIFORMAT II	IV	II	Parameter and Quantification	1, 2, 3, 4
Draft Design Development Submission—Before VE	UNIFORMAT II	V	III	Parameter and Quantification	1, 2, 3, 4, 5, 6, 7
	CSI MasterFormat	V	III		
Final Design Development Submission—After VE Implementation	UNIFORMAT II	V	III	Quantification and Parameter	1, 2, 3, 4, 5, 6, 7, 9
	CSI MasterFormat	V	III		
75% CD	UNIFORMAT II	N/A	III	Quantification and Parameter	1, 2, 3, 4, 5, 6, 8, 9
	CSI MasterFormat	VI	II		
90% CD & 100% CD	UNIFORMAT II	N/A	III	Quantification	1, 2, 3, 4, 5, 6, 8, 9
	CSI MasterFormat	VI	III		
Post-Award Bid Analysis	UNIFORMAT II	III	II	Parameter	10

Note 1. All UNIFORMAT II classification requirements must be in accordance with the ASTM Standard E-1557-05.

Note 2. Services to be any or all of the following: A) cost estimating, B) market studies, C) estimate reviews, D) cost estimate reconciliation meetings, and E) cost estimate revision. Cost estimates are required for all submissions, as dictated by the P120. Estimate reconciliation meetings and estimate revision submissions required when a third-party estimate is prepared, or an estimate review is conducted.

Note 3. If the project is for a campus development, cost estimates, including summary reports, detail reports, and GSA Forms 3473 and 3474, must be prepared for each campus component, building, canopies, and sitework. If a project is phased, a separate estimate must be prepared for each project phase.

Note 4. The organization of the cost elements must be in accordance with the GSA pricing policy, requiring a separation between the building core/shell costs, tenant improvement costs for each tenant, and the amortized capital security costs (i.e., vehicular barriers, secure doors and locks, progressive collapse, blast mitigation and window glazing costs) per each tenant, as applicable.

Note 5. If the detailed drawings and outline specifications are available, provide the CSI MasterFormat cost estimate at the greatest detail that the drawings and specifications would support.

Note 6. The summary of the cost estimate in CSI MasterFormat must correspond with UNIFORMAT Level III as defined in PBS P120.

Note 7. The level of detail of the cost estimate in CSI MasterFormat must correspond with UNIFORMAT Level V as defined in PBS P120.

Note 8. The level of detail of the cost estimate in CSI MasterFormat must correspond with UNIFORMAT Level VI as defined in PBS P120.

Note 9. Unit prices must be broken down into labor, materials, and equipment, as defined in the P120.

Note 10. After the construction contract is awarded, the A/E will analyze bid cost data, including the planned payment schedule, and review the IGE. Upon reviews, the A/E must complete the GSA Form 3472, as identified in the PBS P120, and submit to the Regional and Central Office for use in GSA cost database.

A.2 Performance Expectations Matrices

At the beginning of each project, the GSA project manager, tenants and design A/E need to define the functional objectives of a project. A functional objectives matrix, similar to the one shown in Figure A-1, while not required, may be an effective tool to define these objectives. (Such a matrix may also exist within the project's design programming documents.) By providing a numeric impact weight (e.g., 1-3, where 3 is high) at each intercept, a graphic check list becomes apparent as to which systems/features are most important in delivering a project's performance expectations. The high impact matrix intercepts call for design solutions that will optimize functional interests, consistent with the need to integrate solutions that will support all functional objectives.

High impact intercepts require formal design team technical discussions to help optimize design solutions. These technical discussions must take the form of either a preconcept design charrette and/or a series of design team technical meetings during the concept phase. The technical discussion agenda can

Figure A-1

Program Goals Matrix

		FUNCTIONAL OBJECTIVES							
		Productivity	Sustainability	Security	Seismic	Fire Protection and Life Safety	Accessibility	Historic Preservation	Maintainable
SYSTEMS									
Foundations		1	1	1	3	1	1	1	1
On/Below Grade		1	1	2	3	1	2	1	1
Superstructures		1	1	3	3	2	2	2	1
Enclosure	Walls	2	3	3	3	2	1	3	2
	Window/Doors	3	3	3	2	1	3	3	3
Roofing	Coverings	1	3	2	1	3	1	3	3
	Openings	2	3	2	1	1	1	3	3
Interior Construction	Partitions/Doors	2	2	3	2	3	3	3	2
	Access Floors	3	1	1	2	2	1	1	1
Interior Finishes	Walls	3	2	1	1	2	1	1	2
	Floors	3	3	1	1	2	1	1	3
	Ceiling	3	3	1	2	2	1	1	3
Conveying		2	1	1	2	2	3	1	3
Plumbing		1	3	1	2	2	3	1	3
HVAC	Central Plant	3	3	1	2	1	1	1	3
	Distribution	3	3	1	2	3	1	1	3
Fire Protection		1	1	2	3	3	1	1	1
Electrical	Service/Distribution	2	1	2	3	2	1	1	1
	Lighting	3	3	3	2	2	1	1	3
Equipment		1	1	3	1	2	1	1	2
Furnishings		3	3	1	1	2	3	1	2
Special Construction		1	2	1	2	2	1	1	2
Demolition	Building Elements	3	3	1	1	1	1	3	1
	Hazardous Materials	3	3	1	1	1	1	1	1
Building Sitework	Site Preparation	1	3	1	1	1	2	1	1
	Landscaping	2	3	2	1	1	1	1	3
	Utilities	1	1	1	3	2	1	1	2
Sitework		2	3	1	2	1	3	1	2

be organized by discipline (systems) and/or by functional objective heading, but should address:

- Functional performance goals
- Integrated solution options
- Heading off what can go wrong
- Inspections/certification requirements
- Coordinating construction and turnover-phase issues/deliverables

For both the design concept and design development submissions, the design A/E must identify the attainment of building functional objectives as represented by the matrix. This must take the form of a narrative report that, by system, indicates how the proposed design supports expected building performance.

The Functional Objectives Matrix can be further refined by establishing a matrix for each expectation, e.g., that provided for sustainability, in Figure A-2. While not required, these matrices may help ensure a comprehensive response to functional objectives by breaking down each major function into its component principles/objectives. Sample matrices for productivity, security, and other functional objectives are available upon request through the Office of Design and Construction.

Figure A-2

Sustainability Matrix

		PRINCIPLES/OBJECTIVES					
		Energy	Water	Materials	Indoor Env. Quality	Sitework	O & M
SYSTEMS							
Foundations		1	1	2	1	1	1
On/Below Grade		1	1	2	1	1	2
Superstructures		1	1	2	1	1	2
Enclosure	Walls	3	1	2	2	1	3
	Window/Doors	3	1	1	2	1	3
Roofing	Coverings	3	1	2	3	1	3
	Openings	3	1	1	2	1	3
Interior Construction	Partitions/Doors	1	1	3	3	1	3
	Access Floors	1	1	2	1	1	3
Interior Finishes	Walls	2	1	3	2	1	3
	Floors	2	1	3	2	1	3
	Ceiling	2	1	3	2	1	3
Conveying		2	1	1	1	1	3
Plumbing		3	3	1	1	1	2
HVAC	Central Plant	3	3	2	1	1	3
	Distribution	3	2	1	1	1	3
Fire Protection		1	1	1	1	1	1
Electrical	Service/Distribution	1	1	1	1	1	1
	Lighting	3	1	1	2	2	2
Equipment		2	2	1	1	1	1
Furnishings		1	1	2	2	1	2
Special Construction		1	1	1	1	2	1
Demolition	Building Elements	1	1	2	2	2	1
	Hazardous Materials	1	1	3	3	2	1
Building Sitework	Site Preparation	2	1	1	1	3	2
	Landscaping	3	3	2	1	2	2
	Utilities	1	1	1	1	1	1
Sitework		2	1	1	1	1	1

A.3 New Construction and Modernization

The design process and related submission requirements for new construction and modernizations are somewhat different than those for alteration projects. A modernization is defined as the comprehensive replacement or restoration of virtually all major systems, tenant-related interior work (such as ceilings, partitions, doors, floor finishes, etc.), and building elements and features. The following flow diagram, Figure A-3, and related definitions describe this process for New Construction and Modernization.

Peer Review

The peer review, arranged through the Office of Design and Construction Programs, is required for all new construction projects and any modernization project with significant alterations to the building aesthetic or systems. Designs must be presented to the PBS Commissioner, chief architect, chief engineer, key GSA project team members, and Nationally Selected Peers for approval. The peer reviews occur at all phases of the project to review design concepts, schedule, cost, energy goals, etc.

Figure A-3

Design Process and Related Submission Requirements for New Construction and Modernization

STAGES	ACTIVITIES	SUBMISSIONS
CONCEPTS		
■ Review Space Directive ■ Integrate Expectations into Major Systems and Features	PROGRAM REVIEW DESIGN CHARRETTE PRELIMINARY CONCEPTS (3 or more) VALUE ENGINEERING (Systems Level) COMMISSIONER'S APPROVAL FINAL CONCEPTS	■ Massing Models (New Construction only) ■ Narrative to Include Proposed Building Systems ■ Rendering/Photos ■ Concept Level: Drawings, Narratives/Studies, Calculations, Cost Estimates, Design Quality Review Questionnaire ■ Space Program Statement/Reconciliation
DESIGN DEVELOPMENT		
■ System/Feature Analyses for Selection ■ Final Selection of All Building Systems ■ Intersystem Coordination	PROGRAM REVIEW VALUE ENGINEERING (Analysis Stage) PRODUCTION STAGE PROJECT DIRECTIVE MEETING	■ Architectural Background Drawings Complete ■ Design Development Level: Drawings, Narratives/Studies, Calculations, Cost Estimates, Design Quality Review Questionnaire ■ Concurrence on Narrative for All Building Design Characteristics & Systems ■ Space Program Reconciliation
CONSTRUCTION DOCUMENTS		
■ Presentation of Design in a Format Suitable to Parties Unfamiliar with the Site	PROGRAM REVIEW 75% COMPLETE 90% COMPLETE 100% COMPLETE POSTDESIGN SERVICES	■ Progress Drawings ■ Draft Specifications ■ Narrative Update ■ Current Calculations ■ Final: Drawings, Specifications, Narratives, Calculations, Cost Estimate, Design Quality Review Questionnaire ■ Incorporation of Review Comments ■ Space Program Reconciliation

Design Process Definitions

General

These definitions are for new construction.

Some requirements will be eliminated for a modernization project, such as zoning area, form, massing, etc.

Program Review

Prior to initiating each phase of design, the design team (including the GSA, A/E, and customer agency) must meet to review design program expectations and to exchange ideas, lessons-learned, and concerns.

Such technical "partnering" sessions allow a clearer understanding of expectations, a well defined project scope, and help keep the project on budget and schedule.

Preliminary Concepts

A submission that demonstrates compliance with the Building Program (space tabulation of building program) including all adjacency and functional requirements.

This submission also shows that the proposed project is within the zoning area, and that the building and massing are compatible with the surroundings. The aesthetics should support the design philosophy of GSA shown in the general approach to architecture in the preceding chapters of this document. Building systems and building envelope appropriate for the conceptual designs must be defined in order that they can be evaluated early for effectiveness and efficiency related to operation, maintenance, and energy consumption.

Since there are many options to accomplish these ends with any particular program and site, GSA will participate in the normal design process of comparing options by working with the A/E through Preliminary Concepts. In this phase, the design team should develop their strategy for achieving LEED Gold Certification as defined by the U.S. Green Building Council.

During Preliminary Concepts, three or more concepts must be presented; these Preliminary Concepts are intended to be working level and not presentation documents. They are to be developed only to the level that allows selection of a concept that will still be within program operation and budget goals. This selected concept is to be further refined and presented as the Final Concept by the A/E.

Value Engineering (Systems Level)

Value engineering (VE) is a process that is somewhat continuous throughout the project but its greatest emphasis should be in the early stages of the project (concepts and design development).

GSA policy is to have an independent VE consultant facilitate a value engineering study with an independent team, including participation by the design A/E and the design A/E estimator throughout the study and implementation process. The A/E team must be part of this effort and incorporate the VE consultant's recommendations that were approved by the GSA into the design as part of the scope of work.

Final Concepts

The concept phase study is conducted to focus on the macro level elements of the design. These elements include, but are not limited to, siting, building massing, and environmental and community impacts and concerns. The conceptual phase study workshop is generally of two to four days duration.

For major projects, a presentation is made to the Commissioner of the Public Buildings Service for final approval.

Design Development

This set of submissions reflects a more comprehensive project design developed from the selected final concept design. DD finalizes the selection of all systems with respect to type, size, and other material characteristics.

Systems are not only structural, mechanical, fire protection, and electrical, but include all other building components such as the building envelope (wall, window, and roof), interior construction (flooring, ceiling, and partitions), service spaces, elevators, and so on.

In this phase, the design team should submit a LEED worksheet or comprehensive plan for how the architectural and buildings systems will achieve a LEED Gold Certified building as determined by USGBC.

The design submissions consist of a combination of drawings, narratives, calculations, specifications, and cost estimates. Although final design development plans, sections, and elevations must be to scale, drawings made in the analysis stage to illustrate various options may be freehand.

These submissions are not preliminary construction documents. The approval at the project directive meeting may require that building layout or size changes be incorporated into the construction documents. No design discipline should start work on construction documents until the project directive has been approved.

Life-Cycle Cost Analysis

As specified herein and within programming requirements, life-cycle cost assessments must be made, leading to system/feature selections. Though customer agencies might only look at the first costs of a project, the design team must evaluate life-cycle costs, especially as they relate to sustainable technologies and the GSA energy goals for reducing cost of energy consumption over time. The benefit of life-cycle costs may far outweigh the first costs of a project.

Production Stage

The production stage is the development of each system with supporting calculations and narrative. Plans, sections, elevations, and details showing systems must be included.

Value Engineering (Analysis Stage)

GSA policy is to have an independent VE consultant facilitate a value engineering study with an independent team, including participation by the design A/E and the design A/E estimator throughout the study and implementation process. The A/E team must be part of this effort and incorporate the VE consultant's recommendations that were approved by the GSA into the design as part of the scope of work.

The DD phase VE study is conducted to focus on the subsystem and detail level elements of the design. These elements include but are not limited to the following:

- Material selections
- Specific building systems selection and design
- Proposed design details
- Overall layout options within overall building shell
- Phasing and scheduling plans
- Structural loads and elements
- Major constructibility issues
- Site paving, grading, and utilities

The DD phase study generally takes three to five days. The DD phase study is held after receipt of the draft DD phase submission of the documents. The final design development submission is prepared upon agreement of all implemented VE proposals.

As the project is developed the focus will shift to detailed aspects of the earlier decisions during design development.

- Diagrams, narratives, and sketches with calculations to demonstrate the life-cycle cost effectiveness of the system must be prepared and received during this phase.
- This approach requires a diligent effort and commitment by all project team members early in the project to systems and materials that make sense economically and allow quality and durability.

Project Directive

The report summarizes analysis and design to date at completion of the DD phase. A meeting among GSA, the client, and A/E staff, particularly those who will be working on the construction documents, is held to review the project directive for concurrence.

Construction Documents

This phase requires a detailed set of documents coordinated by all disciplines into one coherent document to become the basis for a construction contract. The construction documents should include all levels of detail drawings from site planning to construction details, as well as specifications, cost estimates, and calculations.

Site Analysis and Preliminary Concepts

Requirements

The preliminary concepts submittal consists of three or more distinctly different architectural design schemes presented in sketch format (single line, drawn freehand to scale), along with massing models, site slides and photographs, and sufficient narrative to allow comparison and selection of a design direction for preparation of a final design concept.

Site Survey

If a survey is part of the scope of work for the project, see Appendix Section A.5 for requirements.

The information requested in subparagraphs 1 and 2 may be in progress and not yet complete. Present site sketches as appropriate.

Drawings

1. Site location plan [at least 2 kilometers (1.25 miles) around site], showing:

a. Site relative to location of city center, major landmarks, major parking facilities, major roads, and airport

b. Location of subway stations and other mass transit links

c. Location of distinct land use types and districts in the vicinity of the site (e.g., historic districts, retail nodes, civic districts, etc.)

2. Existing site plan (at least one block around site), describing:

a. Site boundaries, approximate topography, existing buildings, setbacks, and easements

b. Climatic conditions including path of sun

c. Description of flood plain issues related to building location and mechanical and electric equipment

d. Location of on-site and off-site utilities

e. Natural landscape

f. Pedestrian and vehicular circulation (include direction of traffic on adjoining streets)

g. Neighboring land uses, existing and planned

3. Site plans for each design scheme, showing:

a. Building location and massing

b. Building expansion potential

c. Parking and service areas

d. Description of local plans for surrounding area, relation of each concept to those plans, and summary of relevant recommendations from local officials

4. Floor plans, showing at a minimum:

a. Entrances, lobbies, corridors, stairways, elevators, work areas, special spaces, mechanical rooms for major equipment and air handlers, and service spaces (with the principal spaces labeled). Dimensions for critical clearances, such as vehicle access, should be indicated.

5. Building sections (as necessary), showing:

a. Floor-to-floor heights and other critical dimensions

b. Labeling of most important spaces

c. Labeling of floor and roof elevations

6. Photographs

a. Minimum of six 8 x 10 photographs showing the site and elevations of existing buildings (or landscape, as applicable) surrounding the site

7. Models

a. Massing models of each architectural design scheme on a common base. (No fenestration should be provided at this stage of design development.)

8. Narrative

a. Site statement, describing:
  i. Existing site features
  ii. Climatic conditions
  iii. Topography and drainage patterns
  iv. Any existing erosion conditions
  v. Wetlands and locations of flood plains
  vi. Surrounding buildings (style, scale)
  vii. Circulation patterns around site

b. Site access
  i. Noise/visual considerations
  ii. Local zoning restrictions
  iii. Federal Aviation Administration requirements
  iv. Hazardous waste
  v. Pollution

c. Historic preservation considerations, if applicable
  i. Site photographs, showing contiguous areas and affected preservation zones
  ii. Existing major site utilities
  iii. Potential archeological artifacts

d. Description of each architectural design scheme, explaining:
  i. Organizational concept
  ii. Expansion potential
  iii. Building efficiency
  iv. Energy considerations
  v. Advantages and disadvantages

e. Sustainable design considerations
  i. Potential for incorporation of renewable energy systems in the design
  ii. Potential use of geothermal systems

f. Mechanical system and strategy to comply with P100, Chapter 5 and with the assigned energy goal in Section 1.9.

g. Fire protection design considerations

h. Security features

i. Code statement. Provide a brief statement from each design team discipline member regarding the code requirements that relate to the site and occupancy use. For example, items such as, but not limited to: classification of construction and occupancy group(s), fire resistance requirements and general egress requirements, etc., would be prepared by the design team fire protection engineer.

j. Preliminary concept phase cost estimates
  i. Provide a UNIFORMAT cost estimate for each proposed design scheme submitted
  ii. Cost estimating must be in accordance with the P120 and Table A-1 in this document
  iii. Provide separate estimate for phased work, or bid alternates/options
  iv. Verify that each design scheme presented can be constructed within the project budget

k. Space program statement/reconciliation—provide in metric and imperial units

l. Preliminary energy analysis for compliance with the assigned energy goals for each architectural concept in accordance with Section A.6

m. Art in architecture statement. Provide statement defining the integration of art in architecture. At a minimum identify the location for the proposed art concept.

n. A description of any deviation from the PBS P100.

Final Concept

Site Planning and Landscape Design

The following information must be complete for the final concept submittal of all buildings. (If materials produced for the preliminary concepts submittal do not require modification, such materials are acceptable for this submission.)

Site Plan

(At least one block around site), describing:

1. Site boundaries, approximate topography, existing buildings, setbacks, and easements
2. Building orientation with respect to path of sun
3. Building massing and relationship to massing of surrounding buildings
4. Future building expansion potential
5. Location of on-site and off-site utilities
6. Grading and drainage
7. General landscape design, showing location of major features
8. Pedestrian and vehicular circulation (include direction of traffic on adjoining streets)
9. Parking and service areas
10. Fire protection, water supplies, fire hydrants, and fire apparatus access roads

Narrative

1. Description of site and landscape design final concept
2. Demolition, if required
3. Circulation
4. Parking
5. Paving
6. Landscape design
7. Irrigation, if any
8. Utility distribution and collection systems
9. Method for storm water detention or retention
10. Landscape maintenance concept
11. Fire protection, water supplies, fire hydrants, and fire apparatus access roads
12. Accessibility path for the physically disabled
13. Summary of consultation with local officials regarding site and architectural design and the design's response to relevant recommendations

Architectural

1. Drawings

a. Demolition plans, if required

b. Floor plans, showing at a minimum:
- i. Work areas, lobbies, corridors, entrances, stairways, elevators, special spaces, and service spaces (with the principal spaces labeled). Dimensions for critical clearances, such as vehicle access, should be indicated.
- ii. Office areas must show proposed layouts down to the office level of detail verifying the integration between the approved program and the building concept is achievable.

c. Proposed interior layouts showing:
- i. Open office plan
- ii. Enclosed office plan
- iii. Indicate how major mechanical and electrical equipment can be removed/replaced

d. Elevations of major building facades, showing:
- i. Fenestration
- ii. Exterior materials
- iii. Cast shadows

e. Elevations of major interior spaces, showing:
- i. Lobby/atrium
- ii. Typical public elevator lobby
- iii. Typical courtroom elevations

f. Building sections (as necessary), showing:
- i. Adequate space for structural, mechanical and electrical, telecommunications, and fire protection systems
- ii. Mechanical penthouses
- iii. Floor-to-floor and other critical dimensions
- iv. Labeling of most important spaces
- v. Labeling of floor and roof elevations

2. Color rendering [Minimum size must be 600 mm by 900 mm (24 in. by 36 in.).]

3. Photographs

a. Four 200 mm by 250 mm (8 in. by 10 in.) color photographs, mounted, identified, and framed of the rendering or model image (showing at least two vantage points). In addition, provide for all building elevations (at least one vantage point per each elevation).

b. Two of the photographs are to be sent to the GSA project manager.

c. Provide two additional 600 mm by 900 mm (24 in. by 36 in.) photographs of the rendering for the GSA project manager. (For courthouse projects only.)

4. Model

a. Provide a model of the final concept with sufficient detail to convey the architectural intent of the design.

5. Calculations

a. Acoustical calculations, including noise transmission through:
- i. Envelope
- ii. Interior walls, floors (including raised floors), and ceilings
- iii. Mechanical and electrical equipment

b. Heat transfer through and dew point locations in building envelope

c. Toilet fixture count analysis

d. Illumination, daylighting, and glare analysis

e. Passenger and freight elevator analysis

f. Loading dock analysis

g. Energy analysis in accordance with Section A.6.

6. Narrative

a. Architectural program requirements
- i. Show in tabular form how the final concept meets the program requirements for each critical function.
- ii. A revised description of any deviation from P100.
- iii. Description of final concept, explaining:
  - (1) Expansion potential
  - (2) Building floor efficiency

b. Location and sizes of mechanical equipment rooms for accessibility, maintenance and replacement of equipment (including cooling towers and emergency generators)

c. Conveying systems design (passenger and freight elevators, escalators)

d. Loading docks

e. Thermal, air leakage, and operational performance and maintainability of the building envelope

f. Design strategy to attain the assigned energy goal

g. Treatment of historic zones, if applicable

h. Operations and maintenance goals (exterior and interior window washing, relamping, etc.)

i. Sustainable design concepts (LEED strategy)

j. Vertical transportation analysis (passenger and freight elevators and escalators)

k. Code analysis
- i. The Code criteria must be reviewed by each design team discipline member to the degree of detail necessary to assure that tasks accomplished in this phase meet all the Code requirements.
- ii. A Code/Criteria analysis must be prepared by each design team discipline member that documents an investigation of the applicable codes and agency criteria that will govern the design of a specific project. This analysis should alert the Government to any conflicts in the project's design criteria so that they can be resolved early. The analysis should also provide a common perspective for the design and review of the project. This analysis is probably most critical in building modernization and repair/alteration projects.

Historic Preservation

8.5 in. x 11 in. report, signed by qualified preservation architect, including:

1. Narrative

a. General: Project purpose, scope, groups, and individuals involved

b. Existing conditions, describing:
   i. Overall building size, configuration, character
   ii. Project location
   iii. Existing original materials and design, relevant alterations

c. Preservation design issues and prospective solutions, including:
   i. Location of new work/installation: visibility, impact on historic finishes
   ii. Compare options for preserving/restoring historic materials and design
   iii. Identify further study required to avoid adverse effects as applicable

2. Photographs

a. General and detail views showing existing conditions at affected preservation zones, keyed to plan showing location and orientation of each view

b. Captions identifying location, subject, condition shown

3. Drawings

a. Reduced to 8.5 in. x 11 in., 11 in. x 17 in. foldout or placed in cover pocket

b. Site and floor plans, as applicable

c. Sketches or schematic CAD drawings (elevations, plans) showing preservation design concepts

Structural

1. Drawings

a. Framing plans of the proposed structural system showing column locations, bay sizes, and location of expansion and seismic joints

2. Narrative

a. Identification of unusual local code requirements

b. Code compliance statement

c. Name of model building code followed

d. Building classification

e. Identification of region of seismicity, wind speed, etc.

f. Identification of special requirements, such as high-rise

g. For new buildings:
   i. Statement certifying that the structural engineer has reviewed the building configuration for blast, seismic, and hurricane adequacy, and the criteria in PBS P100 have been met. The structural engineer and the architect must sign this statement.

Mechanical

For the system approved and selected from the three concepts, provide the following:

1. Drawings

a. Demolition plans, if required

b. HVAC Systems
   i. Floor plan(s):
      (1) Identification of equipment spaces for mechanical equipment
      (2) Location of mechanical equipment, including size, weight, access to loading docks and freight elevators, and clearance requirements for operation, maintenance, and replacement
   ii. Flow diagram(s):
      (1) Air flow riser diagrams representing supply, return, outside air, and exhaust systems
      (2) Water flow riser diagrams of the main mechanical systems in the mechanical room(s) and throughout the building

c. Plumbing Systems
   i. Floor plan(s):
      (1) Proposed building zoning and major piping runs
      (2) Locations of proposed plumbing fixtures and equipment
   ii. Systems schematics and flow diagrams

2. Narrative

a. HVAC

A written narrative describing the selected mechanical systems and equipment, including:
   i. Indoor and outdoor design conditions for all spaces under occupied, 24-hour, and unoccupied conditions
   ii. Ventilation rates, dehumidification, and pressurization criteria for all spaces under occupied, 24-hour, and unoccupied conditions
   iii. Equipment capacities, weights, sizes, and power requirements
   iv. Description of heating, cooling, ventilating, and dehumidification systems for each major functional space
   v. Description of heating, cooling, ventilating, and dehumidification control strategies for each air handling system under occupied, 24-hour, and unoccupied conditions
   vi. Fuel and utility requirements
   vii. A code compliance statement

b. Plumbing
   i. Description of proposed plumbing systems, including domestic cold and hot water, sanitary and storm drainage, and irrigation
   ii. Evaluation of alternate sources for preheating of domestic water (solar or heat recovery)

c. Calculations and energy and water analyses
   i. Building heating and cooling load calculations
   ii. Psychrometric calculations for HVAC systems at full load and partial loads. (Partial loads at 50% and 25%, and unoccupied periods)
   iii. Energy consumption calculations and analysis in accordance with Section A.6
   iv. Water consumption calculations and analysis including make-up water for HVAC systems, domestic water consumption, and water consumption for irrigation
   v. Fuel consumption estimates

3. Specifications

a. Table of contents identifying specifications to be used on the project

Fire Protection

Fire protection and life safety submission requirements must be identified as a separate Fire Protection section as outlined in this document.

1. Drawings

a. Plans showing
   i. Equipment spaces for fire protection systems (e.g., fire pump, fire command center, etc.)
   ii. Fire protection water supplies, fire hydrant locations, fire apparatus access roads, and fire lanes

2. Narrative

a. Description of the building's proposed fire protection systems including the egress system

b. Code compliance analysis
   i. The design team fire protection engineer must prepare an analysis of the applicable codes and agency criteria that will govern the design of the specific project. For example, items such as, but not limited to classification of construction and occupancy group(s), rating of structural components, fire resistance requirements, interior finish, occupant load calculations, exit calculations, identification of areas to receive automatic sprinkler systems and/or automatic detection systems, smoke control systems, etc. would be prepared by the design team fire protection engineer as necessary to provide a complete fire protection and life safety analysis for the final concept.

Electrical

1. Drawings

a. Plans showing equipment spaces for all electrical equipment to include: panels; switchboards; transformers; uninterruptible power supply (UPS); and generators

2. Narrative

a. Description of at least two potential electrical systems

b. Describe the proposed lighting and lighting control system

c. Proposed special features of electrical system

d. Code compliance statement

Certification Requirements

The architect/engineer (lead designer) must certify that the concept design complies with the program requirements, PBS P100, GSA's energy goals, Federal energy goals, and local regulatory agencies and review boards.

In bullet form, identify how proposed design features will support performance expectations of the project. Expectations are identified in the project's design program and within the Functional Objectives Matrix, Figure A-1.

Final concept energy analysis, in accordance with Section A.6.

Life-Cycle Cost Analysis

A life-cycle cost analysis of three options for the various building systems under design and evaluation that have been modeled should be included with this submittal.

Final Concept Cost Estimate

A cost estimate must be provided, as required in the P120 and in accordance with the P100.

The final concept estimate submission must include the following:

- Executive summary
- Basis of estimate, rationale, assumptions, and market analysis as required in P120
- GSA Report 3474, GSA Report 3473
- Summary reports (ASTM UNIFORMAT II and CSI MasterFormat formats as applicable)
- Detail line item cost reports
- Core/shell and TI cost estimate, as per GSA pricing policy. TI estimates must be prepared for each tenant.
- Provide separate estimates for phased work, or bid alternates/options.
- To ensure the project is developing on-budget, a list of cost-saving items that would collectively reduce the project cost to approximately 10 percent below budget.
- Verify that the final concept can be constructed within the project budget.

A life-cycle cost analysis of three options for the various building systems under design and evaluation that have been modeled should be included with this submittal.

Design Development

Site Planning and Landscape Design

1. Calculations

a. Site storm drainage combined with building storm drainage and sanitary sewer calculations
b. Storm water detention calculations, if applicable
c. Parking calculations, if applicable
d. Dewatering calculations
  i. Calculations modeling dewatering rates during dry and wet season excavation. Calculations must take into account effect of dewatering on adjacent structures and improvements.
  ii. Calculations must assume a specific shoring system as part of a comprehensive excavation system.

2. Narrative

a. Site circulation concept, explaining:
  i. Reasons for site circulation design and number of site entrances
  ii. Reasons and/or calculations for number of parking spaces provided
  iii. Reasoning for design of service area(s), including description of number and sizes of trucks that can be accommodated
  iv. Proposed scheme for waste removal
  v. Proposed scheme for fire apparatus access and fire lanes
b. Site utilities distribution concept
  i. Brief description of fire protection water supplies
  ii. Brief description of fire hydrant locations
  iii. Drainage design concept
c. Landscape design concept, explaining:
  i. Reasoning for landscape design, paving, site furnishings, and any water features
  ii. Reasoning for choice of plant materials
  iii. Proposed landscape maintenance plan and water conservation plan
  iv. Brief operating description of irrigation system
d. Site construction description
  i. Brief description of materials proposed for pavements and utilities
e. Code analysis
  i. The code criteria must be reviewed by each design team discipline member to the degree of detail necessary to ensure that tasks accomplished in this phase meet all the code requirements.
  ii. Identify local zoning and all building code requirements and provide a complete analysis as they pertain to the project.

3. Drawings

a. Demolition drawings, if required
b. Site layout plan, showing:
  i. All buildings, roads, walks, parking, and other paved areas (including type of pavement)
  ii. Accessible route from parking areas and from public street to main facility entrance
  iii. Fire apparatus and fire lanes
c. Grading and drainage plan, showing:
  i. Site grading and storm drainage inlets, including storm water detention features
d. Site utilities plan, showing:
  i. Sizes and locations of domestic and fire protection water supply lines, sanitary sewer lines, steam/condensate lines, and chilled water supply and return lines, if applicable
e. Landscape design plan, showing:
  i. General areas of planting, paving, site furniture, water features, etc.
  ii. Irrigation plan, if applicable

Architectural

1. Calculations

a. Acoustical calculations, including noise transmission through:
  i. Envelope
  ii. Interior walls, floors (including raised floors), and ceilings
  iii. Mechanical and electrical equipment
b. Heat transfer through dew point locations in building envelope
c. Toilet fixture count
d. Illumination, daylighting, and glare
e. Passenger and freight elevator analysis
f. Loading dock analysis
g. Energy analysis in accordance with Section A.6

2. Narrative

a. Building concept, explaining:
  i. Reasons for building massing, entrance locations, and service locations
  ii. Building circulation and arrangement of major spaces
  iii. Interior design
  iv. Adherence to the building preservation plan, if applicable
  v. Energy conservation design elements
  vi. Water conservation considerations
  vii. Explain how all these design considerations are combined to provide a well integrated cohesive design concept
  viii. Analysis of refuse removal, recycled materials storage and removal, and maintenance requirements
b. Building construction description, explaining:
  i. Structural bay size
  ii. Exterior materials, waterproofing, air barriers/ vapor retarders, and insulation elements
  iii. Roofing system(s)
  iv. Exterior glazing system
  v. Interior finishes, with detailed explanation for public spaces
c. Potential locations for artwork commissioned under the Art in Architecture program, if applicable
d. Use of recycled materials
e. Sustainable design concepts and LEED strategy

f. Review of project for code compliance
   i. Code criteria should be reviewed by each discipline to the degree of detail necessary to assure that tasks accomplished in this phase meet the code requirements.
   ii. For major alterations, provide a determination whether an accessible floor is needed.

g. Building maintenance, explaining:
   i. How unique and tall architectural spaces such as atriums or grand staircases will be cleaned, have their light fixtures maintained, have interior and exterior glass surfaces cleaned and typical maintenance performed.
   ii. How courtrooms, dining facilities, and other assembly spaces with fixed seating, multilevel spaces, or with sloped floors will have their ceilings, lights, and other ceiling elements maintained and repaired.
   iii. Proposed scheme for window washing equipment
   iv. Consideration and prevention of bird nesting on exterior surfaces
   v. How major mechanical and electrical equipment can be serviced and/or replaced in future years giving the necessary dimension clearances

h. Describe the project-specific security design
   i. Report verifying the current design's compliance with the approved space program. Any deviations must be clearly reported. Report in metric and English units.

j. Curtain Wall Report
   i. In projects with complex curtain wall systems, describe size and locations of major movement joints to accommodate structural drift due to seismic and/or wind loading. Describe proposed curtain wall attachment methods to accommodate these lateral movements.
   ii. Describe water migration
   iii. Describe exterior fire safety systems, if applicable
   iv. Describe typical interfaces between exterior wall system and interior finishes
   v. Describe interfaces between major enclosure assemblies such as glass curtain wall to precast or stone panels
   vi. Identification of at least three suppliers that can provide proposed exterior wall system
   vii. Address any requirement for blast resistance in the context of "Windgard" simulations and/or blast testing results, as provided by the Office of Design and Construction

k. Design development energy analysis, in accordance with Section A.6

l. Building keying: Report must fully define the keying hierarchy for the entire building incorporating various levels of access, security, and fire egress. A/E should coordinate with GSA fire safety engineer for keying.

m. Signage Report: Signage system and room numbering system must be integrated with keying system.

n. Provide two finish boards for both public and tenant interior areas and two finish boards of exterior finishes composed of actual material samples and color coded plans, sections, and elevations of major space showing their use.

3. Drawings

a. Demolition drawings, if required

b. Building floor plans, showing:
   i. Spaces individually delineated and labeled
   ii. Enlarged layouts of special spaces
   iii. Dimensions
   iv. Planning module

c. Building reflected ceiling plans, showing:
   i. Enlarged layouts of special spaces
   ii. Spaces individually delineated
   iii. Materials labeled
   iv. Ceiling heights labeled
   v. Lighting fixture types indicated and scheduled

d. Building roof plan, showing:
   i. Drainage design, including minimum roof slope
   ii. Dimensions
   iii. Membrane and insulation configuration of the roofing system
   iv. Mechanical equipment rooms and their relationship to freight elevators

e. Elevations, showing:
   i. Entrances, window arrangements, doors
   ii. Exterior materials with major vertical and horizontal joints
   iii. Roof levels
   iv. Raised flooring and suspended ceiling space
   v. Dimensions

f. Interior elevations, showing:
   i. Lobby, atrium
   ii. Public corridors
   iii. Jury assembly room
   iv. Grand jury
   v. Restrooms
   vi. Chambers
   vii. Typical public elevator lobby
   viii. Typical courtroom elevations
   ix. Typical tenant corridors
   x. Typical conference rooms

g. One longitudinal and one transverse section, showing:
   i. Floor-to-floor dimensions
   ii. Stairs and elevators
   iii. Typical ceiling heights
   iv. General roof construction

h. Exterior wall sections, showing:
   i. Materials of exterior wall construction, including flashing, connections, method of anchoring, insulation, vapor retarders, and glazing treatments
   ii. Vertical arrangement of interior space, including accommodation of mechanical and electrical services in the floor and ceiling zones

i. Proposed room finish schedule, showing:
   i. Floors, bases, walls, and ceilings
   ii. Finish schedule may be bound into narrative
   iii. Perspective sketches, renderings and/or presentation model, if included in the project scope
j. Proposed site furniture, showing:
   i. Site furniture cut sheets or photos
   ii. Proposed locations
k. Diagrams illustrating the ability to access, service, and replace mechanical/electrical equipment showing the pathway with necessary clearance
l. Location of accessible pathways and services for the physically disabled
m. Placement of Art in Architecture elements
n. Design of typical building signage, including wayfinding and room identification, building directory, exterior building signage, and major interior building identification

4. Photographs

a. Two sets of 200 mm by 250 mm (8 in. by 10 in.) photographs for:
   i. rendering or model image (if changed from concept submission)
   ii. elevation views for all exposures (if changed from concept submission)

Historic Preservation

8.5 in. x 11 in. report, signed by qualified preservation architect, including:

1. Narrative

a. Cover page: Building name, address, project title, project control number, author (preservation architect), preservation architect's signature, date of submission
b. General: Project purpose, scope, groups and individuals involved, substantive changes to approach described in concept submission
c. Existing conditions, describing:
   i. Overall building size, configuration, character
   ii. Project location
   iii. Existing original materials and design, alterations
   iv. New findings from testing or analysis in concept phase
d. Preservation solutions explored, how resolved and why, including:
   i. Location of new work: visual impact, protection of ornamental finishes
   ii. Design of new work/installation: visual and physical compatibility with existing original materials and design; materials/finishes chosen
   iii. Methods of supporting new work/installation
   iv. Preservation and protection of historic materials during construction through tenant move-in
e. Effects, describing:
   i. How project will affect the building's architecturally significant qualities
   ii. Measures proposed to mitigate any adverse effects on historic materials or design
f. Photographs
   i. General and detail views showing existing conditions at affected preservation zones, keyed to plan showing location and orientation of each photo view
   ii. Captions identifying location, subject, condition shown

2. Drawings

a. Reduced to 8.5 in. x 11 in., 11 in. x 17 in. foldout or placed in cover pocket:
b. Site and floor plans, as applicable
c. Elevations, plans, and section details showing preservation design solutions for each issue identified, as approved by regional preservation officer

Structural

Design report containing structural design criteria and the following information:

1. Calculations For any computer-generated results, submit a program user's manual, a model of the input data, and all pertinent program material required to understand the output. A narrative of the input and results for computer-generated calculations for the recommended structural concept should be contained in the calculations as well.

a. Gravity load and lateral load calculations, with tabulated results showing framing schedules
b. Foundation calculations
c. Calculations showing that the system is not vulnerable to progressive collapse
d. Vibration calculations
e. Blast calculations

2. Narrative

a. Code criteria should be reviewed by each discipline to the degree of detail necessary to ensure that tasks accomplished in this phase meet the code requirements.
b. Comparative cost analysis of at least three potential framing systems
   i. The analysis should compare first costs based on the design of a typical cross-section of the building, one interior column bay in width, including a comparison of lateral load-resisting elements. Nonstructural building systems that have a bearing on the overall cost of the systems must be included. For example, in a comparison between steel and concrete systems, the cost of fireproofing the steel structure must be considered, if fireproofing is required by code.

ii. The analysis should include a brief narrative listing factors that may have a bearing on the final selection, such as the availability of local labor skilled in the erection systems, speed of construction, and other concerns.

c. Description of recommended structural concept, including:
   i. Choice of framing system, including lateral load-resisting elements, and proposed foundation design
   ii. Verification of adequacy of all assumed dead and live loads

d. Identify all code requirements and provide a complete analysis as it pertains to this project including but not limited to:
   i. Required fire-resistance rating of structural elements
   ii. Summary of special requirements resulting from applicable local codes

e. Proposed methods of corrosion protection, if applicable

f. Geotechnical engineering report, including boring logs (if part of scope of work)
   i. See Section A.5 for specific requirements

g. Geologic hazard report. See Section A.5 for specific requirements

h. Blast consultant's report and analysis (if part of scope of work)

3. Drawings

a. Framing plans and key details

Mechanical

1. Calculations and Energy and Water Analyses

a. Updated building heating and cooling load calculations

b. Updated psychrometric calculations for HVAC systems at full and partial loads (partial loads at 50% and 25%, and unoccupied periods)

c. Updated energy consumption calculations and analysis in accordance with Section A.6

d. Updated water consumption calculations and analysis including make-up water for HVAC systems, domestic water consumption, and water consumption for irrigation

e. Updated fuel consumption estimates

2. Drawings: HVAC

a. Demolition drawings, if required

b. Floor plan(s):
   i. Single line piping and ductwork schematic layout
   ii. Show terminal air units
   iii. Perimeter terminal units

c. Quarter-inch scale drawings of mechanical equipment room(s) showing all mechanical equipment, ductwork, and piping, including equipment access and service requirements in plan, elevations, and cross-sections

d. Roof plan showing all roof-mounted equipment and access to roof

e. Show adequate access from mechanical equipment room(s) to freight elevators

f. Single line schematic flow and riser diagram(s):
   i. Airflow quantities and balancing devices for all heating/cooling equipment
   ii. Water flow quantities and balancing devices for all heating/cooling equipment
   iii. Flow/energy measuring devices for water and air systems for all cooling, heating, and terminal equipment

g. Automatic control diagram(s):
   i. Control flow diagrams showing all sensors, valves, and controllers (analog and digital)
   ii. Sequence of operations of all the systems that describes the control sequences during occupied, 24-hour operations, and unoccupied conditions

h. Schedules:
   i. Provide schedules of major equipment that includes chillers, boilers, pumps, air handling units, and terminal units, cooling towers, and all equipment required for 24-hour operations

i. Air terminal devices

j. Air balance relationships between spaces

3. Drawings: Plumbing

a. Demolition drawings, if required

b. Floor plan(s):
   i. Proposed building zoning and major piping runs
   ii. Locations of proposed plumbing fixtures and equipment

c. Systems schematics and flow diagrams

4. Narrative: HVAC

A written narrative describing the final mechanical system and equipment selection including:

a. Updated indoor and outdoor design conditions for all spaces under occupied, 24-hour, and unoccupied conditions

b. Provide a dew point analysis

c. Updated ventilation rates, dehumidification, and pressurization criteria for all spaces under occupied, 24-hour, and unoccupied conditions

d. Updated equipment capacities, weights, sizes, and power requirements

e. A complete description of the air side and water side systems and the associated components including operating characteristics, ranges, and capacities, spaces served, and special features

f. Descriptions of control strategy and sequence of operations for all spaces under occupied, 24-hour, and unoccupied conditions

g. Updated fuel and utility requirements

h. A P100 compliance statement

i. A description of any deviation from the HVAC system as approved in the Final Concept submittal, in accordance with P100

5. Narrative: Plumbing

a. Updated description of plumbing system, including domestic cold and hot water, sanitary and storm drainage, and irrigation systems

b. Updated evaluation of alternate sources for reheating of domestic water (solar or heat recovery)

6. Specifications

a. Draft of each specification section to be used on the project

Fire Protection

Fire protection and life safety submission requirements must be identified as a separate Fire Protection section as outlined in this document.

1. Calculation

a. Occupant load and egress calculations

b. Fire protection water supply calculations
   i. Includes water supply flow testing data

c. Fire pump calculations where applicable

d. Smoke control calculations where applicable (e.g., atrium)

e. Stairway pressurization calculations where applicable

f. Calculations contained in *The SFPE Handbook of Fire Protection Engineering* for calculating sound attenuation through doors and walls for placement and location of fire alarm system audible notification appliances

2. Drawings

a. Floor plans showing:
   i. Equipment spaces for fire protection systems (e.g., fire pump, fire command center)
   ii. Fire protection water supply lines, fire hydrant locations, fire apparatus access roads, and fire lanes
   iii. Standpipes and sprinkler risers
   iv. Remoteness of exit stairways
   v. Location of firewalls and smoke partitions
   vi. Identification of occupancy type of every space and room in building
   vii. Calculated occupant loads for every space and room in the building
   viii. Location of special fire protection requirements (e.g., kitchens, computer rooms, storage)

b. Riser diagrams for sprinkler system

c. Riser diagram for fire alarm system

3. Narrative

a. Building egress description
   i. Includes egress calculations and stairway exit capacities, remoteness, exit discharge, etc.

b. All building fire alarm and suppression systems

c. Smoke control system(s), where applicable

d. Special fire protection systems (e.g., kitchen extinguishing system), where applicable

e. Fire resistance rating of building structural elements
   i. Coordinate with structural engineer

f. Fire alarm system
   i. Interface of fire alarm system with BAS and security systems
   ii. Review of building for compliance with life safety requirements and building security requirements

g. Interior finish requirements as they pertain to the life safety requirements

h. Mass notification system

Electrical

1. Calculations

a. Lighting calculations for a typical 186 m^2 (2,000 sq.ft.) open office plan with system furniture

b. Lighting calculations for a typical one-person private office

c. Power calculations from building entry to branch circuit panel

d. Load calculations

e. Life-cycle cost analysis of luminaire/lamp system and associated controls

f. Power density analysis for lighting of each area

2. Narrative

a. Description of alternative power distribution schemes
   i. Compare the advantages and disadvantages of each approach. Include the source of power, potential for on-site generation, most economical voltage, and primary vs. secondary metering.

b. Proposed power distribution scheme
   i. Provide a detailed description and justification for the selected scheme. Address special power and reliability requirements, including emergency power and UPS systems.

c. Proposed lighting systems
   i. Discuss typical lighting system features, including fixture type, layout, and type of controls
   ii. Discuss special spaces such as lobbies, auditoria, dining rooms, and conference rooms
   iii. Discuss exterior lighting scheme
   iv. Discuss lighting control systems and daylighting
   v. Describe the energy usage of the lighting system
   vi. Interface with BAS
   vii. Methods proposed for energy conservation and integration with BAS
   viii. Engineering analysis for demand limit controls

d. Description of each proposed signal system
   i. Description of proposed security systems' features and intended mode of operation

ii. Proposed zone schedule
iii. Proposed card access controls, CCTV assessment and intrusion protection system, if applicable

e. Proposed telecommunications Infrastructure
i. Systems proposed for infrastructure and cabling to accommodate the communications systems. These must be designed and provided in compliance with EIA/TIA building telecommunications wiring standards.

f. Code criteria should be reviewed by each discipline to the degree of detail necessary to ensure that tasks accomplished in this phase meet the code requirements.

3. Drawings

a. Site plan
i. Proposed site distribution for power and communications, proposed service entrance and location of transformers, generators, and vaults, etc.

b. Floor plans
i. Proposed major electrical distribution scheme and locations of electrical rooms and closets and communication closets
ii. Proposed major routing of major electrical feeder runs, bus duct, communication backbone systems, and security systems
iii. Plan layouts of electrical rooms, showing locations of major equipment, including size variations by different manufacturers

c. Single line diagram of the building power distribution system

d. Plan of typical office lighting layout

e. Single line diagram of other signal system including: telephones, security, public address, and others

f. Security system site plan
i. Proposed locations for CCTV, duress alarm sensors, and access controls for parking lots. If the system is not extensive, these locations may be shown on the electrical site plan.
ii. Security system floor plans
iii. Proposed locations for access controls, intrusion detection devices, CCTV, and local panels

g. Lightning protection and building grounding

Design Development Cost Estimate

A cost estimate must be provided, as required in the P120 and in accordance with the P100.

The Design Development Estimate submission must include the following:

- Executive summary
- Basis of estimate, rationale, assumptions and market analysis as required in P120
- GSA Report 3474, GSA Report 3473
- Summary Reports (ASTM UNIFORMAT II and CSI MasterFormat formats as applicable)
- Detail line item cost reports
- Core/shell and TI cost estimate, as per GSA pricing policy. TI estimates must be prepared for each tenant.
- Provide separate estimates for phased work, or bid alternates/options
- To ensure the project is developing on-budget, a list of cost-saving items that would collectively reduce the project cost to approximately 10 percent below budget
- Verify that the design development submission can be constructed within the project budget

Address what value engineering items were incorporated from the concept VE workshops. (Document all VE workshop sessions during design development and show what is to be incorporated into the final design.)

Specifications

Assemble all project-related construction guide specifications and mark out all content that does not apply to the project.

Certification Requirements

The A/E (lead designer) of record must provide certification that the project has been designed and is in compliance with project program requirements, PBS P100, and GSA's energy goal.

Assemble material for LEED rating submission, indicating features and points that ensure desired LEED rating.

The A/E of record must provide certification that all VE decisions made during DD are in compliance with the program requirements and PBS P100, and approved by the design team and all GSA and client stakeholders.

In bullet form, identify how selected design features will support the project's performance expectations. All building systems involved with the project must be discussed, each addressing all performance expectations as covered in the design program and Section A.2.

Construction Documents

The construction documents must be complete, coordinated between disciplines, biddable, readable, and buildable, with no room for unreasonable additional interpretation. The drawings listed below represent requirements for GSA's review, and do not constitute any limitation on the documentation required to properly contract for the construction of the project, or limit the professional design liability for errors and omissions.

Update of code analysis. Each design team discipline member must review, to the degree of detail necessary, the design to assure all the code requirements are met.

Site Planning and Landscape Design

1. Calculations

a. Final drainage calculations, including stormwater detention

b. Final parking calculations, if applicable

c. Pipe sizing calculations for water and sewer pipes

d. Pavement design calculations

2. Drawings, General: The plans listed below, except the demolition plans, may be combined on small projects.

a. Demolition plans, if required

b. Site layout plan

i. Location of all buildings, roads, walks, accessible routes from parking and public street to building entrance, parking and other paved areas, and planted areas

ii. Limits of construction

iii. Locations and sizes of fire protection water supply lines, fire hydrants, fire apparatus access roads, and fire lanes

iv. Location of floodplains and wetlands

c. Grading and drainage plan, showing:

i. Existing and new contours [use 600 mm (2 ft.) interval minimum in area around buildings]

ii. Spot elevations at all entrances and elsewhere as necessary

iii. Elevations for walls, ramps, terraces, plazas, and parking lots

iv. All surface drainage structures

v. Water retention and conservation

d. Site utilities plan, showing:

i. All utilities, including inlets, manholes, clean-outs, and invert elevations

e. Planting plan, showing:

i. Building outline, circulation, parking, and major utility runs

ii. Size and location of existing vegetation to be preserved (include protection measures during construction)

iii. Location of all new plant material (identify function, such as windbreak or visual screen where appropriate)

iv. Erosion control

f. Planting schedule, showing:

i. Quantity of plants, botanical names, planted size, and final size

g. Irrigation plan, if applicable

i. Include schematic of irrigation control system

h. Planting and construction details, profiles, sections, and notes as necessary to fully describe design intent

i. Construction phasing, if part of project

i. Survey of surrounding buildings, structures, and improvements in both wet and dry season to document preconstruction elevations

j. Potential archeological artifacts

Architectural

1. Calculations and Compliance Reports

a. Final acoustical calculations, including noise transmissions through:

i. Envelope

ii. Interior walls, floors (including raised floors), and ceilings

iii. Mechanical and electrical equipment

b. Final heat transfer through and dew point locations in building envelope

c. Final toilet fixture count

d. Final illumination, daylighting, and glare analysis

2. Drawings

a. Project title sheet, drawing index

b. Demolition plans if required

c. Floor plans

d. Show planning grids and raised access floor grid, if applicable

i. Reflected ceiling plans

ii. Show ceiling grid and location of all elements to be placed in the ceiling

e. Building sections

i. Vertical zoning for electrical and mechanical utilities must be indicated on sections

f. Roof plans

i. Roof plans must show slopes, low points, drains and scuppers, equipment, equipment supports, roof accessories, and specialty items, if applicable

g. Exterior elevations

h. Wall sections

i. Interior elevations

j. Details

k. Schedules. Diagrams illustrating proper clearance for servicing and replacement of equipment

3. Specifications

a. Room finish, ceiling types, floor finish, color, and door schedules can be incorporated into either the specifications or drawings

b. Call for thermographic scans of building envelope to identify sources of heat transfer

c. Call for assembly of visual and performance mock-ups for spaces such as courtrooms and sample office space fit outs

d. Provide lighting fixture type schedule

Historic Preservation

Specifications

Competency of bidder and restoration specialist qualification requirements, Sections 00120 and 009[00], cross-referenced in material specifications.

1. Technical specifications for repair and restoration of historic materials, including:

a. Specialized materials and procedures for repair and restoration of historic materials

b. Procedures for protecting historic materials in areas being altered

c. Sample review requirements of repair and restoration procedures

d. Sample submittal requirements for replacement materials and new installations in preservation zones

Structural

Calculations

For any computer-generated results, submit a model of the input data and all pertinent program material required to understand the output. A narrative of the input and results should be contained in the calculations as well.

Whenever a figure is obtained from some other page of the calculations, refer to that page number in parentheses next to the figure used in the calculation.

Provide sketches showing framing plans with dimensions and grid lines, free-body/force diagram in support of the calculations. Refer to drawing numbers where the calculated items are shown on the drawing: for example, structural sizes, connection details, etc.

Narrative/description must be submitted explaining the computer program used to perform the calculation.

1. Final structural calculations, including:

a. Gravity loads

b. Lateral loads

c. Foundations

d. Thermal loads where significant

e. Vibration propagation

f. Progressive collapse

g. Supports for nonstructural elements, including mechanical and electrical equipment on the roof and in equipment rooms, louvers, and other penetrations

h. Steel connections

i. Blast analysis

2. Drawings

a. Demolition plans (when applicable)

b. Full set of structural construction drawings

i. Drawings must be fully dimensioned, noted and detailed for accurate bidding and construction

ii. Load criteria for all floor live loads, roof live load, roof snow load, wind load, earthquake design data, and special loads must be shown on drawings. Live load reduction of the uniformly distributed floor live loads, if used in the design, must be indicated.

iii. Basic wind speed (3-second gust), miles per hour (km/hr), wind importance factor, I, and building category, wind exposure, the applicable internal pressure coefficient must be indicated.

iv. Seismic design criteria, such as seismic use group, spectral response coefficients SDS and SD1, site class, basic seismic-force-resisting system, design base shear, and analytical procedure must be indicated. Additional information may be required by the local building official.

v. Soil bearing pressure and lateral earth pressure must be indicated.

vi. Properties of basic materials must be indicated

vii. Blast-resistant requirements if applicable

viii. Indicate the codes and standards used to develop the project.

c. Schedules

i. Schedules for foundations, columns, walls, beams, slabs, and decks, as applicable

d. Structural details. (All typical details must be shown on the drawings.)

i. Include details for steel connections

ii. Include details for all fire-rated assemblies, indicating Underwriters Laboratories Inc. or other nationally recognized testing laboratory fire resistance directory design numbers

iii. Include details indicating if the assembly is restrained or unrestrained in accordance with Appendix X to ASTM E119 (the classification must be determined by a licensed structural engineer)

iv. Include details for anchorage of building system equipment and nonstructural building elements (may be shown on mechanical, electrical, or architectural drawings, as applicable).

Mechanical

1. Drawings HVAC

a. Demolition plans, if required

b. Floor plan(s):

i. Double line piping and ductwork layout

ii. Show terminal air units

iii. Perimeter terminal units

iv. Show locations of automatic control sensors (e.g., temperature, relative humidity, CO_2, room pressurization)

c. Roof plan showing all roof-mounted equipment and access to roof

i. Show adequate access from mechanical equipment room(s) to freight elevators

d. Mechanical details:

i. Quarter-inch scale drawings of mechanical equipment room(s) showing all mechanical equipment, ductwork, and piping including access and service requirements in plan, elevations, and cross-sections

ii. All valves must be shown. Indicate locations where temperature, pressure, flow, contaminant/combustion gases, or vibration gauges are required, and if remote sensing is required.
iii. Mechanical room piping and ductwork layout must be double line.
iv. All dampers—both fire dampers and volume control dampers—must be shown. Ductwork ahead of the distribution terminals must be indicated in true size (double line).

e. Single line schematic flow and riser diagram(s):
i. Airflow quantities and balancing devices for all heating/cooling equipment
ii. Water flow quantities and balancing devices for all heating/cooling equipment
iii. Show location of all flow/energy measuring devices for water and air systems for all cooling, heating, and terminal equipment, and their interface with the BAS

f. Automatic control diagrams:
i. Control flow diagrams showing all sensors, valves, and controllers (analog and digital inputs for controllers, front end equipment, and system architecture)
ii. Diagrams to show control signal interfaces, complete with sequence of operation of all heating, ventilating, and cooling systems during occupied, 24-hour, and unoccupied conditions

g. Schedules:
i. Provide schedules of equipment that includes chillers, boilers, pumps, air handling units, terminal units, cooling towers, and all equipment required for 24-hour operations.
ii. Air terminal devices

h. Air balance relationships between spaces

2. Drawings: Plumbing

a. Demolition plans, if required
b. Floor plans
i. Plumbing layout and fixtures, equipment and piping; large-scale plans should be used where required for clarity

c. Riser diagrams for waste and vent lines
d. Riser diagrams for domestic cold and hot water lines
e. Plumbing fixture schedule

3. Narrative HVAC

a. A written narrative describing the final mechanical system and equipment selection including:
i. Final indoor and outdoor design conditions for all spaces under occupied, 24-hour, and unoccupied conditions
ii. Final ventilation rates, dehumidification, and pressurization criteria for all spaces under occupied, 24-hour, and unoccupied conditions.
iii. Final equipment capacities, weights, sizes, and power requirements
iv. Final psychrometrics of HVAC systems
v. A final description of the air side and water side systems and the associated components including operating characteristics, ranges, and capacities, spaces served, and special features
vi. Final descriptions of the control strategy and sequence of operations for all spaces under occupied, 24-hour, and unoccupied conditions

b. Final fuel and utility requirements
c. A final code compliance statement
d. A final P100 compliance statement
e. A final description of any deviation from the HVAC system as approved in the Final Concept submittal, in accordance with P100

4. Narrative: Plumbing

a. A final description of plumbing system, including domestic cold and hot water, sanitary and storm drainage, and irrigation systems
b. A final evaluation of alternate sources for preheating of domestic water (solar or heat recovery)

5. Calculations and Energy and Water Analyses HVAC

a. Final building heating and cooling load calculations
b. Final system pressure static analysis at peak and minimum block loads for occupied and unoccupied conditions
c. Building pressurization analysis for peak and minimum block loads for occupied and unoccupied conditions
d. Acoustical calculations for peak and minimum block loads for occupied conditions
e. Flow and head calculations for pumping systems for peak and minimum block loads for occupied conditions
f. Final selection of equipment, cut sheets of selected equipment
g. Final psychrometric calculations for the selected HVAC systems at full and partial loads (partial loads at 50% and 25%, and unoccupied periods)
h. Final energy consumption calculations and analysis in accordance with Section A.6
i. Final fuel consumption estimates
j. Sizing of fuel storage and distribution system
k. Sizing of vibration isolators for mechanical equipment

6. Calculations: Plumbing

a. Include entire building, including roof drainage calculations and hot water heating calculations
b. Water supply calculations, including pressure
c. Roof drainage calculations
d. Sanitary waste sizing calculations
e. Final water consumption calculations and analysis including make-up water for HVAC systems, domestic water consumption, and water consumption for irrigation

7. Specifications

a. Completely edited version of each specification section to be used on the project

Fire Protection

Fire protection and life safety submission requirements must be identified as a separate Fire Protection section as outlined in this document.

1. Drawings

a. Demolition plans, if required

b. Full set of fire protection construction drawings

i. Drawings must be carefully dimensioned, noted, and detailed for accurate bidding and construction

c. Fire protection details (all typical details must be shown on the drawings)

i. Building construction

(1) Building's construction type (e.g., 443, 222, etc.)

(2) Firewalls and smoke partitions

(3) Panel and curtain walls

(4) Fire-stopping configurations. Include details of all openings between the exterior walls (including panel, curtain, and spandrel walls) and floor slabs, openings in floors, and shaft enclosures

(5) Mass notification system equipment

ii. Life safety

(1) Each stair

(2) Horizontal exits

(3) Each required fire door

(4) Stairway pressurization fans

(5) Security door hardware, including operation procedures

iii. Water supply

(1) Fire pump configuration

(2) Anchorage of underground fire protection water supply lines

(3) Standpipe riser

iv. Water-based fire extinguishing systems

(1) Installation of waterflow switches and tamper switches

(2) Sprinkler floor control valves, sectional valves, and inspector text assembly

v. Non-water-based fire extinguisher systems

(1) Special fire extinguishing systems (e.g., wet chemical)

vi. Fire alarm system

(1) Fire alarm riser

(2) Typical firefighter telephone station

(3) Typical firefighter telephone jack

(4) Electrical closets for fire alarm system panels

(5) Fire alarm telephone panel (includes voice paging microphone and firefighter telephone system)

(6) Visual indicating device control and power detail, typical for floors (state location)

(7) Amplifier rack (state location)

(8) Typical location of duct smoke detectors

(9) Outdoor fire alarm speaker

(10) Wall-mounted cone fire alarm speaker

(11) Typical terminal cabinet

(12) Lay-in ceiling-mounted fire alarm speaker

(13) Lay-in ceiling-mounted fire alarm combination speaker/strobe

(14) Wall-mounted strobe device

(15) Typical manual fire alarm box installation

(16) Fire alarm system input/output matrix

(17) Graphic annunciator panel

(18) Installation of the graphic annunciator

(19) Fire command center showing the locations of each panel to be installed

2. Specifications

a. Final specifications

b. Specifications must be based on GSA Fire Protection Supplements to Masterspec

3. Calculations For any fire modeling generated results, submit a copy of the input data and all pertinent program material and assumptions required to understand the output and the analysis. A narrative of the input and results must be part of the calculations.

a. Final occupant load and egress calculations

b. Final fire protection water supply calculations. Includes water supply flow testing data.

c. Final fire pump calculations where applicable

d. Final smoke control calculations where applicable (e.g., atrium)

e. Final stairway pressurization calculations

f. Fire modeling

g. Final calculations contained in *The SFPE Handbook of Fire Protection Engineering* for calculating sound attenuation through doors and walls for placement and location of fire alarm system audible notification appliances

Electrical

1. Drawings: General Systems must be fully drawn and sized to permit accurate bidding and construction.

a. Demolition plans, if required

b. Floor plans

  i. Show lighting, power distribution, and communications raceway distribution, and locations of fire alarm and annunciator panels

c. Single-line diagram of primary and secondary power distribution

d. Include normal power, emergency power, and UPS

e. Single-line diagram of fire alarm system

f. Single-line diagram of telecommunications system

g. Circuit layout of lighting control system

h. Details of underfloor distribution system

  i. Site plan

i. Indicate service locations, manholes, ductbanks, and site lighting

j. Layout of electrical equipment spaces

i. Show all electrical equipment. Include elevations of substation transformers and disconnect switches

k. Schedules for switchgear, switchboards, motor control centers, panelboards, and unit substations

l. Grounding diagram

m. Complete phasing plan (if required) for additions and alterations

n. Security systems site plan

  i. Final locations of all security devices and conduit runs

o. Security system floor plans

  i. Layout of all security systems

p. Storage areas for electrical equipment/spare parts

2. Specifications

a. Final specification

b. Zone schedules may be bound into the specifications or shown on drawings

3. Calculations

a. Illumination level and lighting power calculations

b. Lighting power densities must be calculated by the electrical engineer. The illumination levels for all spaces are to be calculated by the architect, who must also calculate daylighting and glare.

c. Short circuit calculations

d. Voltage drop calculations

e. Overcurrent coordination study

f. Generator calculations

  i. Include starter loads

Certification Requirements

The A/E (lead designer) must provide certification that the project has been designed and is in compliance with ASHRAE 90.1 and will meet GSA energy goal requirements.

Certification will also indicate that the architectural/engineering design elements have been integrated with the overall project design, and that the building can meet the programmed LEED rating.

All VE decisions made during construction documentation are in compliance with code requirements, the PBS P100 criteria and requirements, and have been approved by the GSA and client stakeholders.

The A/E certification must be signed and sealed by a principal of the architectural/engineering firm in charge of the project.

Construction Documents Cost Estimate

A cost estimate must be provided, as required in the P120 and in accordance with the P100.

The construction documents estimate submissions must include the following:

- Executive summary
- Basis of estimate, rationale, assumptions, and market analysis as required in P120
- GSA Report 3474, GSA Report 3473
- Summary Reports (ASTM UNIFORMAT II and CSI MasterFormat formats as applicable)
- Detail line item cost reports
- Core/shell and TI cost estimate, as per GSA pricing policy. TI estimates must be prepared for each tenant.
- Provide separate estimates for phased work, or bid alternates/options.
- To ensure the project is developing on-budget, a list of cost-saving items that would collectively reduce the project cost to approximately 10 percent below budget.
- Verify that the construction documents submissions can be constructed within the project budget.

Data and Operations Manual

An operations manual must be prepared and training provided for the building Operations and Maintenance personnel describing the design objectives and how to operate the building. The manual must include: as-built drawings, equipment data, model numbers for the equipment, parts lists, equipment options, operating manuals for each piece of equipment, testing and balancing reports and certifications, maintenance schedules, videos, and warranty schedules. The manual must be reviewed and certified complete by the GSA project manager before submission to the facilities manager.

A.4 Alteration Projects

The design process and related submission requirements for alterations are somewhat different than those for new construction and modernizations. An alteration is defined as a limited construction project for an existing building that comprises the modification or replacement of one or a number of existing building systems or components. Alterations are less than total building modernizations. Figure A-4 and the following definitions define the design process and related submission requirements for alterations, including renovations.

Figure A-4

Design Process and Related Submission Requirements for Renovation

STAGES	ACTIVITIES	SUBMISSIONS
CONCEPTS		
■ Review Space Directive ■ Study Adjacencies Circulation Aesthetics ■ System/Features That Integrate Delivery of Expectations	PROGRAM REVIEW DESIGN CHARRETTE CONCEPT (1 or more) VALUE ENGINEERING (Systems Level)	■ Drawings ■ Narratives ■ Rendering/Photos ■ Proposed Systems ■ Cost Estimates
DESIGN DEVELOPMENT		
■ System/Feature Analyses for Selection ■ 30% Complete Documentation ■ Final Selection of All Building Systems	PROGRAM REVIEW VALUE ENGINEERING (Analysis Stage)	■ Drawings ■ Narratives ■ Calculations ■ Cost Estimates
CONSTRUCTION DOCUMENTS		
■ Presentation of Design in a Format Suitable to Parties Unfamiliar with the Site	PROGRAM REVIEW 75% COMPLETE 90% COMPLETE 100% COMPLETE POST DESIGN SERVICES	■ Progress Drawings ■ Draft Specifications ■ Narrative Update ■ Current Calculations ■ Final: Drawings Specifications Narratives Calculations Cost Estimate ■ Incorporation of Review Comments

Design Process Definitions

Program Review

Prior to initiating each phase of design, the design team should meet to review design program expectations and to exchange ideas, lessons-learned, and concerns. Such technical "partnering" sessions allow a clearer definition of expectations while remaining within the project's scope and budget.

Phases of Construction

Prior to each phase of design, a construction phasing plan must be prepared to ensure that services such as power, lighting, HVAC, plumbing, elevators, fire-safety, building security, telecommunications, and data are available in the area/spaces which will be occupied during the phased construction. This phasing plan must be coordinated with clients, property managers, and other stakeholders.

Demolition Plan

Prior to each phase of design, a demolition narrative and drawings must be prepared for each element (i.e., architectural, site, structural, mechanical, electrical, fire-safety) to ensure coordination of the demolition and removal of the elements. Abandonment-in-place of unused elements is not permitted.

Concept

A submission that will demonstrate that the space program has been accomplished, including any adjacency and functional requirements. This submission will also show that the proposed project is compatible with the project authorization and complies with the criteria and requirements in Chapters 1-9 of this document. A preliminary analysis of proposed building systems must be accomplished to determine the most cost-effective alternatives.

Design Development

A set of submissions and meetings that will finalize the selection of type, size, and other material characteristics of all systems. Systems are not only structural, mechanical, fire protection, and electrical, but all other building components such as envelope (wall, window, and roof), interior (flooring, ceiling, and partitions), toilet and service rooms, elevators, and so on. The submission will consist of a combination of drawings, narrative, and calculations.

Construction Documents

A set of detailed and coordinated submissions that become the basis of a construction contract. They must be produced in a general fashion that any construction contractor nationwide can understand. Designs must be illustrated to distinguish between existing construction and new work, and be clear enough to result in a single interpretation of a specific set of data or facts. Language used in the specifications must be consistent and complementary to notes on the drawings. The documents must avoid using terms that the design specialist may know, but which have nothing to do with the purchase and installation of a product.

Specifications

Specifications to be organized according to CSI format, fully edited, typed, and bound.

Code Analysis

Code criteria should be reviewed by each discipline to the degree of detail necessary to ensure that tasks accomplished in each phase meet the code requirements.

Concept

Site Planning and Landscape Design

A sitework drawing and narrative need to be submitted only if sitework is a substantial part of the scope of work for the alteration.

1. Drawings

a. Site plans as described in Section A.3

2. Narrative

a. Existing site features
   i. Topography and drainage patterns
   ii. Any existing erosion conditions
   iii. Wetlands and location of flood plains
   iv. Circulation patterns around site
   v. Site access
b. Noise/visual considerations
c. Local zoning restrictions
d. Historic preservation considerations, if applicable
   i. Potential archeological artifacts
e. Fire protection considerations, if applicable
f. Site analysis of utilities, if utilities are to be changed
g. Description of site and landscape design concept
   i. Proposed changes to circulation design
   ii. Proposed changes to parking
   iii. Proposed method for stormwater detention or retention
   iv. Proposed changes to paving
   v. Description of local urban design goals for surrounding neighborhood and summary of relevant recommendations from local officials

Architectural

An architectural concept needs to be submitted only if architectural work is a part of the scope of work for the alteration.

1. Drawings

a. Demolition plans

b. Floor plans, elevations, and sections as described in Section A.3

c. Existing and new spaces, circulation, entrances, stairways, elevators, freight elevators, loading docks, special spaces and service spaces, and service rooms and space for mechanical, fire protection, electrical, and communication equipment. Dimensions for critical clearances, such as vehicle access, fire apparatus access, deliveries, and maintenance should be indicated.

2. Narrative

a. Architectural program requirements
   i. Describe how the design meets the project authorization

b. Design concept, explaining:
   i. General layout
   ii. Treatment of historic zones, if applicable

3. Calculations

a. Where building renovation involves window or insulated wall systems, perform a life-cycle cost assessment to optimize selection

Historic Preservation

8.5 in. x 11 in. report, signed by qualified preservation architect, including:

1. Narrative

a. General: Project purpose, scope, groups, and individuals involved

b. Existing conditions, describing:
   i. Overall building size, configuration, character
   ii. Project location
   iii. Existing original materials and design, relevant alterations

c. Preservation design issues and prospective solutions, including:
   i. Location of new work/installation: visibility, impact on historic finishes
   ii. Compare options for preserving/restoring historic materials and design
   iii. Identify further study required to avoid adverse effects as applicable

2. Photographs

a. General and detail views showing existing conditions at affected preservation zones, keyed to plan showing location and orientation of each view

b. Captions identifying location, subject, condition shown

3. Drawings

a. Reduced to 8.5 in. x 11 in., 11 in. x 17 in. foldout or placed in cover pocket:
   i. Site and floor plans, as applicable.
   ii. Sketches or schematic CAD drawings (elevations, plans) showing preservation design concepts.

Structural

Structural drawings and narrative only need to be submitted if a structural upgrade is part of the scope of work.

1. Drawings

a. Structural plans as described in Section A.3

2. Narrative

a. Description of current structural systems, state of repair, variances from present codes and available spare load capacity. Data may be obtained from review of original construction drawings and codes or from an analysis of the actual structure.
   i. This report may have been completed as part of the prospectus development study

b. Identification of governing codes

c. Description of recommended changes to the structural system, addressing:
   i. Structural materials, required selective demolition or alteration of existing structural elements, roof and floor framing system, means of resisting lateral loads, and connections between existing and new structural systems

d. If a seismic safety study exists for the building, describe any variations taken in design, compared to the study's recommendations.

Mechanical

Mechanical drawings, narrative, and calculations need to be submitted only if the alteration scope of work involves changes to the mechanical systems.

1. Drawings

a. Demolition plan of all piping, ductwork, equipment, and controls that are to be removed

b. Drawings for new work must be provided as described in Section A.3

2. Narrative

a. Description of current mechanical systems, state of repair, variances from present codes and P100. Data may be obtained from review of original construction drawings, P100 requirements and codes, and from an analysis of the actual facility.

b. Description of changes to existing systems as authorized and described in the prospectus and the building evaluation report

c. Describe existing and proposed HVAC and plumbing systems, including available capacities, compliance with the criteria and requirements in Chapter 5 of this document and their operational characteristics

d. Identify how new systems will be integrated with existing systems

e. Provide analysis of energy conservation opportunities for the project

3. Calculations and Energy Analysis

a. Calculations and energy analysis for alterations must show compliance with Chapters 1, 3, 5, and Sections A.3 and A.6.

Fire Protection

Fire protection and life safety submission requirements must be identified as a separate fire protection section as outlined in this document.

1. Drawings

a. Demolition plans
   i. Identify existing fire protection systems (e.g., sprinklers, fire alarm notification appliances)

b. Floor plans, showing a minimum:
   i. New fire protection systems (e.g., sprinklers, fire alarm notification appliances)

2. Narrative A fire protection narrative needs to be submitted only if the fire protection work is a substantial part of the scope of work for the alteration or involves changes to a fire protection system.

a. Fire protection program requirements

b. Description of the building's proposed fire protection systems including modifications to the existing egress systems

c. Code statement identifying changes in building occupancy classification, occupancy group(s), fire resistance requirements, egress requirements, and so on.

Electrical

An electrical narrative needs to be submitted only if the alteration scope of work involves changes to the type or location of major electrical systems.

1. Narrative

a. Description of requested changes to existing systems.
   i. Describe lighting, power, and signal systems, including available capacity versus criteria in Chapter 6, and operational characteristics.
   ii. Describe code deficiencies. Identify how new systems will be tied into existing systems.
   iii. This report may have been completed as part of the prospectus development study.

b. Describe both existing and new distribution systems within the building
   i. Special power and reliability requirements should be addressed, including emergency power and UPS systems.

Concept Cost Estimate

The final concept phase estimate submission must include the following:

1. Executive summary

2. Basis of estimate, rationale, assumptions and market analysis as required in P120

3. GSA Report 3474, GSA Report 3473

4. Summary reports (ASTM UNIFORMAT II, Work Items and CSI MasterFormat formats as applicable)

5. Detail line item cost reports

6. Core/shell and TI cost estimate, as per GSA pricing policy. TI estimates must be prepared for each tenant.

7. Provide separate estimates for phased work, or bid alternates/options.

8. To ensure the project is developing on-budget, a list of cost-saving items that would collectively reduce the project cost to approximately 10 percent below budget.

9. Verify that the final concept submissions can be constructed within the project budget.

A life-cycle cost analysis of three options that have been modeled should be included with this submittal.

Design Development

Site Planning and Landscape Design

1. Calculations

a. Storm drainage and sanitary sewer calculations
b. Storm water detention facility calculations, if applicable
c. Parking calculations, if applicable

2. Narrative

a. Site circulation concept, explaining:
  i. Reasons for site circulation design and number of site entrances
  ii. Reasons and/or calculation for number of parking spaces provided
  iii. Reasoning for design of service area(s), including description of number and sizes of trucks that can be accommodated
  iv. Proposed scheme for waste removal
  v. Proposed scheme for fire apparatus access (including aerial apparatus), roads, and fire lanes
b. Site utilities distribution concept
c. Drainage design concept
d. Landscape design concept, explaining:
  i. Reasoning for landscape design, paving, site furnishings, and any water features
  ii. Reasoning for choice of plant materials
  iii. Proposed landscape maintenance plan
  iv. Brief operating description of irrigation system
  v. Summarize water conservation opportunities that have been studied
  vi. Brief description of fire protection water supplies
  vii. Brief description of fire hydrant locations
  viii. Reasoning for urban design choices and their relation to local urban design goals
e. Site construction description
  i. Brief description of materials proposed for pavements and utilities
f. Code analysis
  i. Analysis of applicable local zoning and building code requirements

3. Drawings

a. Demolition plans (when applicable)
b. Preliminary site layout plan, showing:
  i. Roads, walks, parking, and other paved areas (including type of pavement). Show access route for the physically disabled from parking and from public street to main entrance.
  ii. Fire apparatus access (including aerial apparatus) and fire lanes
c. Preliminary grading and drainage plan, showing:
  i. Preliminary site grading, storm drainage inlets, including detention facilities
d. Preliminary site utilities plan, showing:
  i. Sizes, inverts, and locations of domestic and fire protection water supply lines, sanitary sewer lines, gas lines, steam/condensate lines and chilled water supply and return lines, if applicable
e. Preliminary landscape design plan, showing:
  i. Preliminary hardscape design, including site furniture, water features, etc.
  ii. Preliminary planting scheme
  iii. Preliminary irrigation design

Architectural

1. Narrative

a. Building concept, explaining:
  i. Entrance locations and service locations
  ii. Building circulation and arrangement of major spaces
  iii. Interior design
  iv. Adherence to the historic building preservation plan, if applicable
b. Building construction description, explaining, if applicable:
  i. Exterior materials, waterproofing, air barriers/vapor retarders and insulation elements
  ii. Roofing system(s)
  iii. Exterior glazing system
  iv. Interior finishes, with detailed explanation for public spaces
  v. Potential locations for artwork commissioned under the Art in Architecture program, if applicable

2. Drawings

a. Demolition plans
b. Building floor plans, showing:
  i. Spaces individually delineated and labeled
  ii. Enlarged layouts of special spaces
  iii. Dimensions
  iv. Accessible routes for the physically disabled as well as other compliance requirements regarding signage, toilets, etc.
c. Building roof plan, if applicable, showing:
  i. Drainage design, including minimum roof slope
  ii. Dimensions
  iii. Membrane and insulation configuration of the roofing system
d. Elevations of major building facades (if changes to the exterior are proposed), showing:
  i. Existing and new fenestration
  ii. Existing and new exterior materials
  iii. Cast shadows
e. Two building sections (of renovated areas only), showing:
  i. Accommodation of structural systems
  ii. Mechanical penthouses, if any
  iii. Floor to floor and other critical dimensions
  iv. Labeling of most important spaces
f. Exterior wall sections, showing:
  i. Materials of exterior wall construction, including flashing, connections, and method of anchoring
  ii. Vertical arrangement of interior space, including accommodation of mechanical, fire protection, and electrical services in the floor and ceiling zones
g. Proposed room finish schedule, showing:
  i. Floors, base, walls, and ceilings
  ii. Finish schedule may be bound into narrative

Historic Preservation

8.5 in. x 11 in. report, signed by qualified preservation architect, including:

1. Narrative

a. Cover
  i. Building name, address, project title, project control number, author (preservation architect), preservation architect's signature, date of submission

b. General: Project purpose, scope, groups, and individuals involved, substantive changes to approach described in concept submission

c. Existing conditions, describing:
  i. Overall building size, configuration, character
  ii. Project location
  iii. Existing original materials and design, alterations
  iv. New findings from testing or analysis in concept phase

d. Preservation solutions explored, how resolved, and why, including:
  i. Location of new work: visual impact, protection of ornamental finishes
  ii. Design of new work/installation: visual and physical compatibility with existing original materials and design; materials/finishes proposed (as specified)
  iii. Methods of supporting new work/installation
  iv. Preservation and protection of historic materials during construction through tenant move-in

e. Effects, describing:
  i. How project will affect the building's architecturally significant qualities
  ii. Measures proposed to mitigate any adverse effects on historic materials or design

2. Photographs

a. General and detail views showing existing conditions at affected preservation zones, keyed to plan showing location and orientation of each photo view

b. Captions identifying location, subject, condition shown

3. Drawings

a. Reduced to 8.5 in. x 11 in., 11 in. x 17 in. foldout or placed in cover pocket:

b. Site and floor plans, as applicable

c. Elevations, plans, and section details showing preservation design solutions for each issue identified, as approved by Regional Preservation Officer

Structural

1. Calculations For any computer-generated results, submit a model of the input data and all pertinent program material required to understand the output. A narrative of the input and results should be contained in the calculations as well.

a. Gravity load calculations

b. Lateral load calculation

c. Foundation calculations

d. Calculations showing that system is not vulnerable to progressive collapse

e. Vibration calculations

f. Results of any other studies necessary for the project design

2. Narrative

a. Description of structural concept, including:
  i. Choice of framing system, including lateral load resisting elements
  ii. Proposed foundation design
  iii. Verification of adequacy of all assumed dead and live loads

b. Code analysis
  i. Building classification, required fire resistance of structural elements, identification of seismic zone, wind speed, etc.
  ii. Identification of special requirements, such as high-rise
  iii. Summary of special requirements resulting from applicable local codes

c. Proposed methods of corrosion protection, if applicable

d. Geotechnical engineering report, including boring logs (if part of scope of work). See Section A.5 for specific requirements.

e. Geologic hazard report

3. Drawings

a. Demolition plans (where applicable)

b. Preliminary framing plans and key details
  i. Include column locations, bay sizes, and location of expansion and seismic joints

c. Preliminary schedules, including:
  i. Column, beam, slab, metal deck, and wood framing schedules, as applicable
  ii. Preliminary seismic details

Mechanical

In addition to the design development submission of the demolition plan, drawings, narrative, and calculations and analysis must be provided as described in Chapters 1, 3, 5 and Sections A.3 and A.6.

Fire Protection

Fire protection and life safety submission requirements must be identified as a separate Fire Protection section as outlined in this document.

1. Calculations

a. Occupant load and egress calculations
b. Fire protection water supply calculations
c. Fire pump calculations where applicable
d. Smoke control calculations where applicable (e.g., atrium)
e. Stairway pressurization calculations where applicable
f. Calculations contained in *The SFPE Handbook of Fire Protection Engineering* for calculating sound attenuation through doors and walls for placement and location of fire alarm system audible notification appliances

2. Narrative

a. Building egress system
  i. Includes egress calculations and stairway exit capacities, remoteness, exit discharge, etc.
b. All building fire alarm and suppression systems
c. Smoke control system(s), where applicable
d. Special fire protection systems (e.g., kitchen extinguishing system), where applicable
e. Fire resistance rating of building structural elements
  i. Coordinate with structural engineer
f. Fire alarm system
g. Interface of fire alarm system with BAS and security systems
h. Review of building for compliance with life safety requirements and building security requirements
i. Interior finish requirements as they pertain to the life safety requirements

3. Drawings

a. Floor Plans showing:
  i. Equipment spaces for fire protection systems (e.g., fire pump, fire alarm)
  ii. Fire protection water supply lines, fire hydrant locations, fire apparatus access roads, and fire lanes
  iii. Standpipes and sprinkler risers
  iv. Riser diagrams for sprinkler system
  v. Riser diagram for fire alarm system
  vi. Remoteness of exit stairways
  vii. Location of firewalls and smoke partitions
  viii. Identification of occupancy type of every space and room in building
  ix. Calculated occupant loads for every space and room in the building
  x. Location of special fire protection requirements (e.g., kitchens, computer rooms, storage)

Electrical

1. Calculations

a. Lighting calculations for a typical 186 m^2 (2,000 sq. ft.) open plan office with system furniture
b. Lighting calculations for a typical one person private office
c. Power calculations from building entry to branch circuit panel
d. Load calculations
e. Life cycle cost analysis of luminaire/lamp system
f. Life cycle cost study on the options to integrate related building systems

2. Narrative

a. Proposed power distribution scheme
  i. Provide a detailed description and justification for the selected scheme
b. Interface with BAS
  i. Methods proposed for energy conservation and integration with BAS
c. Engineering analysis for demand limit controls
d. Description of each proposed signal system
e. Description of proposed security systems features and intended mode of operation
  i. Proposed zone schedule
  ii. Proposed card access controls, CCTV assessment and intrusion protection system, if applicable

3. Drawings

a. Demolition plans
b. Site plan
  i. Proposed site distribution for power and communications, proposed service entrance and location of transformers, generators, and vaults, etc.
c. Floor plans
  i. Proposed major electrical distribution scheme and locations of electrical closets
d. Floor plans
  i. Major routing of communications system, communications equipment rooms, and closets
e. Underfloor distribution system
  i. Show typical detail for power and communications services
f. One-line diagram
g. Typical lighting layout
  i. Include lighting for special areas
h. Exterior lighting scheme
i. Layout of electrical rooms
  i. Show locations of major equipment
j. One-line diagrams of other signal systems
k. Security system site plan
  i. Location for CCTV, duress alarm sensors and access control locations for parking lots shown. If the system is not extensive, these locations may be shown on the electrical site plan.
l. Security system floor plans
  i. Access controls, intrusion detection devices, and CCTV locations shown. Preliminary local panel locations shown.

Design Development Cost Estimate

The Design Development Phase Estimate submissions must include the following:

1. Executive Summary
2. Basis of Estimate, Rationale, Assumptions and Market Analysis as required in P120
3. GSA Report 3474, GSA Report 3473
4. Summary Reports (ASTM UNIFORMAT II, Work Item and CSI MasterFormat formats as applicable)
5. Detail Line Item Cost Reports
6. Core/Shell and Tenant Improvement Cost Estimate, as per GSA Pricing Policy. TI estimates must be prepared for each tenant.
7. Provide separate estimates for phased work, or bid alternates/options
8. To ensure the project is developing on-budget, a list of cost-saving items that would collectively reduce the project cost to approximately 10 percent below budget.
9. Verify that the Design Development Phase Submissions can be constructed within the project budget.

Construction Documents

The construction documents must be complete, coordinated between disciplines, biddable, readable and buildable, with no room for unreasonable additional interpretation.

The A/E firm must provide a signed and dated professional seal on all final contract documents. The cover sheet should also include a statement by the design A/E, certifying the design meets the listed design criteria. Exceptions and waivers to the design criteria should also be listed on the cover sheet of the contract documents, including the name and date of the individual providing authorization.

Site Planning and Landscape Design

1. Cover Sheet

a. Provide code clarification statement for compliance with specified codes and standards by each discipline with professional seals and signatures. In addition, include a drawing index.

2. Drawings, General: The plans listed below, except the demolition plans, may be combined on small projects.

a. Demolition plans

b. Site layout plan
   i. Location of all buildings, roads, walks, accessible routes, parking, and other paved areas and planted areas
   ii. Limits of construction
   iii. Locations of fire protection water supply lines, fire hydrants, fire apparatus access roads, and fire lanes

c. Grading and drainage plan, showing:
   i. Existing and new contours [use 500 mm (2 ft.) interval minimum in area around buildings]
   ii. Spot elevations at all entrances and elsewhere as necessary
   iii. Elevations for walls, ramps, terraces, and plazas
   iv. All surface drainage structures

d. Site utilities plan, showing:
   i. All underground utilities, including inlets, manholes, clean-outs, and invert elevations

e. Planting plan, showing:
   i. Building outline, circulation, parking, and major utility runs
   ii. Size and location of existing vegetation to be preserved (include protection measures during construction)
   iii. Location of all new plant material (identify function, such as windbreak or visual screen where appropriate)

f. Planting schedule, showing:
   i. Quantity of plants, botanical names, planted size, and final size

g. Irrigation plan, if applicable
   i. Include schematic of irrigation control system

h. Construction details, profiles, and sections and notes as necessary to fully describe design intent
   i. Construction phasing, if part of project

3. Calculations

a. Final drainage calculations, including stormwater detention

b. Final parking calculations, if applicable

c. Pipe sizing calculations for water and sewer pipes

d. Pavement design calculations

Architectural

1. Drawings

a. Demolition plans

b. Floor plans
   i. Show planning grids and raised access floor grid, if applicable

c. Reflected ceiling plans
   i. Show ceiling grid and location of all elements to be placed in the ceiling

d. Building sections
   i. Vertical zoning for electrical and mechanical utilities must be indicated on sections

e. Roof plans
   i. Roof plans must show slopes, low points, drains, and scuppers, if applicable

f. Exterior elevations

g. Wall sections

h. Interior elevations

i. Details

j. Schedules

2. Specifications

a. Instructions to bidders

b. Division 1, edited to suit specific GSA requirements

c. Room finish, color, and door schedules can be incorporated into either the specifications or drawings

Historic Preservation

1. Specifications Division 1

a. Competency of bidder and restoration specialist qualification requirements, cross referenced in material specifications

2. Technical specifications for repair and restoration of historic materials, including:

a. Specialized materials and procedures for repair and restoration of historic materials

b. Procedures for protecting historic materials in areas being altered

c. Sample review requirements of repair and restoration procedures

d. Sample submittal requirements for replacement materials and new installations in preservation zones

Structural

1. Drawings

a. Demolition plans (where applicable)

b. Full set of structural construction drawings

- i. Drawings must be fully dimensioned, noted and detailed for accurate bidding and construction.
- ii. Load criteria for all floor live load, roof live load, roof snow load, wind load, earthquake design data, and special loads must be shown on drawings. Live load reduction of the uniformly distributed floor live loads, if used in the design, must be indicated.
- iii. Basic wind speed (3-second gust), miles per hour (km/hr), wind importance factor, I, and building category, wind exposure, and the applicable internal pressure coefficient must be indicated.
- iv. Seismic design criteria, such as seismic use group, spectral response coefficients SDS and SD1, site class, basic seismic-force-resisting system, design base shear, and analytical procedure must be indicated. Additional information may be required by the local building official.
- v. Soil bearing pressure and lateral earth pressure must be indicated

c. Schedules

- i. Schedules for foundations, columns, walls, beams, slabs, and decks, as applicable

d. Structural details. (All typical details must be shown on the drawings.)

- i. Include details for steel connections
- ii. Include details for all fire-rated assemblies, indicating Underwriters Laboratories Inc. or other nationally recognized testing laboratory fire resistance directory design numbers
- iii. Include details indicating if the assembly is restrained or unrestrained in accordance with Appendix X to ASTM E119 (the classification must be determined by a licensed structural engineer)
- iv. Include details for anchorage of nonstructural building elements

2. Calculations For any computer-generated results, submit a model of the input data and all pertinent program material required to understand the output. A narrative of the input and results should be contained in the calculations as well.

a. Final structural calculations, including:

- i. Gravity loads
- ii. Lateral loads
- iii. Foundations
- iv. Thermal loads where significant
- v. Vibration propagation
- vi. Progressive collapse
- vii. Supports for nonstructural elements, including mechanical and electrical equipment
- viii. Steel connections

Mechanical

In addition to the construction documentation submittal for the demolition plan, drawings, narrative, and calculations and analysis must be provided as described in Chapters 1, 3, 5 and Sections A.3 and A.6.

Fire Protection

Fire protection and life safety submission requirements must be identified as a separate fire protection section as outlined in this document.

1. Drawings

a. Demolition plans

b. Full set of fire protection construction drawings

- i. Drawings must be carefully dimensioned noted and detailed for accurate bidding and construction

c. Fire protection details (all typical details must be shown on the drawings)

- i. Building construction
  - (1) Building's construction type (e.g., 443, 222)
  - (2) Firewalls and smoke partitions
  - (3) Panel and curtain walls
  - (4) Fire-stopping configurations. Include details of all openings between the exterior walls (including panel, curtain, and spandrel walls) and floor slabs, openings in floors, and shaft enclosures.
- ii. Life safety
  - (1) Each stair
  - (2) Horizontal exits
  - (3) Each required fire door
  - (4) Stairway pressurization fans
  - (5) Security door hardware, including operation procedures
- iii. Water supply
  - (1) Fire pump configuration
  - (2) Anchorage of underground fire protection water supply line
  - (3) Standpipe riser
- iv. Water-based fire extinguishing systems
  - (1) Installation of waterflow switches and tamper switches
  - (2) Sprinkler floor control valves, sectional valves, and inspector text assembly
- v. Non-water-based fire extinguisher systems
  - (1) Special fire extinguishing systems (e.g., wet chemical)

vi. Fire Alarm System
  (1) Fire alarm riser
  (2) Typical firefighter telephone station
  (3) Typical firefighter telephone jack
  (4) Electrical closets for fire alarm system panels
  (5) Fire alarm telephone panel (includes voice paging microphone and firefighter telephone system)
  (6) Visual indicating device control and power detail, typical for floors (state location)
  (7) Amplifier rack (state location)
  (8) Typical location of duct smoke detectors
  (9) Outdoor fire alarm speaker
  (10) Wall-mounted cone fire alarm speaker
  (11) Typical terminal cabinet
  (12) Lay-in ceiling-mounted fire alarm speaker
  (13) Lay-in ceiling-mounted fire alarm combination speaker/strobe
  (14) Wall-mounted strobe device
  (15) Typical manual fire alarm box installation
  (16) Fire alarm system input/output matrix
  (17) Graphic annunciator panel
  (18) Installation of the graphic annunciator
  (19) Fire command center showing the locations of each panel to be installed

2. Calculations For any fire modeling generated results, submit a copy of the input data and all pertinent program material and assumptions required to understand the output and the analysis. A narrative of the input and results must be part of the calculations.

a. Final occupant load and egress calculations
b. Final fire protection water supply calculations
c. Includes water supply flow testing data
d. Final fire pump calculations where applicable
e. Final smoke control calculations where applicable (e.g., atrium)
f. Final stairway pressurization calculations
g. Fire modeling
h. Final calculations contained in The *SFPE Handbook of Fire Protection Engineering* for calculating sound attenuation through doors and walls for placement and location of fire alarm system audible notification appliances

Electrical

1. Drawings

a. Demolition plans
b. Floor plans
  i. Show lighting, power distribution, and communications raceway distribution
c. Single-line diagram of primary and secondary power distribution
  i. Include normal power, emergency power, and UPS
d. Single-line diagram of fire alarm system
e. Single-line diagram of telecommunications system
f. Circuit layout of lighting control system
g. Details of underfloor distribution system
h. Site plan
  i. Indicate service locations, manholes, ductbanks, and site lighting
i. Layout of electrical equipment spaces
  i. Show all electrical equipment. Include elevations of substation transformers and disconnect switches
j. Schedules for switchgear, switchboards, motor control centers, panelboards, and unit substations
k. Grounding diagram
l. Complete phasing plan (if required) for additions and alterations
m. Security systems site plan
  i. Final locations of all security devices and conduit runs
n. Security system floor plans
  i. Layout of all security systems
o. Storage areas for electrical equipment/spare parts

2. Calculations

a. Illumination level calculations
b. Short circuit calculations
c. Voltage drop calculations
d. Overcurrent coordination study
e. Generator calculations
f. Include starter loads
g. UPS calculation (if UPS provided)

3. Code criteria should be reviewed by each discipline to the degree of detail necessary to ensure that tasks accomplished in this phase meet the code requirements.

Construction Documents Specifications

1. Instructions to bidders

2. Division 1, edited to suit specific GSA requirements

3. Technical specifications sections, organized according to CSI format

4. Specifications must be fully edited, typed, and bound. Room finish, color, and door schedules can be incorporated into either the specifications or drawings.

Construction Documents Cost Estimate

The construction documents cost estimate submissions must include the following:

1. Executive summary

2. Basis of estimate, rationale, assumptions, and market analysis as required in P120

3. GSA Report 3474, GSA Report 3473

4. Summary reports (ASTM UNIFORMAT II, Work Items and CSI MasterFormat formats as applicable)

5. Detail line item cost reports

6. Core/shell and TI cost estimate, as per GSA pricing policy. TI estimates must be prepared for each tenant.

7. Provide separate estimate for phased work, or bid alternates/options

8. To ensure the project is developing on-budget, a list of cost-saving items that would collectively reduce the project cost to approximately 10 percent below budget

9. Verify that the construction documents submissions can be constructed within the project budget

A.5 Surveys and Geotechnical Reports

Site Survey

Site surveys are generally prepared for GSA projects involving sitework. The survey may be contracted separately by GSA or may be included in the scope of the A/E for the project. The guidelines given here apply in either case. In cases where GSA contracts for the survey directly, the A/E may be requested to review the scope of work for the survey and recommend modifications to the technical requirements to suit the specific project site. The geotechnical report must be available to all contractors so that there will be a common reference on which to base their bids. Also, the report would subsequently function as the basic reference for evaluating "changed conditions" or "differing site conditions" during construction and, therefore, need be of sufficient detail, number of borings, groundwater, and contamination evaluations to support the design and mitigate large changed conditions issues.

The criteria listed here are not absolute; they should be modified by the civil engineer to suit the particular conditions of the project. All surveys should be prepared and sealed by a surveyor licensed in the state where the project is located.

General Requirements

Surveys should generally contain the following information:

- Locations of all permanent features within limits of work, such as buildings, structures, fences, walls, concrete slabs and foundations, above-ground tanks, cooling towers, transformers, sidewalks, steps, power and light poles, traffic control devices, manholes, fire hydrants, valves, culverts, headwalls, catch basins or inlets, property corner markers, benchmarks, etc.
- Location of all adjacent and abounding roads or streets and street curbs within limits of work, including driveways and entrances. Type of surfacing and limits should be shown. For public streets, right-of-way widths and centerlines should also be shown.
- Location of all trees, shrubs, and other plants within limits of work. For trees, caliper size should be shown; dead trees should be indicated.
- Location of all overhead telephone and power lines within the limits of work and their related easements.
- Based on existing records, location of underground utilities, such as gas, water, steam, chilled water, electric power, sanitary, storm, combined sewers, telephone, etc., should be shown. Sizes of pipes (I.D.), invert elevations, inlet, or manhole rim elevations should be indicated. Where appropriate, information should be verified in the field.
- Based on existing records, location of underground storage tanks or other subsurface structures.
- Topography field criteria should include such items as 300 millimeter or 600 millimeter (1 to 2 ft.) contour intervals plotted on a grid system appropriate to the scale of the survey; elevations at top and bottom of ditches and at any abrupt changes in grade; periodic top-of-curb and gutter elevations, as well as street centerline elevations; elevations at all permanent features within the limits of work; ground floor elevations for all existing buildings.
- Bearings and distances for all property lines within the limits of work.
- Official datum upon which elevations are based and the benchmark on or adjacent to the site to be used as a starting point.
- Official datum upon which horizontal control points are based.
- If there are not already two benchmarks on the site, establish two permanent benchmarks.
- Elevations of key data points of all building structures and improvements directly adjacent and across the street from the project site during both wet and dry season.
- Delineate location of any wetlands or floodplains, underground streams, or water sources.

Geotechnical Investigation and Engineering Report

On most GSA projects geotechnical investigations will take place at three separate stages: during site selection, during building design, and during construction. The requirements for geotechnical work during site selection and during construction are described in other GSA documents. The requirements for geotechnical work for the building design are defined here. They apply whether GSA contracts for geotechnical work separately or includes the geotechnical investigation in the scope of the A/E services.

Purpose

The purpose of the geotechnical investigation during building design is to determine the character and physical properties of soil deposits and evaluate their potential as foundations for the structure or as material for earthwork construction. The investigation must also determine the hydrological capacities of the soil. The type of structure to be built and anticipated geologic and field conditions has a significant bearing on the type of investigation to be conducted.

The investigation must therefore be planned with knowledge of the intended project size and anticipated column loads, land utilization, and a broad knowledge of the geological history of the area.

The guidelines given here are not to be considered as rigid. Planning of the exploration, sampling and testing programs, and close supervision must be vested in a competent geotechnical engineer and/or engineering geologist with experience in this type of work and licensed to practice engineering in the jurisdiction where the project is located.

1. Analysis of Existing Conditions The report should address the following:

a. Description of terrain
b. Brief geological history
c. Brief seismic history
d. Surface drainage conditions
e. Groundwater conditions and associated design or construction problems
f. Description of exploration and sampling methods and outline of testing methods
g. Narrative of soil identification and classification, by stratum
h. Narrative of difficulties and/or obstructions encountered during previous explorations of existing construction on or adjacent to the site
i. Description of laboratory test borings and results
j. Plot plan, drawn to scale, showing test borings or pits
k. Radon tests in areas of building location
l. Soils resistivity test, identifying resistivity of soil for corrosion protection of underground metals and electrical grounding design
m. Boring logs, which identify:
   i. Sample number and sampling method
   ii. Other pertinent data deemed necessary by the geotechnical engineer for design recommendations, such as:
   (1) Unconfined compressive strength
   (2) Standard penetration test values
   (3) Subgrade modulus
   (4) Location of water table
   (5) Water tests for condition of groundwater
   (6) Location and classification of rock
   (7) Location of obstructions
   (8) Atterberg tests
   (9) Compaction tests
   (10) Consolidation tests
   (11) Triaxial compression test
   (12) Chemical test (pH) of the soil
   (13) Contamination

2. Engineering Recommendations Engineering recommendations based on borings and laboratory testing should be provided for the following:

a. Recommendations for foundation design, with discussion of alternate solutions, if applicable, include:
   i. Allowable soil bearing values
   ii. Feasible deep foundation types and allowable capacities, where applicable, including allowable tension (pull-out) and lateral subgrade modulus
   iii. Feasibility of slab on grade versus structurally supported floor construction, including recommended bearing capacities and recommended subgrade modulus (k)

b. Discussion of evidence of expansive soils and recommended solutions

c. Lateral earth design pressures on retaining walls or basement walls, including dynamic pressures

d. Design frost depth, if applicable

e. Removal or treatment of contaminated soil

f. Discussion of potential for consolidation and/or differential settlements of substrata, with design recommendations for total settlement and maximum angular distortion

g. Use and treatment of in-situ materials for use as engineered fill

h. Recommendations for future sampling and testing

i. Recommendations for pavement designs, including base and sub-base thickness and subdrains

j. Recommendations for foundation and subdrainage, including appropriate details

k. Discussion of soil resistivity values

l. Discussion of soil hydrological capabilities

m. Discussion of radon values and recommendation for mitigating measures, if required

Geologic Hazard Report

A geologic hazard report must be prepared for all new building construction in regions of low, moderate, and high seismicity, except for structures located in regions of low seismicity designed to the life safety performance level. Geologic hazard reports are not required for minor or relatively unimportant facilities for which earthquake damage would not pose a significant risk to either life or property.

Required Investigation

When required by the project scope, a geologic hazard investigation that addresses the hazards indicated below should be performed. Whenever possible, a preliminary investigation should be performed in the planning stage of siting a facility, to provide reasonable assurance that geologic hazards do not preclude construction at a site. During a later stage of geotechnical investigations for a facility at a selected site, supplemental investigations may be conducted as needed to define the geologic hazards in more detail and/or develop mitigating measures. The scope and complexity of a geologic hazard investigation depends on the economics of the project and the level of acceptable risk. In general, major new building complexes, high-rise buildings, and other high value or critical facilities must have thorough geologic hazard investigations. Small, isolated buildings need not have elaborate investigations.

Surface Fault Rupture

For purposes of new building construction, a fault is considered to be an active fault and a potential location of surface rupture if the fault exhibits any of the following characteristics:

- Has had documented historical macroseismic events or is associated with a well-defined pattern of microseismicity
- Is associated with well-defined geomorphic features suggestive of recent faulting
- Has experienced surface rupture (including fault creep) during approximately the past 10,000 years (Holocene time)

Fault investigations must be directed at locating any existing faults traversing the site and determining the recency of their activity. If an active fault is found to exist at a site and the construction cannot reasonably be located elsewhere, investigations must be conducted to evaluate the appropriate set-back distance from the fault and/or design values for displacements associated with surface fault rupture.

Soil Liquefaction

Recently deposited (geologically) and relatively unconsolidated soils and artificial fills, without significant cohesion and located below the water table, are susceptible to liquefaction. Sands and silty sands are particularly susceptible. Potential consequences of liquefaction include foundation bearing capacity failure, differential settlement, lateral spreading and flow sliding, flotation of lightweight embedded structures, and increased lateral pressures on retaining walls. The investigation must consider these consequences in determining the size of the area and the depth below the surface to be studied. An investigation for liquefaction may take many forms. One acceptable method is to use blow count data from the standard penetration test conducted in soil borings. This method is described in publications by H. B. Seed and I. M. Idriss, (1982), *Ground Motions and Soil Liquefaction During Earthquakes:* Earthquake Engineering Research Institute, Oakland, CA, Monograph Series, 134 p. and H.B. Seed et al, (1985) "The Influence of SPT Procedures in Soil Liquefaction Resistance Evaluations": *Journal of Geotechnical Engineering*, ASCE 111(12): pp. 1425-1445.

Landsliding

New construction must not be sited where it may be within a zone of seismically induced slope failure or located below a slope whose failure may send soil and debris into the structure. Factors that affect slope stability include slope angle, soil type, bedding, ground water conditions, and evidence of past instability. The geologic hazard investigation must address the potential for seismically induced slope deformations large enough to adversely affect the structure.

Differential Settlement

Loosely compacted soils either above or below the water table can consolidate during earthquake shaking, producing surface settlement. The potential for total and differential settlements beneath a structure must be assessed. If liquefaction is not expected to occur, then in most cases, differential settlement would not pose a significant problem to construction.

Flooding

Earthquake-inducing flooding can be caused by tsunamis, seiches, and dam and levee failures. The possibility of flooding must be addressed for new construction located near bodies of water.

Duration of Strong Ground Shaking

Estimates of the duration of strong ground shaking at a site are defined by earthquake magnitude and must be used to assess geologic hazards such as liquefaction and slope failure. Strong motion duration is strongly dependent on earthquake magnitude.

Estimates of the duration of strong ground shaking must be based on the assumption of the occurrence of a maximum considered earthquake generally accepted by the engineering and geologic community as appropriate to the region and to the subsurface conditions at the site.

Mitigative Measures

A site found to have one or more geologic hazards may be used, provided the hazards are removed, abated, or otherwise mitigated in the design, or if the risk is judged to be acceptable. Examples of mitigative measures include: removal and recompaction of poorly compacted soils; use of special foundations; stabilizing slopes; and draining, compaction, or chemical treatment of liquefiable soils. The geological hazard report must identify feasible mitigative measures.

Required Documentation

Investigations of geologic hazards must be documented. As noted in the paragraph entitled "Required Investigation" above, a preliminary geologic hazard investigation must be conducted and a report issued during the siting phase for a facility. However, unless the geologic hazard investigations have been documented in a stand-alone report, they must be addressed in a section of the geotechnical engineering report prepared during the design phase of a project. The geologic hazard report, whether it is a separate report or a section of the geotechnical engineering report, must at a minimum contain the following:

- List of hazards investigated, which must include the five described earlier in this section
- Description of the methods used to evaluate the site for each hazard
- Results of any investigations, borings, etc.
- Summary of findings
- Recommendations for hazard mitigation, if required

In some cases, estimates of site ground motions may be needed for assessment of geologic hazards such as liquefaction and slope failure.

A.6 Energy Analysis Input and Output

This Appendix defines the procedures to achieve compliance with the requirements in Section 5.3 (Energy Analysis Criteria).

Procedures

The Architectural/Engineering Design Team (A/E) must reference and utilize the following format for building input parameters, schedules of building operations, and categories for reporting results for the baseline and alternate building models. These procedures must be consistent throughout the design process. Input parameters and output data must be provided in all document submissions (see Section 5.3).

At each phase of the design process (i.e., conceptual design, design development, and construction documentation), the A/E must provide inputs as indicated in this appendix, if they are not otherwise defined in the program requirements (see P100 Section 5.3). The A/E must refer to ASHRAE Standard 90.1-2007 (including addenda) documents for climate zone and other pertinent information as may be required. If any changes are required to these input values due to special field conditions, the A/E must adjust the inputs giving an explanation in the beginning of the energy analysis report.

The analysis must document the sources of input data and all assumptions.

Table A6-1

Building Envelope Criteria (Input)

Building Envelope Requirements [1,2]

Opaque Element	Assembly	Remarks
Wall Above Grade	Mass Metal Steel Framed Wood Framed	Wall design must allow a thermal lag of at least 8 hours except in areas where diurnal temperature change is less than 16.7°C (30°F).
Wall Below Grade		
Roof	Insulation above deck Metal Attic/other	
Floors	Mass Steel-joist Wood framed/other	
Slab on Grade	Unheated Heated	
Doors Opaque	Swinging Non-swinging	
Fenestration	Glazing	Refer to Chapter 5, Section 5.3, Heat and Moisture Transfer
Infiltration		Refer to Chapter 5, Section 5.3 for requirements

1. Values for Thermal Conductance (C), Perimeter Heat Loss Factor (F), and Thermal Transmittance (U) shall be the minimum compliance values indicated in ASHRAE 90.1-2007 Chapter 5 and Table 5.5 for the associated project climate zone.

2. The “project climate zone” is the zone in which the project building is located on the Climate Zone Map and pursuant to the associated tables of ANSI/ASHRAE Standard 169.

Conceptual Design

The A/E must conduct an energy analysis for each of the three preliminary concepts (see Section A.3), using approved simulation software (See P100 Section 5.3). The primary variables in these analyses are orientation and massing. For the conceptual design, the performance parameters for the envelope, which include glazing, must be equal to the prescriptive minimum values listed in the applicable sections of ASHRAE Standard 90.1-2007, as referenced by P100 Input Table A6-1. All other parameters and input values as may be necessary to complete the model must be the minimum compliance values obtained from Input Tables A6-2 through A6-5. For the conceptual design analyses, glass and wall ratios and the shape must be configured to achieve the requirements of Chapters 1, 2, 3, 5 and 6 of P100.

Building site-energy and property site-energy consumption rates must be calculated for each of the three concepts, and presented as indicated by Output Table A6-6. For comparison purposes, all energy system alternatives for each concept must be adjusted to equivalent building site-energy consumption rates.

For the final concept submission, the energy analysis must provide output data to indicate optimization of the envelope, massing, and orientation that minimize the annual building or property site-energy consumption rates. This energy analysis report must include a statement summarizing the optimization findings and comparing the results with the energy target (see Chapter 1).

Design Development

The A/E must optimize system performance using simulation software (See P100, Section 5.3) to minimize annual building site-energy and property site-energy consumption rates. The primary variables in these analyses are the internal electrical and thermal loads imposed by the interior and exterior lighting, power requirements, other fixed loads (e.g., elevators, computer facilities), and schedules in accordance with P100, Chapters 3, 5, 6, 7 and 8. All other parameters and input values as may be necessary to complete the model must be obtained from those used in the final concept simulations and Input Tables A6-2 through A6-5 in this appendix. Project-specific envelope construction details must be applied as determined and detailed on the project submission drawings by the A/E. These analyses must be performed for the HVAC system as approved in the Final Concept submittal, in accordance with P100.

If alternative HVAC systems and components are to be considered (See Section 5.5), energy analyses must be conducted and compared to the results from the analysis of the reference system that has the lowest first cost of the alternatives being considered, in accordance with P100, Sections 1.12 and 5.3. These results must also be used as the input data to the life-cycle analysis required in P100, Section 1.12.

At completion of the DD phase, the system selection must be completed from which annual building site-energy and property site-energy consumption rates must be calculated. For these analyses, assume pump heads of 90 feet and fan total static pressures of 4 in.

For the 100 percent DD submission, the energy analysis must provide output data to indicate optimization of the baseline reference system and any cost-effective alternatives that minimize the annual building or property site-energy consumption. This energy analysis report must include a statement summarizing the optimization findings and comparing the results with the final concept results. Additionally, this analysis must continue to document the sources of input data and all assumptions, and refinements to the assumptions made in the concept phase. Equipment performance capacities and full- and part-load efficiencies must be substantiated by including representative equipment selections from manufacturers forming the basis of design. At least two additional simulations must be conducted to determine this impact of the input assumptions, which are to be varied to their maximum, or worst-case minimum, limits.

Construction Documents

The A/E must refine the optimized results from the 100 percent DD submission by using the actual input values rather than the assumed input values for the envelope, lighting, and power wattage, assumed pump heads and fan static pressures, HVAC and thermal zoning criteria, and schedules of operation (i.e., in lieu of Tables A6-1 through A6-5 in this appendix).

For the 90 percent construction document (CD) submission, the energy analyses must provide updated listings of input values including schedules of operation, and output data to indicate refinements in the optimization of the baseline and any cost-effective alternatives in the 100 percent DD analysis that minimize the annual building or property site-energy consumption rate. The 90 percent CD energy analysis report must include a statement summarizing the refined optimization findings and comparing the results with the 100 percent DD results.

Table A6-2

Building Internal Load Criteria (Input)

Internal Loads			
Lighting	Lighting power densities	Interior	Comply with Table 6-1
	LED and emergency lighting	0.8 W (2.7 Btu/h) per sign	
Equipment load	Receptacle load		Comply with Table 6-2
Occupancy	Function	Persons/92.9 m² (1,000 sq.ft.)	
	Office	5	
	Reception	30	
	Main entry lobbies	10	
	Auditorium	150	
	Courtrooms	70	
	Libraries	10	
	Lobbies	150	
	Coffee stations	20	
	Conference/meeting	50	
	Cafeteria	100	
	Computer lab	25	
	Sensible load per person	71.8 W (245 Btu/h)	*ASHRAE Handbook of Fundamentals, 2009*
	Latent load per person	60.1 W (205 Btu/h)	*ASHRAE Handbook of Fundamentals, 2009*

Table A6-3

Building Miscellaneous Loads Criteria (Input)

Elevator	Passenger	14.9 kW (20 hp)
	Freight	29.8 kW (40 hp)
Exterior lighting		Comply with Table 6-1
Daylighting	Area to be daylit	25% of floor area, using photo sensors

Table A6-4

Building HVAC and Thermal Zoning Criteria (Input)

Thermal Zoning — Area	Interior (open office)	Not to exceed 139 m^2 (1,500 sq. ft.)		
	Interior (closed office)	Maximum of 3 offices per zone		
	Perimeter	Not to exceed 28 m^2 (300 sq. ft.), no more than 4.6 m (15 ft.) from outdoor wall		
	Corner office	Dedicated zone		
Outdoor Air Ventilation System (OAVS)	Type	100% outside air unit		
	Load	Calculated as per Chapter 5, Section 5.3		
	Heat Recovery	Building exhaust air heat recovery to precondition outside air		
	Supply Air Dew Point Control	11°C (52°F)		
Building Pressurization	Occupied hours	Positive pressure on each floor	OAVS supply 10% more than mechanical exhaust	
	Unoccupied hours		Refer to Chapter 5, Section 5.4 for requirements	
Perimeter and Interior Heating and Cooling	Area	Type		Criteria
	Perimeter Zones	1. VAV with inline VAV terminals with	Hot water heat	climates > 1000HDD
			Electric heat	climates < 1000HDD
		2. VAV with fan powered VAV terminals with	Hot water heat	climates > 1000HDD
			Electric heat	climates < 1000HDD
		3. Floor-mounted four-pipe fan coil unit		
	Interior Zones	Same as perimeter zones	No heating coil	Except if adjacent to roof or unconditioned space
Air Handling Units	Type	Capacity		
	OAVS	< 11,800L/s (25,000 cfm)		
	AHU	< 11,800L/s (25,000 cfm)		
	AHU for special areas	< 11,800L/s (25,000 cfm)		
	Supply air temperature	Dew point temp > 10°C (50°F)		
		Dry bulb temp > 11°C (52°F)		
Supply, Return, Relief Air Fans	Fan Power Limitation	Comply with ASHRAE 90.1-2007 Table 6.5.3.1.1		
	VAV Fan Part Load Performance	Comply with ASHRAE 90.1-2007 Table G3.1.3.15		
Filters	Filters (AHU)	Prefilters	MERV 8	
		Final filters	MERV 13	
		Size	2.5 m/s (500 fpm) maximum face velocity	
	Filters (VAV)		MERV 10	
	Filters (FCU)		MERV 10	

Heat Recovery		Efficiency	70%
		Filters	MERV 10
	Sensible Heat Recovery		Run around type heat pipe system
			Cross flow, air to air heat exchanger
		Sensible heat wheel	Variable speed drives
	Total Heat Recovery	Desiccant-impregnated enthalpy wheel	Variable speed drives
Motors		Efficiency	Comply with Section 10.4.1 of ASHRAE 90.1-2007
		Polyphase	> 0.37 kW (½ hp)
		Single phase	< 0.37 kW (½ hp)
Boilers	Dual Fuel Modular Units (Natural Gas and Oil)	Efficiency (Natural gas boiler)	ASHRAE 90.1-2007 Table 6.8.1F
		Control	Modulating burner control
			Outside air reset
Hot Water Pumps	Primary	Type	Centrifugal
		Efficiency	80%-85%
			1,750 RPM
		Quantity	Correspond to number of boilers
	Secondary		Variable volume
Chilled Water and Condenser Water Pumps		Type	Centrifugal, variable volume
		Efficiency	80%-85%
			1,750 RPM
		Quantity	Correspond to number of chillers
Central Chilled Water Plant	Chillers	Full load and part load efficiencies (COP & IPLV)	Comply with ASHRAE 90.1-2007 Table 6.8.1
		Central chilled water systems > 500 tons	Centrifugal chillers
		Central chilled water systems < 500 tons	Reciprocating compressor chiller
		Control	Chiller staging should be enabled
Heat Rejection Equipment	Cooling Tower	Quantity of cells	Equal or exceed the number of chillers
		Type	Induced draft
		Condenser fan	Multispeed or variable speed
		Performance requirement	Comply with ASHRAE 90.1-2007 Table 6.8.1G
Domestic Hot Water		Boiler Efficiency	Comply with ASHRAE 90.1-2007 Table 7.8
		Recirculation pump	1/10th of the DHW pump HP
Waterside Economizers	Design Capacity	Provide 5.5°C (42°F) chilled water	1.2°C (2°F) approach temperature
			Dedicated pumping system

Table A6-5

Schedules of Operation (Input)

				Hour																							
Schedule	Schedule Type	Area	Time of Operation	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Lighting	Fraction	Office	WD 8AM-5PM	0.1	0.1	0.1	0.1	0.1	0.1	0.7	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.7	0.1	0.1	0.1	0.1
			WEH	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Courtroom	WD 8AM-4PM	0.1	0.1	0.1	0.1	0.1	0.1	0.7	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.7	0.1	0.1	0.1	0.1	0.1
			WEH	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		24-hr facility	24/7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Occupancy	Fraction	Office	WD 8AM-5PM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0
			WEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Courtroom	WD 8AM-4PM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
			WEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		24-hr facility	24/7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Fan	On/Off	Office	WD 8AM-5PM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
			WEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Courtroom	WD 8AM-4PM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
			WEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		24-hr facility	24/7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cool Thermostat	DegF	Office	WD 8AM-5PM	84	84	84	84	84	84	84	84	74	74	74	74	74	74	74	74	74	74	84	84	84	84	84	84
			WEH	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
		Courtroom	WD 8AM-4PM	84	84	84	84	84	84	84	84	74	74	74	74	74	74	74	74	74	84	84	84	84	84	84	84
			WEH	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
		24-hr facility	24/7	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74

WD–Weekday

WEH–Weekend Hours

Schedule	Schedule Type	Area	Time of Operation	Hour 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Heat Thermostat	DegF	Office	WD 8AM-5PM	55	55	55	55	55	55	55	55	70	70	70	70	70	70	70	70	70	70	55	55	55	55	55	55
			WEH	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
		Courtroom	WD 8AM-4PM	55	55	55	55	55	55	55	55	70	70	70	70	70	70	70	70	70	55	55	55	55	55	55	55
			WEH	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
		24-hr facility	24/7	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Elevator	On/Off	Office	WD 8AM-5PM	0	0	0	0	0	0	0	0.4	1	0.5	0.4	0.5	0.6	0.5	0.4	0.4	0.5	0.6	0.2	0.1	0.1	0.1	0	0
			WEH	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0	0	0	0	0
		Courtroom	WD 8AM-4PM	0	0	0	0	0	0	0	0.4	1	0.5	0.4	0.5	0.6	0.5	0.4	0.4	0.6	0.2	0.1	0.1	0	0	0	0
			WEH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		24-hr facility	24/7	0	0	0	0	0	0	0	0.4	1	0.5	0.4	0.5	0.6	0.5	0.4	0.4	0.5	0.6	0.2	0.1	0.1	0.1	0	0

Table A6-6

Output Energy Reporting Criteria (Output in Btu/GSF/year)

Output energy to be reported under following categories

Equipment	Lighting	Task Lighting	Space Heating	Space Cooling	Heat Rejection	Pumps and Auxiliary	Vent Fans	Domestic Hot Water	External Usage	Total

B.1 References

List of Reference Publications and Web Sites

All references are to the edition in effect at the time of execution of the A/E contract for the project, unless noted otherwise.

Introduction

The following references apply to all P100 chapters.

Publications

Guiding Principles of Federal Architecture

Hallmark of the Productive Workplace

42 U.S.C. 4151 et seq., Architectural Barriers Act Accessibility Standard (ABAAS)

Web Sites

www.gsa.gov/firstimpressions
(First Impressions Program)

www.gsa.gov/workplace
(Workplace 20/20 Program)

www.gsa.gov/bim
(3D-4D Building Information Modeling)

www.wbdg.org/ccb/GSAMAN/buildingcommissioningguide.pdf
(Building Commissioning Guide)

Chapter One General Requirements

The following references apply to all P100 chapters.

Publications—General Federal

40 U.S.C. 601a, Public Buildings Cooperative Use Act of 1976

Energy Policy Act of 2005

National Historic Preservation Act of 1966 as amended (NHPA)

40 CFR, Protection of Environment

Federal Management Regulation (FMR), based on the Public Buildings Amendments of 1988, Title 40, Subtitle II, Part A, Chapter 33, Section 3312

36 CFR 67, Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings

29 CFR 1926, Safety and Health Regulations for Construction, Section 1926.62, Lead (including lead-based paint)

29 CFR 1910 Occupational Safety and Health Standards, Section 1910.146(b)—Definition of "Confined space"

EO 13423 Strengthening Federal Environmental, Energy, and Transportation Management (includes guiding principles of Federal leadership in high-performance and sustainable buildings)
http://www.wbdg.org/sustainableEO

Executive Order 13502, Use of Project Labor Agreements for Federal Construction Projects, February 6, 2009
http://edocket.access.gpo.gov/2009/pdf/E9-3113.pdf

EO 13514 Federal Leadership in Environment, Energy, and Economic Performance

EPA Comprehensive Procurement Guidelines (CPG) (recycled products)
http://www.epa.gov/cpg

USDA BioPreferred Program
http://www.biopreferred.gov

DOE Guidance for Electric Metering in Federal Buildings DOE/EE 0312

Food, Conservation and Energy Act of 2008

Farm Security and Rural Investment Act of 2002

Publications Related to Specific GSA PBS Programs

PBS Design Excellence Policies and Procedures

PBS Pricing Desk Guide

PBS National Business Space Assignment Guide
http://www.gsa.gov/sdm

GSA 3490.1A on Document Security for Sensitive But Unclassified Building Information

Federal Courthouses

GSA Courthouse Visitor's Guide, February 2003

GSA Courthouse Project Handbook, August 2004

U.S. Courts Design Guide

U.S. Marshals Service Judicial Security Systems Requirements and Specifications, Volume 3, Publication 64, 2005

U.S. Marshals Service Requirements and Specifications for Special Purpose and Support Space, Volume One: Architectural & Engineering, 2007; *Volume Two: Electronic Security & Hardware,* 2007

Land Ports of Entry

United States Border Station Design Guide (PBS-PQ130)

Childcare Centers

Child Care Center Design Guide (PBS-P140)

Accreditation Criteria and Procedures of the National Association for the Education of Young Children (NAEYC)

Design Excellence and the Arts

GSA PBS Design Excellence Policies and Procedures

GSA PBS Design Excellence in Leasing

GSA PBS Art in Architecture Program Policies and Procedures

GSA PBS Fine Arts Program Policies and Procedures

Office of Design and Construction

GSA PBS *Project Management Guide*

GSA PBS *Project Planning Guide*

GSA PBS *Project Estimating Requirements Guide*

GSA PBS *Building Commissioning Guide*

GSA PBS *Site Selection Guide*

GSA PBS PQ Z60 *Metric Design Guide*

Security

Interagency Security Committee's Physical Security Criteria for Federal Facilities and the ISC Security Level Determination of Federal Facilities, dated February 21, 2008 (Official Use Only—request from project manager)

GSA PBS *Design Notebook for Federal Lobby Security*

GSA PBS *Site Security Design Guide*

Office Facilities Management and Services Programs

GSA PBS *Floodplain Management Desk Guide*

GSA PBS *NEPA Desk Guide*

GSA PBS *UST Guide*

GSA PBS *Universal Waste Guide*

Publications from Industry

American National Standards Institute/ American Industrial Hygiene Association (ANSI/AIHA):

Z10-2005, American National Standard—Occupational Health and Safety Management Systems

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

Standard 62.1-2004—Ventilation for Acceptable Indoor Air Quality

2001 *ASHRAE Fundamentals Handbook*

National Fire Protection Association (NFPA)
www.nfpa.org

NFPA 241: Standard for Safeguarding Construction, Alteration, and Demolition Operations

Additional Web sites

www.iccsafe.org (International Code Council)

www.wbdg.org (Whole Building Design Guide)

Chapter 2
Site Engineering and Landscaping

In addition to references cited for the Introduction and Chapter 1, the following are specifically relevant to Chapter 2.

Publications

33 U.S.C. 1251 Federal Water Pollution Control Act (Clean Water Act)

GSA PBS *The Site Selection Guide*
www.gsa.gov/siteselection

GSA PBS *Site Security Design Guide*

GSA ADM 1095.6, Consideration of Floodplains in Decision Making

GSA PBS *Wetlands Impact Management Desk Guide*

GSA PBS *NEPA Desk Guide*

GSA PBS *Sustainability Matters*
www.gsa.gov/sustainabledesign

U.S. Army Corps of Engineers (U.S.C.O.E.) *Wetlands Delineation Manual*

American National Standards Institute (ANSI)

American Standard for Nursery Stock/American National Landscape Association (ANLA)
www.anla.org

EPA Document No. EPA-832-R-92-005

Additional Web Sites

www.gsa.gov/environmental

www.access-board.gov

www.gsa.gov/nepa

www.epa.gov/owow/nps/lid/lidlit.html (EPA Low Impact Development (LID) Literature Review and Fact Sheets)

www.invasivespeciesinfo.gov

http://www.thecptedpage.wsu.edu/Resources.html (Crime Prevention Through Environmental Design— CPTED)

Chapter 3
Site and Architectural Planning and Design

In addition to references cited for the Introduction and Chapter 1, the following are specifically relevant to Chapter 3.

Publications

GSA PBS *Concession Management Desk Guide* (PMFC-93)

Fine Arts Collection Policies and Procedures, Chapter 10

PBS Order No. 3490.1, Document Security for Sensitive but Unclassified Paper and Electronic Building Information, Section 7.d.(1.)

Federal Standard 795, Uniform Federal Accessibility Standards

Publications from Industry

American Architectural Manufacturers Association (AAMA)

1502.7, Voluntary Test Method for Condensation Resistance of Windows, Doors, and Glazed Wall Sections

101/I.S.2/A440-05, Standard/Specification for Windows, Doors, and Unit Skylights (includes AAMA/WDMA 101/I.S.2/NAFS)

1600 Voluntary Specification for Skylights

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

Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings

American Society of Mechanical Engineers (ASME)

A17.1 Safety Code for Elevators and Escalators

American Society of Testing and Materials (ASTM)

C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

C635, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings

C636, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels

C645, Standard Specification for Nonstructural Steel Framing Members

C1371, Standard Test Method For Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

C1396, Standard Specification for Gypsum Board

E90, Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

E336, Standard Test Method for Measurement of Airborne Sound Insulation in Buildings

E903, Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres

E1007, Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures

E1130, Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index

E1414, Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum

E1918, Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field

E1946, Standard Practice for Measuring Cost Risk of Buildings and Building Systems

E1980, Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces

E2396, Standard Test Method for Saturated Water Permeability of Granular Drainage Media [Falling-Head Method] for Green Roof Systems

E2397, Standard Practice for Determination of Dead Loads and Live Loads Associated with Green Roof Systems

E2398, Standard Test Method for Water Capture and Media Retention of Geocomposite Drain Layers for Green Roof Systems

E2399, Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems

E2400, Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roof Systems

American National Standards Institute (ANSI)

ANSI/ASSE Provision of Slip Resistance on Walking/Working Surfaces

Architectural Woodwork Institute (AWI)

Architectural Woodwork Quality Standards (for grades of interior architectural woodwork, construction, finishes, and other requirements)

Brick Industry Association (BIA)

Technical Notes on Brick Construction

Indiana Limestone Institute (ILI)

ILI Handbook

Marble Institute of America

Dimension Stone Design Manual

National Concrete Masonry Association (NCMA)

TEK Manual for Concrete Masonry Design and Construction

Annotated Design and Construction Details for Concrete Masonry

National Roofing Contractors Association (NRCA)

Roofing Manual: Membrane Roof Systems

Roofing and Waterproofing Manual

Steep-Slope Roofing Manual

Architectural Metal and Sheet Metal Roofing Manual

Precast/Prestressed Concrete Institute

Architectural Precast Concrete

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

Architectural Sheet Metal Manual

Steel Door Institute (SDI)

SDI 122-99 Installation and Troubleshooting Guide for Standard Steel Doors and Frames

Telecommunications Industry Association/ Electronic Industries Alliance (TIA/EIA)

TIA/EIA-569-A, Commercial Building Standards for Telecommunications Pathways and Spaces

Chapter 4 Structural Engineering

In addition to references cited for the Introduction and Chapter 1, the following are specifically relevant to Chapter 4.

Publications

Federal Emergency Management Agency (FEMA):

Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings (FEMA 350)

Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel Moment-Frame Buildings (FEMA 351)

Recommended Post-Earthquake Evaluation and Repair Criteria for Welded Steel Moment-Frame Buildings (FEMA 352)

Recommended Specifications and Quality Assurance Guidelines for Steel Moment-Frame Construction for Seismic Applications (FEMA 353)

Techniques for the Seismic Rehabilitation for Existing Buildings (FEMA 547)

American Society for Testing and Materials (ASTM)

C150, Standard Specifications for Portland Cement

C 311, Standard Methods of Sampling and Testing Fly Ash and Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete

C 595, Standard Specification for Blended Hydraulic Cements

C 618, Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

C 989, Ground Granulated Blast-Furnace Slag for Use in Concrete Mortars

Interagency Committee on Seismic Safety in Construction (ICSSC)

ICSSC RP 6 (NISTIR 6762), Standards of Seismic Safety for Existing Federally Owned Leased Buildings. ICSSC RP 6 can be downloaded as a PDF at **http://fire.nist.gov/bfrlpubs/build01/PDF/b01056.pdf**

American Institute of Steel Construction (AISC) Series

Steel Design Guides

American Society of Civil Engineers

ASCE/SEI 31, Seismic Evaluation of Existing Buildings

ASCE/SEI 41, Seismic Rehabilitation of Existing Buildings

Telecommunications Industry Association/ Electronic Industries Alliance (TIA/EIA)

TIA/EIA-569-A, Commercial Building Standards for Telecommunications Pathways and Spaces

Web sites

http://fire.nist.gov/bfrlpubs/build01/PDF/b01056.pdf

http://nsmp.wr.usgs.gov/celebi/gsa_report_instrumentation.pdf

Chapter 5
Mechanical Engineering

In addition to references cited for the Introduction and Chapter 1, the following are specifically relevant to Chapter 5.

Publications

American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)

Handbook of Fundamentals

Handbook of Refrigeration

Handbook of HVAC Applications

Handbook of HVAC Systems and Equipment

Standard 15: Safety Code for Mechanical Refrigeration

Standard 52.2: Method of Testing: General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

Standard 55: Thermal Environmental Conditions for Human Occupancy

Standard 62.1: Ventilation for Acceptable Indoor Air Quality

Standard 90.1-2004: Energy Standard for Buildings Except Low-Rise Residential Buildings

Standard 100-2006: Energy Conservation in Existing Buildings

Standard 105-1999: Standard Method of Measuring and Expressing Building Energy Performance

Standard 111-1988: Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC Systems

Standard 113-2005: Method of Testing for Room Air Diffusion

Standard 135-2004: BACnet: A Data Communication Protocol for Building Automation and Control Networks

Guideline 0-2005: The Commissioning Process

Guideline #4-1993: Preparation of Operating and Maintenance Documentation for Building Systems

Guideline #12-2000: Minimizing the Risk of Legionellosis Associated with Building Water Systems

Guideline #29-2007: Guideline for Risk Management of Public Health and Safety in Buildings

American National Standards Institute (ANSI)

ANSI Z 223.1., National Fuel Gas Code

American Society of Plumbing Engineers (ASPE)

ASPE Data Books

American Society for Testing and Materials (ASTM)

ASTM E-84, Surface Burning Characteristics of Building Materials

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

HVAC Duct Construction Standards: *Metal and Flexible HVAC Air Duct Leakage Test Manual*

Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems

Seismic Restraint Manual Guidelines for Mechanical Systems

National Fire Protection Association (NFPA)

NFPA 70, National Electrical Code

NFPA 101, Life Safety Code

EIA/TIA Standard 569

Commercial Building Standard For Telecommunications Pathways and Spaces (and related bulletins)

Underwriters Laboratories (UL)

UL 710

Chapter 6
Electrical Engineering

In addition to references cited for the Introduction and Chapter 1, the following are specifically relevant to Chapter 6.

Publications

American National Standards Institute (ANSI)

ANSI/ASHRAE/IESNA: Standard 90.1-2004: Energy Standard for Buildings Except Low-Rise Residential Buildings

ANSI/UL50, Enclosures for Electrical Equipment for Types 12, 3, 3R, 4, 4X, 5, 6, 6P, 12, 12K, and 13

American Society of Mechanical Engineers (ASME)

A17.1: Safety Code for Elevators and Escalators

BICSI

Telecommunications Distribution Methods Manual

Wireless Design Reference Manual

Federal Information Processing Standard 175

Federal Building Standard for Telecommunication Pathways and Spaces

Illuminating Engineering Society of North America (IESNA)

Lighting Handbook

National Fire Protection Association (NFPA)

NFPA 70, National Electrical Code

NFPA 101, Life Safety Code

NFPA 110, Standard for Emergency and Standby Power Systems

NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems

NFPA 780, Standard for the Installation of Lightning Protection Systems

Underwriters Laboratories (UL)

UL 67 Panelboards

UL 96

Chapter 7
Fire Protection and Life Safety

In addition to references cited for the Introduction and Chapter 1, the following are specifically relevant to Chapter 7.

Publications

American Society of Mechanical Engineers (ASME)

ASME A17.1, Safety Code for Elevators and Escalators

American Society for Testing Materials (ASTM)

ASTM E-2073, Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings

Code of Federal Regulations (CFR)

CFR 36 Part 1228, Subpart K—Facility Standards or Record Storage Facilities

National Archives and Records Administration (NARA)

NARA Directive 1571

National Fire Protection Association (NFPA)

NFPA 13, Standard for the Installation of Sprinkler Systems

NFPA 13D, Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes

NFPA 14, Standard for the Installation of Standpipe and Hose Systems

NFPA 17A, Standard for Wet Chemical Extinguishing Systems

NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection

NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NFPA 30, Flammable and Combustible Liquids Code

NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals

NFPA 72, National Fire Alarm Code

NFPA 75, Standard for the Protection of Electronic Computer/Data Processing Equipment

NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems

NFPA 101, Life Safety Code

NFPA 170, Standard for Fire Safety Symbols

NFPA 214, Standard on Water-Cooling Towers

NFPA 232, Standard for the Protection of Records

NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations

NFPA 914, Code for Fire Protection of Historic Structures

Underwriters Laboratories (UL)

UL 1994 Standard for Luminous Egress Path Marking Systems

B.2 Acronyms and Abbreviations

A/E architect/engineer

AABC Associated Air Balance Council

AAMA American Architectural Manufacturers Association

ABA Architectural Barriers Act of 1968

ABAAS Architectural Barriers Act Accessibility Standard

ACH air changes per hour

ACM asbestos-containing material

ADP automated data processing

ADPI air diffusion performance index

AEDG Advanced Energy Design Guide

AHJ Authority having jurisdiction

AHU air-handling unit

AIHA American Industrial Hygiene Association

AISC American Institute of Steel Construction

ALS assisted listening system

ANLA American National Landscape Association

ANSI American National Standards Institute

AOC Administrative Office of the United States Courts

AOUSC Administrative Office of the United States Courts

ASD allowable stress design

ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers

ASME American Society of Mechanical Engineers

ASPE American Society of Plumbing Engineers

ASTM American Society of Testing and Materials

ATS automatic transfer switch

AWI Architectural Woodwork Institute

BAS building automation system

BF ballast factor

BIA Brick Institute of America

BICSI Building Industry Consulting Service International

BIM building information modeling

BIM building information models

BLCC building life-cycle cost

BOMA Building Owners and Managers Association International

BPP Building Preservation Plan

BSO basic safety objective

CATV cable television

CAV constant air volume

CCMG Central Courthouse Management Group

CCR Criteria Change Request

CD construction drawings

CD construction documentation

CDC Centers for Disease Control

CFC chlorofluorocarbon

CFL compact fluorescent lamps

CFR Code of Federal Regulations

CHP combined heat and power plant

CPG Comprehensive Procurement Guidelines

CPI Consumer Price Index

CPTED Crime Prevention through Environmental Design

CPVC chlorinated polyvinyl chloride

CRF condensation resistance factor

CRI color rendering index

CSC Court Security Committee

DC direct current

DD design development

DDC direct digital control

DHS Department of Homeland Security

DNL day-night average noise level

EA environmental assessment

ECS emergency communications systems

EIA Electronic Industries Alliance

EIS environmental impact statement

EISA 2007 Energy Independence and Security Act of 2007

EPAct 2005 Energy Policy Act of 2005

EPO emergency power off

EPPS emergency power supply system

EPR ethylene propylene rubber

ETS environmental tobacco smoke

FAR	Federal Acquisition Regulation
FAS	Federal Acquisition Service
FC	final concepts
FCxA	fire commissioning agent
FEMA	Federal Emergency Management Agency
FIIC	field impact isolation class
FMR	Federal Management Regulation
FPS	Federal Protective Service
FPT	functional performance test
FSC	Forest Stewardship Council
FSC	Facility Security Committee
FTE	full-time equivalent
GFI	ground fault interrupt
GSA	General Services Administration
gsf	gross square feet
HB	heat balance
HET	high efficiency toilet
HEU	high efficiency urinal
HGL	hydraulic grade line
HID	high intensity discharge
HMT	harmonic mitigating transformers
HUD	Department of Housing and Urban Development
HVAC	heating, ventilating, and air conditioning
IBC	International Building Code
ICC	International Code Council
ICSSC	Interagency Committee on Seismic Safety in Construction
IEBC	International Existing Building Code
IESNA	Illuminating Engineering Society of North America
IG	isolated ground
IGE	independent government estimate
ILI	Indiana Limestone Institute
IMC	intermediate metallic conduit
IRC	international residential code
IRI	International risk insurance
IRMA	inverted membrane roof assembly
ISC	Interagency Security Committee
ISC	Interagency Security Criteria
ISO	International Organization for Standardization
JSST	Judicial Security Systems Team
LCC	life-cycle costing
LCS	luminaire classification system
LED	light emitting diode
LEED	Leadership in Energy and Environmental Design
LID	Low impact development
LLD	lamp lumen depreciation
LPD	lighting power density
LPOE	Land Ports of Entry
LPW	lumen per watt
LRFD	load resistance factor design
MCC	motor control center
MERV	minimum efficiency reporting value
MOA	memorandum of agreement
MRL	machine roomless
NAEYC	National Association for the Education of Young Children
NARA	National Archives and Records Administration
NC	noise criteria
NC-B	balanced noise criteria
NCMA	National Concrete Masonry Association
NEBB	National Environmental Balance Bureau
NEII	National Elevator Industries, Inc.
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NHPA	National Historic Preservation Act
NIC	noise isolation class
NIST	National Institute of Standards and Technology
NRCA	National Roofing Contractors Association
OAVS	outdoor air ventilation system
ODCP	Office of Design and Construction Programs
OMB	Office of Management and Budget

OSHA	Occupational Health and Safety Administration
P100	Public Buildings Service PBS 100
PBAX	telephone exchange
PBS	Public Buildings Service
PBS-P140	Child Care Center Design Guide
PBS-PQ130	United States Border Station Design Guide
PBS-PQ260	Metric Design Guide
PBT	persistent bio-accumulative toxin
PCC	point of common coupling
PCI	Precast Concrete Institute
PDA	personal digital assistant
PDI	Plumbing and Drainage Institute
PDU	power distribution unit
PER	project estimating requirements
PF	power factor
PMFC-93	Concession Management Desk Guide
PV	photovoltaic system
PWM	pulse width modulation
R&A	repairs and alterations
RAF	raised access floor
RC	room criteria
RD	requirements development
RGS	rigid galvanized steel
RH	relative humidity
RHPO	Regional Historic Preservation Officer
ROD	record of decision
RTS	radiant time series
SAA	sound absorption average
SBU	sensitive but unclassified
SCAQMD	South Coast Air Quality Management District
SCIF	sensitive compartmented information facility
SDI	Steel Door Institute
SFI	Sustainable Forestry Initiative
SFO	solicitation for offers
SFPE	Society of Fire Protection Engineers
SI	international system
SIR	savings to investment ratio
SLC	signaling line circuits
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
STC	sound transmission class
SWAT	smart water application technology
TAB	testing, adjusting, and balancing
TABB	Testing, Adjusting, and Balancing Bureau
TBC	Total Building Commissioning
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solid
TFM	transfer function method
THD	total harmonic distortion
TI	tenant improvement
TIA	Telecommunications Industry Association
TM	training manual
TTY	text telephone
U.S.C.O.E.	U.S. Army Corps of Engineers
UFAD	underfloor air distribution
UFAS	Uniform Federal Accessibility Standards
UL	Underwriters Laboratory
UPS	uninterruptible power supply
USCDG	U.S. Courts Design Guide
USMS	U.S. Marshals Service
UST	underground fuel oil storage tank
UV	ultraviolet
VAV	variable air volume
VE	value engineering
VFD	variable frequency drive
VOC	volatile organic compound
XLP	cross-linked polyethylene

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