



Facilities Standards for the Public Buildings Service

March 2005

U.S. GENERAL SERVICES ADMINISTRATION
OFFICE OF THE CHIEF ARCHITECT

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U.S. General Services Administration
Public Buildings Service
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More Information: <http://www.gsa.gov/P100>

General Requirements

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United States Courthouse

Seattle, Washington

Architect: NBBJ

GSA Project Manager: Rick D. Thomas

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1.1 Purpose of the Facilities Standards for the Public Buildings Service

The *Facilities Standards for the Public Buildings Service* establishes design standards and criteria for new buildings, major and minor alterations, and work in historic structures for the Public Buildings Service (PBS) of the General Services Administration (GSA). This document applies to all new facilities or alterations of GSA owned, or lease construction with Government Option to Purchase (See Section 1.3) buildings. It is recommended that the *Facilities Standards* apply to significant build-to-suit lease buildings. This document contains policy and technical criteria to be used in the programming, design, and documentation of GSA buildings.

The *Facilities Standards* is a building standard: it is not a guideline, textbook, handbook, training manual or substitute for the technical competence expected of a design or construction professional.

The *Facilities Standards* shall be used in conjunction with the specific building program for each project, which delineates all project information, such as number and sizes of building spaces, and requirements for mechanical, electrical and other operating systems. It is imperative that each building be designed so that all components comprise an integrated solution, so that operation of the facility, energy usage and other criteria may be maximized.

Since the *Facilities Standards* contain general criteria, there may sometimes be conflicts between the *Facilities Standards* and specific project requirements. The Office of the Chief Architect, Public Buildings Service, General Services Administration, Washington, DC 20405, (202) 501-1888, may be contacted for clarification of any particular requirement.

The provisions of this document are not intended to prohibit the use of alternative systems, methods, or devices not specifically prescribed by this document, provided GSA has approved such alternatives. All technical documentation shall be submitted to the GSA Project Manager. The technical documentation submitted shall demonstrate that the proposed alternative design is at least equivalent or superior to the prescribed requirements in this document with regard to quality, strength, effectiveness, fire resistance, durability, and safety. It is not to be considered a waiver or deletion of a requirement, but shall be recognized as being equivalent protection and in compliance with the technical requirements of this document. The alternative system, method, or device shall be approved when the GSA technical design professional determines that the proposed alternative design is deemed equivalent or superior to the intent of the prescribed requirements of this document for the intended purpose.



U.S. Census Bureau, Bowie, MD.

1.2 General Design Philosophy

As addressed in Appendix A2, all program goals shall be developed with integrated design practices. The following objectives are to be reflected in project programming and design:

Design Quality

GSA is committed to excellence in the design and development of its sites and buildings. For GSA, this means an integrated approach that achieves the highest quality of aesthetics in meeting the requirements of the building's users and accomplishing the mission of the Federal client agency, while at the same time delivering a building that is cost effective to maintain throughout its useful life and is a lasting architectural legacy that will serve the American people for many decades.

Most of the interaction between the Government and its citizens occurs in GSA buildings. Federal buildings express the image of the Government to the public. The Guiding Principles for Federal Architecture, written in 1962 by Senator Daniel Patrick Moynihan, then Special Assistant to the Secretary of Labor, and issued by the Kennedy Administration, embody GSA's commitment to produce quality design and construction. See Figure 1-1.

Design Excellence and Construction Excellence

The GSA Design Excellence Program was formally initiated in 1994 and the Construction Excellence Program in 1998. These programs ensure GSA's long-term commitment to excellence in public architecture, engineering, and construction. The selection of private

sector architects and engineers who design GSA facilities is based foremost on their talent, creativity, and ingenuity. The entire architect/engineer (A/E) design team must demonstrate its ability to satisfy the comprehensive project development and management requirements of the Federal Acquisition Regulations (FAR). The Design Excellence Program incorporates peer professional in the selection of A/E design teams and the review of proposed designs. The peer professionals are distinguished architects, engineers, landscape architects, urban designers, public arts administrators, design educators and critics from across the Nation. The main goal of the Design Excellence Program is to realize the objectives of the Guiding Principles of Federal Architecture.

The main goal of the Construction Excellence Program is to ensure that GSA's construction program delivers exceptionally well-built facilities economically, efficiently, and professionally. Like the Design Excellence Program, the Construction Excellence Program depends on a strong working relationship with the private sector design and construction community.

Flexibility and Adaptability

Federal buildings undergo many changes during their lifetime. As government missions change and priorities change, Federal agencies are created, expanded, and abolished. As a consequence, requirements for space and services change frequently, and space must be reconfigured often. The flexibility to accommodate continual change needs to be "built in" to the building design from the outset and respected in subsequent alterations. Systems flexibility is necessary in GSA buildings.

Sustainability and Energy Performance

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, environmental, societal and human benefits while meeting the mission and function of the intended facility or infrastructure.

Costs

It is imperative that Federal Facilities be designed with the objective of achieving lowest life cycle cost for the taxpayer. To do so, a project's design program must comprehensively define reasonable scope and performance requirements, and must match those needs to an appropriate overall budget. Consistent with programming and budgetary constraints, designed building systems/ features that influence operating costs must then be analyzed and selected to achieve lowest overall life cycle cost.

Life cycle costing will always require the application of professional judgement. While life cycle cost assessments can often be based upon the merits of single system/ feature comparisons, the A/E is expected to expand the analysis to include other systems/features when necessary to establish synergistic effects and first cost trade-offs. There will also be instances where involved life cycle cost elements are not well defined within the industry, defying

credible inclusion with known cost impacts. In such cases, life cycle cost comparisons must be weighed with qualitative issues when making design decisions.

Operations and Building Maintenance

Systems and materials should be selected on the basis of long-term operations and maintenance costs as those costs will be significantly higher over time than first costs. The design of the facility operating systems should ensure ease and efficiency of operation and allow for easy and cost effective maintenance and repair during the facility’s useful life.

The designer should obtain constant feedback from the building manager and other maintenance personnel during design. This collaboration will allow the facility to be designed with adequate understanding by both the designer and the building manager as to what is required for optimal life-cycle performance.

GSA requires detailed instructions from the designer stating the operational/maintenance procedures and design intent for all building systems. These instructions will be developed during the design phase and incorporated into the comprehensive training for operation and maintenance personnel.

Historic Buildings

The Historic Buildings program was formally initiated in 1998 as part of the Historic Buildings and the Arts Center of Expertise, established in 1997. The Historic Buildings program provides strategic and technical support to GSA business lines and regional project teams to promote the reuse, viability, and architectural design integrity of historic buildings GSA owns and leases. This mission requires GSA to be on the cutting edge in developing 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.

The National Historic Preservation Act 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. 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 Act and serve as first points of contact within each region to ensure that projects follow the Secretary’s Standards while satisfying GSA’s functional requirements.

Principal goals of the Historic Buildings program are to realize the objectives of the National Historic Preservation Act by: a) developing strategies that enable reuse of GSA’s historic buildings and b) developing creative design solutions to resolve conflicts between preservation, codes, and functional requirements of modern office use. The program depends on the integral involvement of preservation design professionals in the A/E team throughout design development and project execution and on effective coordination between the design team, GSA preservation staff, and outside review groups.

Art-in-Architecture

GSA has a policy of incorporating fine art into the design of new Federal buildings and in major repair and alterations of existing Federal buildings. One half of one percent of the estimated construction cost is reserved for commissioning works by living artists. These works are acquired through a commissioning process that involves public participation by art professionals, community representatives (including the primary client), and the architect of the building. The A/E team has a responsibility to work with GSA to ensure that the art is an integral component of the building.

Urban Design and Community Development

GSA is committed to maximizing the returns on its Federal real estate investment and to leveraging its investments in ways that support communities, wherever possible. Collaboration with local officials, neighboring property owners, residents, and appropriate interest groups is essential to shape the project in ways that provide positive benefits to the surrounding neighborhood and community.

Project teams should seek out potential issues and collaborate with local partners to solve them. Aggressive identification of issues and opportunities is necessary to minimize project risk and delay, strategize the long term use and maintenance of the facility, maximize the project's positive impact on the community, and bring local resources to bear on delivering the best final product to GSA clients.

Issues of common interest, such as facility location, architectural and urban design, parking, transportation, and security provide significant opportunities to work to address issues. Partners should include not only city officials but other entities with relevant knowledge, concerns, or resources. Formal planning and consultation

processes, such as NEPA, zoning, or Section 106, are important. But less formal planning, information sharing, and problem solving activities can be equally valuable to the project team.

First Impressions

The GSA First Impressions Program is a comprehensive, nationwide effort to improve the appearance of the public areas inside and surrounding our existing buildings. The program is comprised of five basic principles: streamlining security, consolidating functions, unifying signage, reducing clutter, and where necessary, implementing architectural modifications to transform the building's overall image. These principles should be applied to any building modernization, repair and alterations project, security upgrade, or landscape improvement that affects the public areas of a property. For mor information visit, www.gsa.gov/firstimpressions.

The Integrated Workplace and WorkPlace 2020

The GSA supports an interior design program that provides tenants with superior workplace environments that meet their business goals and enhances employee health, satisfaction, and performance. The workplace is successful when it is a strategic tool that is integral to business and real estate goals. It should provide an effective workplace for federal employees reflecting the clients' culture, motivation, business strategy and nature of their work.

PBS has developed the WorkPlace 2020 Program to help particular organizations identify the unique nature of its work, its culture and its organizational goals, and to directly link design recommendations based on those understandings to the workplace. For more information, visit the WorkPlace 2020 website at: www.gsa.gov/workplace2020, or www.gsa.gov/integratedworkplace.

Figure 1-1

Guiding Principles for Federal Architecture

In the course of its consideration of the general subject of Federal office space, the committee has given some thought to the need for a set of principles which will guide the Government in the choice of design for Federal buildings. The committee takes it to be a matter of general understanding that the economy and suitability of Federal office design space derive directly from the architectural design. The belief that good design is optional, or in some way separate from the question of the provision of office space itself, does not bear scrutiny, and in fact invites the least efficient use of public money.

The design of Federal office buildings, particularly those to be located in the nation's capital, must meet a two-fold requirement. First, it must provide efficient and economical facilities for the use of Government agencies. Second, it must provide visual testimony to the dignity, enterprise, vigor and stability of the American Government.

It should be our object to meet the test of Pericles' evocation to the Athenians, which the President commended to the Massachusetts legislature in his address of January 9, 1961: "We do not imitate – for we are a model to others."

The committee is also of the opinion that the Federal Government, no less than other public and private organizations concerned with the construction of new buildings, should take advantage of the increasingly fruitful collaboration between architecture and the fine arts. With these objects in view, the committee recommends a three point architectural policy for the Federal Government.



The policy shall be to provide requisite and adequate facilities in an architectural style and form which is distinguished and which will reflect the dignity, enterprise, vigor and stability of the American National Government. Major emphasis should be placed on the choice of designs that embody the finest contemporary American architectural thought. Specific attention should be paid to the possibilities of incorporating into such designs qualities which 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 shall adhere to sound construction practice and utilize materials, methods and equipment of proven dependability. Buildings shall be economical to build, operate and maintain, and should be accessible to the handicapped.

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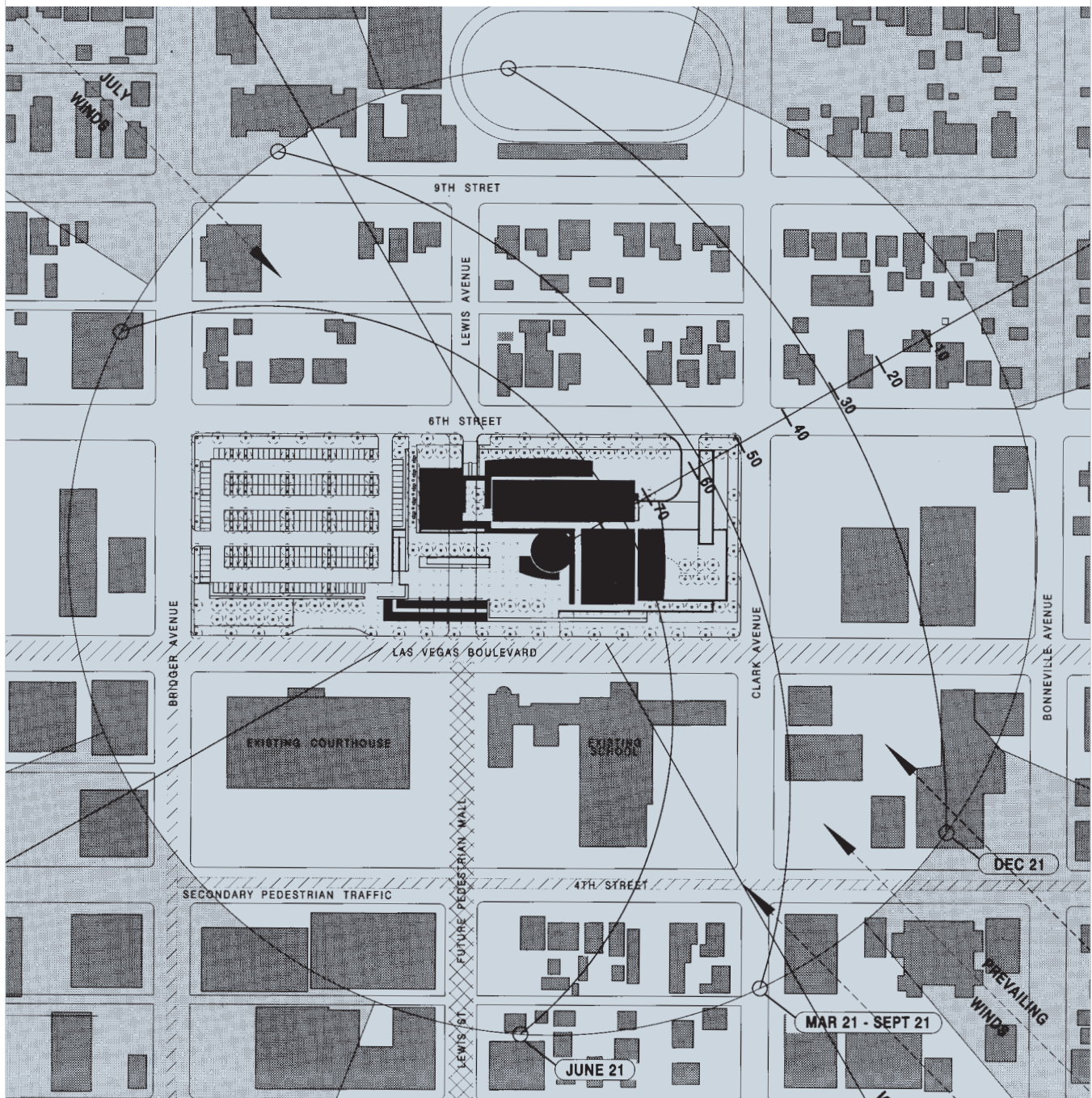
The development of an official style must be avoided. Design must flow from the architectural profession to the Government, and not vice versa. The Government should be willing to pay some additional cost to avoid excessive uniformity in design of Federal buildings. Competitions for the design of Federal 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.

2

The choice and development of the building site should be considered 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.

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— *Daniel Patrick Moynihan*



1.3 National Codes and Standards

Federal Law. The Public Buildings Amendments of 1988, 40 U.S.C. 3312 (formerly section 21 of the Public Buildings Act of 1959, 40 U.S.C. 619), require that each building constructed or altered by GSA or any other federal agency shall, to the maximum extent feasible, be in compliance with one of the nationally recognized model building codes and with other applicable nationally recognized codes.

Nationally Recognized Codes. 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 following nationally recognized codes referred to in this subsection. The technical requirements of these nationally recognized codes will supplement other GSA requirements mandated by Federal Laws and Executive Orders, as well as other GSA criteria noted within this document that has been established to meet our customers needs and their unique requirements. In addition, the latest edition of the nationally recognized codes, including the current accumulative supplements, in effect at the time of design contract award shall be used throughout design and construction of that project.

Building Code. The International Code Council (ICC) is a consolidated organization that is comprised of what was formerly the Building Officials and Code Administrators International, Inc. (BOCA), the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International, Inc. (SBCCI). Based upon this consolidation and consistent with GSA's established national policy, the GSA will utilize the technical requirements of the family of codes issued by ICC in lieu of the National Building Code (published by BOCA), the

Uniform Building Code (published by ICBO), and the Standard Building Code (published by SBCCI).

The ICC family of codes includes, but is not limited to: International Building Code (IBC), International Fire Code (IFC), International Plumbing Code (IPC), International Mechanical Code (IMC), and the International Energy Conservation Code (IECC). The ICC family of codes is available through www.iccsafe.org/.

Furthermore, the National Fire Protection Association (NFPA) has established its own family of national model codes and standards. Consistent with GSA's long-standing policy to comply with local codes and standards to the maximum extent practicable, NFPA codes may be used (to the maximum extent practicable) in jurisdictions where NFPA codes have been duly adopted by that locality.

Life Safety Code. GSA has adopted the technical egress requirements of the NFPA, Life Safety Code (NFPA 101), in lieu of the technical egress requirements of the IBC. NFPA 101 is available through www.nfpa.org/.

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

State and Local Codes. GSA recognizes that the national building codes are typically the foundation of state and local building codes. However, state and local codes also represent important regional interests and conditions. As such, State and Local building codes shall also be followed to the maximum extent practicable.

Legally, however, buildings built on Federal property are exempt from State and local building codes. Notwithstanding, it is GSA's policy to comply with State and local building codes to the maximum extent practicable.

National Standards. The latest edition of the nationally recognized standards herein, in effect at the time of design contract award shall be used during design and construction.

Lease Construction. Lease construction is defined as new construction of a building for Government use in response to GSA’s formal solicitation for offers. The construction may be either on a pre-selected site assigned by GSA to the successful offeror or on the offeror’s site. Therefore, the building will be developed on private land and the building will be leased to GSA. In these cases, the applicable State and local government codes apply. The developer/owner (i.e., offeror) must also obtain the necessary building permits and approvals from the appropriate State and/or local government officials. The Facilities Standards do not apply to Lease Construction, it does, however, apply to Lease Construction with Government Option to Purchase and is recommended for significant build-to-lease buildings. For requirements for Lease Construction see SFO specific program, i.e. seismic, environmental, fire safety, accessibility, etc.

Lease Construction with Government Option to Purchase. In cases where GSA’s formal solicitation for offers has an option for GSA to purchase the building at a future date, the GSA adopted nationally recognized codes and requirements apply as well as the applicable State and local government codes. Should a conflict exist between applicable State and local government codes and the GSA requirements, the GSA requirements take precedence. However, GSA shall carefully consider each conflict based on adequacy, cost, and nationally accepted practice. In addition, the developer/owner must also obtain the necessary building permits and approvals from the appropriate State and/or local government officials as well as from GSA.

Conflicts between Nationally Recognized Codes and GSA Requirements. To ensure flexibility, it is GSA policy to make maximum use of equivalency clauses in all nationally recognized codes. Should a conflict exist between GSA requirements and the GSA adopted nationally recognized codes, the GSA requirement shall prevail. All code conflicts shall be brought to the attention of the GSA Project Manager for resolution.

Code Requirements for Alterations. Generally, involved 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 nationally recognized codes adopted by GSA and interpreted by the specific GSA Region. If only a portion of the building is being renovated, the IBC shall be evaluated to determine if the entire building must be brought up to code compliance. Any questions or concerns should be discussed with the GSA Project Manager.

Zoning Laws. During the planning process and development of associated environmental documentation for new construction and renovation projects, GSA shall consider all requirements (other than procedural requirements) of zoning laws, design guidelines, and other similar laws of the State and/or local government. This includes, but is not limited to, laws relating to landscaping, open space, building setbacks, maximum height of the building, historic preservation, and aesthetic qualities of a building. The project design team is to fully address such laws and requirements in their planning and design documents. Any proposed deviations from such laws are to be documented, fully justified, and brought to the attention of the GSA Project Manager for resolution.

Local regulations must be followed without exception in the design of systems that have a direct impact on off-site terrain or utility systems (such as storm water run-off,

erosion control, sanitary sewers and storm drains and water, gas, electrical power and communications, emergency vehicle access, and roads and bridges).

With respect to the number of parking spaces, the requirements stated in the building program take precedence over zoning ordinances in all cases. Although GSA may not be able to directly compensate for displaced parking (as a result of site acquisition), the project team should seek creative alternatives and partnerships to address parking concerns brought about by GSA's development. Considerations may include shared parking facilities and strategies to encourage transit use.

In the case of leased facilities built on private land, all local zoning ordinances apply.

State and Local Government Consultation, Review, and Inspections. The GSA project manager shall provide to the appropriate State and/or Local Government officials the opportunity to review the project for compatibility with local plans, zoning compliance, building code compliance, and construction inspections. This must occur early in project design so that the design can easily respond to appropriate recommendations. This includes, but is not limited to the review of drawings and specifications, any on-site inspections, issuing building permits, and making recommendations for compliance with local regulations and compatibility with local fire fighting practices. The GSA Project Manager shall also inform the State and local government officials that GSA and its contractors will not be required to pay any amount for any action taken by the State and/or local government officials to carry out their mission. However, GSA shall review all recommendations made by State and local government officials. Each recommendation shall be carefully considered based on adequacy, cost, and nationally accepted practice. However, GSA has the final authority to accept or reject any recommendation from State and/or local government officials.

Zoning and other considerations relating to urban design issues. The design team should offer local officials an opportunity to informally review and comment on the design concept, for compatibility with local plans, zoning, and design guidelines. Key design milestones, such as at initial concepts and around the project's peer review sessions, offer logical timeframes for these reviews and can be especially helpful to the designers. If local officials choose to review the concept, the GSA project manager should establish a concise window in which comments can be accepted (e.g., no longer than 30 days), and this should be coordinated with the project design schedule. If local officials choose not to review the design concept, this should be noted in the project file.

Design review for code compliance. If the State and local government officials elect to review building designs for code compliance (i.e., final concepts, preliminary designs, and final working drawings), such design submissions will be officially forwarded to the appropriate local officials by the GSA Project Manager. Local officials will be provided 30 days for their review and comment in writing for each proposed design submission, with no time extensions. If comments are not received after the commenting period is over, the GSA Project Manager will proceed with project execution.

Construction Inspections. If the State and local government officials elect to perform code compliance construction inspections, the GSA Project Manager shall include special provisions in the A/E's and each contractor's contract to handle the additional requirement of coordinating their work with State and local government officials. Any findings resulting from such inspections by the State and local government officials shall be immediately communicated to the GSA Project Manager for consideration. It is to be clearly understood by all parties (e.g., State and local government officials, construction contractors, GSA, etc.)

that the State and local government officials do not have the authority to reject, accept, or make changes to the work and is there only to assist GSA in achieving code compliance.

State and local government recommendations. The GSA Project Manager should make an effort to incorporate State and local government recommendations when reasonable and when in the best interest of the Government. Notwithstanding, it is GSA’s policy to comply with State and local building codes to the maximum extent practicable. GSA shall review all recommendations made by State and local government officials. Each recommendation shall be carefully considered based on adequacy, cost, and nationally accepted practice. However, GSA has the final authority to accept or reject any recommendation. The GSA Project Manager shall maintain a record of all recommendations and comments from State and local government officials for the duration of the project.

1.4 Guides

The *Facilities Standards* and the noted guides apply to the GSA building program.

(In case of conflict between the Facilities Standards and a specific building guide, the guide takes precedence.)

Federal Courthouses	See also: <i>U.S. Courts Design Guide</i> ; <i>U.S. Marshals Service Requirements and Specifications for Special Purpose and Support Space Manual - sections 1,2 & 3</i> ; <i>Courthouse Project Handbook</i> , August 2004.
Border Stations	See also: <i>United States Border Station Design Guide</i> (PBS – PQ130).
Child Care Centers	See also: <i>Child Care Center Design Guide</i> (PBS – P140).
Design Excellence	GSA <i>PBS Design Excellence, Policies and Procedures</i> . GSA <i>PBS Design Excellence in Leasing</i> . <i>The Whole Building Design Guide</i> , www.wbdg.org .
Fine Arts	GSA <i>PBS Fine Arts Program Desk Guide</i> 2002.

1.5 Commissioning

Project Development

GSA PBS *Project Management Guide*.
GSA PBS *The Project Planning Guide*.
GSA PBS *Cost Estimating Guide*.
GSA PBS *The Building Commissioning Guide*.

Historic Buildings

See also: Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* (36 CFR67).
GSA PBS *Growth Efficiency and Modernism*.

Landscape

See also: local standards. Also use *American Association of Nurserymen: ANSI Z60.1* in addition as a design guide.

Security

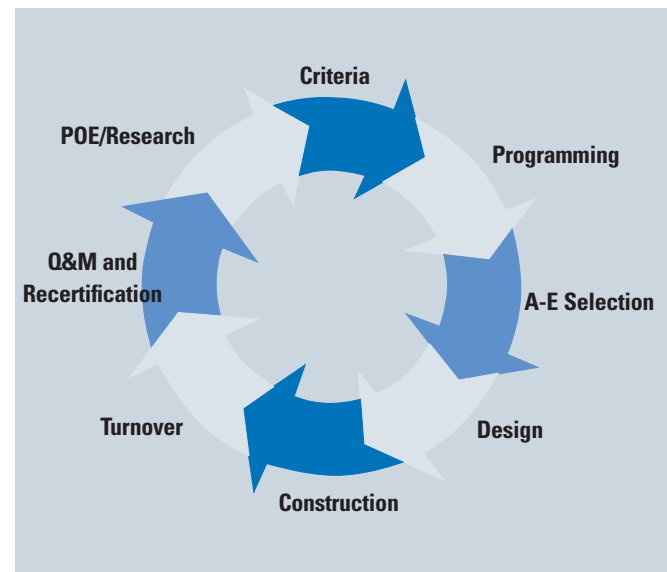
Interagency Security Committee's *Security Design Criteria*.
GSA PBS *Design Notebook for Federal Lobby Security*.

Site Selection

GSA PBS *Site Selection Guide*.
GSA PBS *Floodplain Management Deskguide*.

Definition. All GSA capital construction projects shall employ Total Building Commissioning (TBC) practices to assure delivery of program goals and related performance requirements. TBC practices shall be applied as described herein and compliant with the *GSA Building Commissioning Guide*. See www.gsa.gov/commissioning for more information.

As represented in the diagram below, GSA's commissioning process begins with design criteria (as contained within P-100) and client driven design programming requirements, reflected in design A/E selection factors, carried into design through technical submissions/reviews, followed by construction quality control/inspections and tests, leading to turnover practices for facility operations and subsequent recertification testing. This is followed by extended operating practices and the necessary lessons learned to both define research needs and subsequent criteria enhancement.



Commissioning Team. For GSA, commissioning is the responsibility of the entire delivery team. Each member must do their part to ensure that all decisions reflect programmed goals, that submissions/constructed features are reviewed/tested for effectiveness, and that proper documentation is made to certify and support the maintenance of expectations.

Architect-Engineer Role. The design Architect-Engineer shall identify all functional and performance testing/certification requirements for designed features, systems, components, equipment, and materials, necessary to assure programmed performance goals. Commissioned parameters are to address functional/performance issues, not incidental quality control testing. Performance goals, and adequate testing procedures and certifications to assure achievement of these goals, shall be reflected within construction specifications. Construction specification references shall also define any required

permanent testing, monitoring and research equipment/provisions.

Procedurally, the A/E is responsible for initiating Program Review Workshops at the beginning of each design submission stage, to review expectations and to identify delivery team concerns. The A/E shall coordinate with the Construction Manager and, if contracted separately, the Commissioning Authority, to fully define commissioning based issues and testing procedures.

Identifying Commissioning Requirements. Selected performance goals must balance the critical nature of expectations with inspection/testing and certification costs. The A/E shall coordinate with GSA's Project Manager and the project's Commissioning Authority to identify appropriate commissioning program goals and develop supporting inspection and testing practices. Commissioning practices and certifications are addressed within individual chapters of this document.



United States and Canada Shared Border Station, Sweet Grass, Montana/Coutts, Alberta

1.6 Environmental Policies & Practices

GSA is committed to being a responsible environmental steward through the consideration of the environment in all our business practices, compliance with environmental laws and regulation, using environmentally beneficial products and services, and using resources in a sustainable manner.

Sustainable Design

GSA is committed to incorporating principles of sustainable design and energy efficiency into all of its building projects. Sustainable design seeks to locate, 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, environmental, societal and human benefits while meeting the mission and function of the intended facility or infrastructure. Further information can be obtained on the Internet through the Whole Building Design Guide www.gsa.gov/sustainable.

The essential principles of sustainable design and development for Federal agencies address:

- Site – Optimize site potential
- Energy – Minimize non-renewable energy consumption
- Materials – Use environmentally preferable products
- Water – Protect and conserve water

- Indoor Environmental Quality – Enhance indoor environmental quality
- Operations and Maintenance – Optimize operational and maintenance practices

These principles shall serve as the basis for planning, programming, budgeting, construction, commissioning, operation, maintenance, decommissioning of all new GSA facilities, and for major renovation and alteration of existing buildings and facilities.

LEED® Certification. As a means of evaluating and measuring our green building achievements, all GSA new construction projects and substantial renovations must be certified through the Leadership in Energy and Environmental Design (LEED®) Green Building Rating System of the U.S. Green Building Council. Projects are encouraged to exceed basic LEED® green building certification and achieve the LEED® “Silver” Level.

Energy Performance

By Executive Order mandate, GSA’s overall building inventory has an energy performance goal of 55,000 BTU/GSF/year. For new construction, GSA must achieve better energy performance. Therefore, each new facility shall have specific energy targets (BTU/GSF/ year) as established by the Office of the Chief Architect. When no target is provided, energy performance shall exceed 20% below ASHRAE 90.1. The A/E shall design to these targets. For additional information see section 1.7, *Energy Conservation Standards*.



Ronald Reagan Building, Washington, D.C.

Building Materials

Prohibited Materials. The use of the following materials is prohibited on all GSA projects:

- Products containing asbestos.
- Products containing added urea formaldehyde.
- Products containing polychlorinated biphenyls.
- Products containing chlorinated fluorocarbons. (See Chapter 5 for replacements.)
- Solder or flux containing more than 0.2 percent lead and domestic water pipe or pipe fittings containing more than 8 percent lead.
- Paint containing lead.

Recycled-Content Products. GSA is required to buy recycled-content products as designated by EPA through the Comprehensive Procurement Guidelines (CPG).

Architects and engineers should always make environmentally responsible choices regarding new building materials and the disposal of discarded products. Buying recycled-content products ensures that the materials collected in recycling programs will be used again in the manufacture of new products.

Section 6002 of the Resource Conservation and Recovery Act (RCRA) requires EPA to designate products that are or can be made with recovered materials, and to recommend practices for buying these products. Once a product is designated, procuring agencies are required to purchase it with the highest recovered material content level practicable.

EPA also issues guidance on buying recycled-content products in Recovered Materials Advisory Notices (RMANs). The RMANs recommend recycled-content ranges for CPG products based on current information on commercially available recycled-content products. RMAN levels are updated as marketplace conditions change.

Architects and engineers must maximize the opportunity for contractors to bid recycled-content materials by including CPG items in the design specifications. Exceptions will only be permitted if written justification is provided when a product is not available competitively, not available within a reasonable time frame, does not meet appropriate performance standards, or is only available at an unreasonable price.

Examples of CPG construction products are included in Chapter 3, *Architectural and Interior Design*, and Chapter 4, *Structural Engineering*. Information can be obtained about EPA's list of designated products and the accompanying recycled-content recommendations on the Internet at www.epa.gov/cpg.

Lead-Based Paint. Paint will be tested for lead content when alteration or demolition requires sanding, burning, welding or scraping painted surfaces. When lead is found,

implement the controls required by OSHA in 29 CFR 1926.62. Do not abate lead-based paint when a painted surface is intact and in good condition, unless required for alteration or demolition. In child care centers, test all painted surfaces for lead and abate surfaces containing lead-based paint.

Asbestos-Containing Materials. Prior to design in a facility to be renovated, a building evaluation by a qualified inspector will be performed. This evaluation will include review of inspection reports and a site inspection. If asbestos damage or the possibility of asbestos disturbance during construction activity is discovered, one of the following four corrective actions must be taken: removal, encapsulation, enclosure or repair.

All design drawings and specifications for asbestos abatement must be produced by a qualified specialist. The guiding standards for this work are the GSA PBS IL-92-8 and OSHA and EPA regulations, in particular 29 CFR 1926.58, 40 CFR 61.140-157 and 49 CFR 171-180. In general, projects should be designed to avoid or minimize asbestos disturbance. The environmental standards will be supplied by the regional office of GSA.

All GSA construction work that disturbs asbestos must be performed using appropriate controls for the safety of workers and the public.

Regular inspection of the abatement work area and surrounding areas should be performed on behalf of GSA to protect the interests of GSA, the building occupants and the public. Such inspections should include visual and physical inspection and air monitoring by phase contrast microscopy and/or transmission electron microscopy, as appropriate. Inspections should be performed under the supervision of a Certified Industrial Hygienist, or individuals accredited under the Asbestos Hazard Emergency Response Act (AHERA) for asbestos abatement supervision.

Laboratories analyzing samples for asbestos must be accredited by the American Industrial Hygiene Association (AIHA) or the National Institute for Standards and Technology's Voluntary Laboratory Accreditation Program. Laboratories analyzing air samples by phase contrast microscopy must have demonstrated successful participation in the National Institute for Occupational Safety and Health (NIOSH) Proficiency in Analytical Testing program for asbestos.

On-site analysis by phase contrast microscopy may be performed as required, provided that the analyst is board-approved in the AIHA Asbestos Analysis Registry and provided that a quality assurance program is implemented, including recounting of a fraction of samples by a qualified laboratory. All final clearance transmission electron microscopy air samples must be analyzed in accordance with the EPA AHERA protocol in 40 CFR 763, Appendix A of subpart E.

Indoor Air Quality

All products to be incorporated into the building, including finishes and furniture, should be researched regarding characteristics of off-gassing and noxious odors that will affect indoor air quality.

Soil Contamination

The Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA or Superfund) provides authority and distributes responsibility for cleanup of contaminated soil, surface water and groundwater from inactive hazardous substance disposal sites and from hazardous substances released into the environment that facility permits do not cover. If soil or water contamination is a concern during construction of new buildings, major and minor alterations, and work in historic structures, then the EPA regulations under 40 CFR should be followed.

Underground Storage Tanks (USTs)

The EPA finalized regulations USTs in 40 CFR Parts 280 and 281. These regulations apply to all tanks containing petroleum products and hazardous substances as defined by the EPA. The regulations direct facilities to implement technical standards and corrective actions for the management of and releases from USTs. If USTs are a concern during construction of new buildings, major and minor alterations, and work in historic structures, then the EPA regulations should be followed. If a leaking UST is detected/discovered, contact EPA.

Compliance with the National Environmental Policy Act (NEPA)

GSA conducts an environmental review of each project prior to the start of design as required by the National Environmental Policy Act (NEPA). The review identifies environmental impacts and alternative courses of action that may have less impacts. The review can result in:

- A Categorical Exclusion (CATEX) from the requirement to prepare an Environmental Impact Statement (EIS),
- The preparation of an Environmental Assessment that results in a finding of No Significant Impact (FONSI),
- The preparation of an Environmental Assessment that identifies significant impacts, followed by preparation of an Environmental Impact Statement (EIS), or
- The preparation of an EIS.

If an Environmental Assessment or EIS has been prepared, it will constitute the primary guideline for environmental design issues. In those instances where GSA has committed to implementing specific mitigation measures, programmers and designers must ensure that those measures are carried out in the design. For more information on GSA's compliance with NEPA and to download the GSA PBS NEPA Desk Guide and other environmental technical guides visit, www.gsa.gov/nepa.

Guidance

The following documents contain specific design requirements or may influence design decisions:

- Council of Environmental Quality (CEQ), Code of Federal Regulations (CFR) Title 40, Parts 1500 - 1508: *Regulations for Implementing the National Environmental Policy Act*.
- GSA ADM 1095.1F: *Environmental Considerations in Decision Making*.
- GSA ADM 1095.6: *Consideration of Floodplains in Decision Making*.
- GSA ADM 1095.5: *Consideration of Wetlands in Decisionmaking*.
- GSA PBS *Floodplain Management Desk Guide*.
- GSA PBS *NEPA Desk Guide*.
- Environmental Protection Agency (EPA), 10 CFR 40, 1.23, 1-4, 1-16: *Procedures for Implementing the Clean Air Act and the Federal Water Pollution Control Act*.
- EPA, 40 CFR 50: *National Primary and Secondary Ambient Air Quality Standards*.
- EPA, 40 CFR 60: *New Source Performance Standards*.
- EPA, 40 CFR 61: *National Emission Standards for Hazardous Air Pollutants*.
- EPA, 40 CFR 82: *Protection of Stratospheric Ozone*.
- EPA, 40 CFR 260-299: *Solid Wastes*.
- EPA, 40 CFR 300-399: *Superfund, Emergency Planning and Community Right-to-Know Programs*.
- EPA, 40 CFR 401-403: *Effluent Guidelines and Standards*.
- LEED® (*Leadership in Energy & Environmental Design*) *Green Building Reference Guide*, developed by the U.S. Green Building Council.

1.7 Energy Conservation Standards

Performance Goals

Legislation directs the Federal Government to adhere to voluntary Commercial Energy Standards, reflected within the Code of Federal Regulations, 10-CFR 434. ASHRAE Standard 90.1 meets or exceeds 10-CFR 434, and may be substituted as a reference (with exceptions in lighting system performance as addressed in Chapter 6).

Executive Order 13123 establishes a national program goal to reduce building annual energy consumption by 35 percent, using a 1985 baseline. To achieve this goal, GSA's inventory must reach a metered (boundary) annual energy consumption of approximately 55,000 BTU/GSF.

GSA's sustainability objective for LEED certification will likely be associated with trying to beat ASHRAE 90.1 energy performance by defined percentage levels, (e.g. 2 points toward certification for new construction projects with every 20% increment, and for alterations projects with every 10% increment).

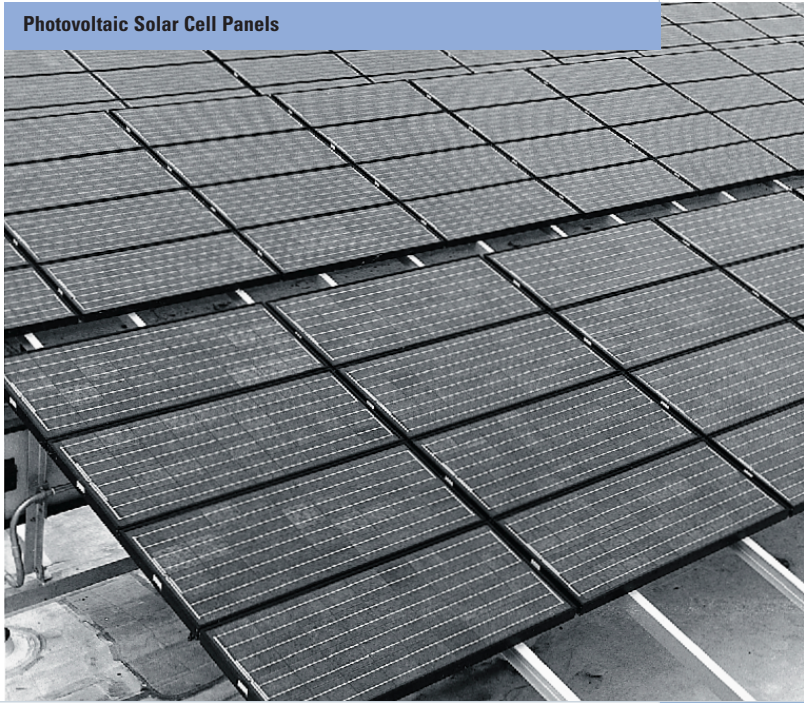
GSA also fully supports the Government's Energy Star Buildings Program for its existing inventory, achieving metered consumption within the top 25% of involved building categories.

Energy Goal Applications

For New Construction and building modernizations, designs shall achieve the project's individually assigned annual energy goal, established by the Office of the Chief Architect. Generally , this goal will be below the 55,000 BTU/GSF-YR target of the above referenced Executive Order.

For new construction and building modernizations, certification shall be based upon computer simulations of the overall building's annual energy consumption. Computer programs must be approved by the Project Manager, represented by the designer as being capable of simulating weather variations, envelope heat transmission, internal load fluctuations, ventilation and air infiltration impacts, HVAC equipment part-load efficiencies, and considered control strategies.

For Major Renovation/Alterations projects, that do not involve total building modernization, involved system performance shall be certified to achieve at least a 10 percent better peak load energy efficiency, compared to ASHRAE 90.1. Involved equipment efficiencies shall also be within the top 25% of manufactured product lines. Certification shall include side-by-side performance comparisons of each involved system/feature.



Photovoltaic Solar Cell Panels

1.8 Life Cycle Costing

Purpose

Life Cycle Costing (LCC) is an important economic analysis used in the selection of alternatives that impact both pending and future costs. It compares initial investment options and identifies the least cost alternatives for a twenty year period.

The A/E shall contact local utility companies to determine available demand-side management programs and no-cost assistance provided by these companies to designers and owners.

Applications

Basic applications of LCC are addressed within the individual chapters herein and may be further defined within an A-E's design programming scope requirements. As applied to building design energy conservation measures, the process is mandated by law and is defined in the Code of Federal Regulations (CFR), Title 10, Part 436, Subpart A: *Program Rules of the Federal Energy Management Program*. In general, LCC is expected to support selection of all building systems that impact energy use: thermal envelope, passive solar features, fenestration, HVAC, domestic hot water, building automation and lighting. However, LCC can also be applied to building features or involve costs related to occupant productivity, system maintenance, environmental impact and any other issue that impacts costs over time. It is very important to recognize the significance of integrated building systems design in the overall efficiency of the design.

Methodology

There are many established guidelines and computer-based tools that effectively support Present Value LCC analyses. 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 includes current energy price indices and discount factor references. These NIST materials define all required LCC methodologies used in GSA design applications.

It is recommended that the A/E obtain the BLCC software and update from NIST. The latest information on the BLCC software is available on the Internet at: www.eere.energy.gov/femp.

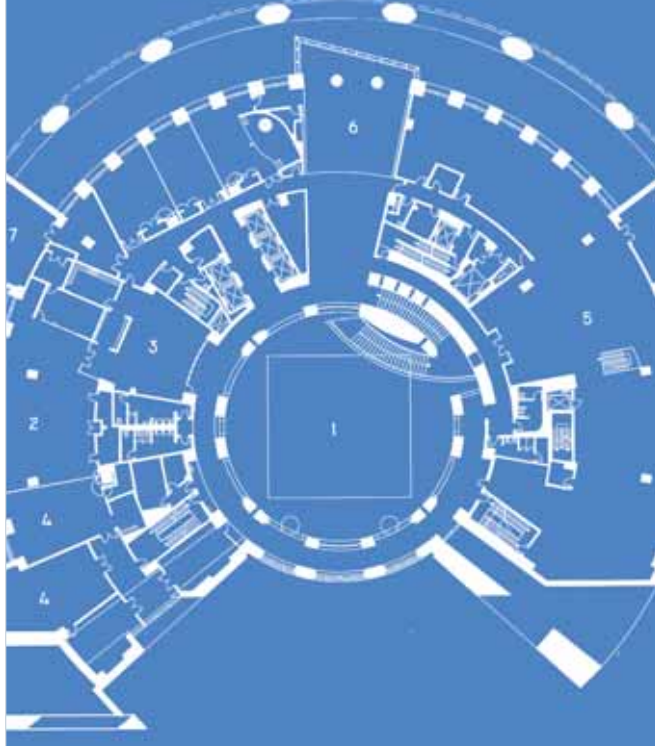
Procedures and Approach

The most effective approach to LCC is to appropriately integrate it into the design process.

The building design evolves from general concepts to detailed analysis. LCC needs to follow the same approach paralleling the focus to the current level of detail study.

It is extremely important for the effective development of the project that commitments are made and retained on the building systems, in a general sense, during the Conceptual Phase.

The building systems should be analyzed for appropriateness during the first stages of the Design Development Phase. A commitment on direction for the systems needs to be made at this time, and any further LCC studies focused on detail within each system.



Charles Evans Whittaker U.S. Courthouse, Kansas City, MO

All LCC effort should be completed in the Design Development Phase of the project.

The following practices are typically required when conducting LCC analyses for building design. They are listed here to address common concerns and frequently asked questions.

- When defining alternatives for life cycle costing, an acceptable level of overall building services must be assured throughout the analysis period.
- Design alternatives must be compared against a baseline reference alternate that is the lowest first cost of the alternatives being considered. The baseline alternate must offer a viable system, employing state-of-the-art design features, and be in compliance with all project requirements. Where existing conditions

form part of the baseline alternate, the analysis must not only include intended project work, but also the additional costs necessary to achieve code compliance and reliable operation over the analysis period.

- 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 25 years unless otherwise directed by GSA.
- Costs that have already been incurred or must be incurred, regardless of the chosen alternative, can be deemed “sunk” and excluded from the analysis. Costs that must be incurred during the period from design decisions to construction award should be deemed sunk.
- Baseline and alternative first costs are typically those estimated for the construction award date. The life cycle cost analysis can assume that the award date can be considered the zero point in time for the analysis period, with all other event times referenced to the construction award date. For greater simplicity, the year of design decision can also be considered as the zero point in time, and it can be assumed that the construction award will occur in that year.
- Salvage values for alternatives are typically zero. However, in those cases where scrap values could impact decisions, the present value is calculated as its future value (scrap value) discounted back to the present from the year of occurrence. The formula for this is shown in the LCC Formulas Table 1-1.

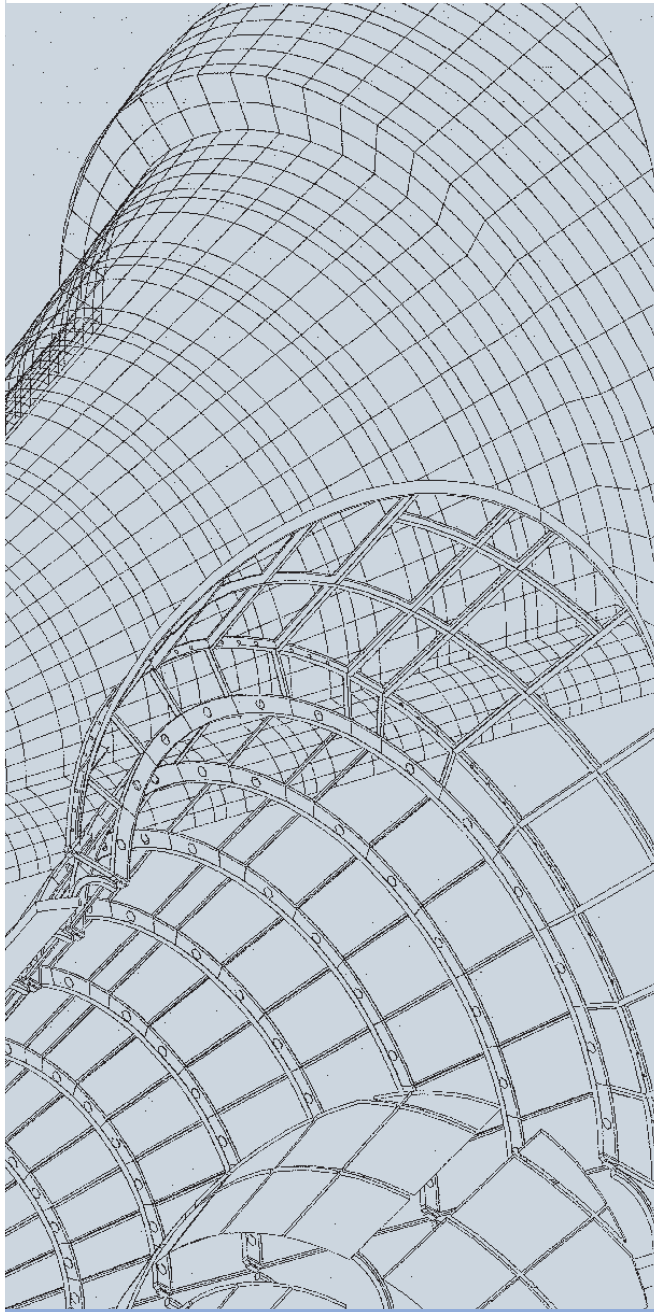
Table 1-1

LCC Formulas

Type of Cost	Cost Examples	Present Value Relationships	Comments
Sunk	<ul style="list-style-type: none"> • Design Fees • Funds irrevocably committed 	Not Applicable	Costs are not included in the Analysis
First	<ul style="list-style-type: none"> • Investment Costs • Construction Costs • Purchase Price 	$PV = TV$	For those investment costs that begin at the start of the analysis period
Salvage Value	<ul style="list-style-type: none"> • Scrap value of equipment at the end of its service life 	$PV = \frac{FV}{(1+d)^n}$ <p>where $FV=TV(1+e)^n$</p>	Present value equals the future value at the end of the service life, discounted by n service years
Future Investment	<ul style="list-style-type: none"> • One time investments occurring after the start of the analysis period • Non-Annual maintenance or repair • Major alterations to initial investment work 	$PV = TV \frac{(1+e)^n}{(1+d)^n}$ <p>Where FV is the time pro-rated amount that separates investment value to the end of service life salvage value.</p>	Discount the future value (Today's Value escalated at rate e to year n) back to the present.
Residual Value	<ul style="list-style-type: none"> • Equipment with a service life extending beyond the analysis period 	$PV = \frac{FV}{(1+d)^n}$	Residual value equals the future value at the end of the analysis period, discounted to the present.
Annually Recurring Fixed	<ul style="list-style-type: none"> • Fixed payment service contracts with inflation adjustments • Preventative maintenance 	$PV = TV(UPW)$ <p>where</p> $UPW = \frac{(1+d)^n - 1}{d(1+d)^n}$	Annually Recurring Cost, relating to today's value, which increase in price at the same rate as general inflation. The UPWn factors are within the NIST BLCC program.

Type of Cost	Cost Examples	Present Value Relationships	Comments
Annually Recurring Escalating	<ul style="list-style-type: none"> Service or maintenance which involve increasing amounts of work Frequent replacements that escalate at a rate different than inflation 	$PV = TV(UPW^*)$ <p>where</p> $UPW^* = \frac{\left[\frac{(1+e)}{(1+d)} \right]^n - 1}{1 - \frac{(1+d)}{(1+e)}}$ <p>or $UPW^* = \left(\frac{1+e}{d-e} \right) \cdot \left[1 - \left(\frac{1+e}{1+d} \right)^n \right]$</p>	The present value of such costs are calculated by using a modified version of the UPW formula (UPW*) which allows for cost escalation.
Energy	<ul style="list-style-type: none"> Fuel related costs, such as fuel oil, natural gas or electricity 	$PV = TV(UPW^*)$	Energy related UPW* factors are found in the NIST BLCC program.
Escalation Rates	<ul style="list-style-type: none"> Relating Budgetary Escalation to Real Growth Escalation 	$E = e + I + eI$ <p>or $e = \frac{E - I}{1 + I}$</p>	Needed to convert budgetary escalation to real growth escalation.
Definitions	<p>FV = future value</p> <p>PV = present value</p> <p>TV = today's value</p> <p>d = real discount rate</p> <p>e = real growth escalation rate (the differential escalation rate that exists after removing the influence of general inflation)</p> <p>n = number of years to occurrence or the analysis period, as appropriate</p> <p>E = Budgetary Escalation</p> <p>I = Inflation Rate</p> <p>UPW = Uniform Present Worth factor for fixed recurring costs</p> <p>UPW* = Modified Uniform Present Worth factor for escalating recurring costs</p>		

- Future one-time costs, such as replacement costs, are established by escalating a known today's value (using real growth rate) to its future value in the year it occurs, then discounting that value back to its present value (using a real discount rate). The formula for this is shown in the LCC Formulas Table 1-1.
- For instances where an alternative has service life beyond the analysis period, allowance shall be made for the associated residual service worth. This calculation involves identifying the future residual value at the end of the analysis period, then discounting the amount back to the present. The future residual value can be approximated by multiplying the future investment value (less future salvage value at the end of its service life) by the proportion of time remaining in the analysis period, compared to its service life.
- Annually recurring fixed costs include those costs where increases have no real growth, such as costs that increase at the general inflation rate. They can be represented by the formula shown in the LCC Formulas Table 1-1. Also in this table is the formula for recurring costs where recurring costs escalate. Both formulas involve multiplying a known cost (in today's value) by a uniform present worth value.
- Fuel costs represent a special case of recurring escalating costs. Uniform present worth values are available from NIST data, correlating specific fuel types by sector/location for a defined analysis period. For simplicity, demand charges may be assumed to escalate at the same rate as consumption charges.
- Investment and replacement actions over time may impact recurring costs. For simplicity, unless otherwise directed, fluctuating recurring cost savings may be assumed to be proportionate to the savings realized at the start of the analysis period.
- Calculate the savings to investment ratio (SIR) for comparisons of dissimilar alternatives, such as comparing an HVAC alternative to a lighting alternative. Calculate net savings for comparisons of similar alternatives, such as optimizing insulation thickness in a wall.
- A sensitivity analysis is required whenever assumptions may be considered questionable. This simply requires conducting multiple LCC analyses using extremes of cost parameters in question.
- Due to possible margins of error in estimating costs, alternatives with a life cycle cost differential of less than 10 percent can be judged inconclusive by GSA.
- To define energy related cost impacts for alternatives that are influenced by weather and/or varying loads/schedules, the energy use modeling program DOE2 or other approved software shall be used.



Ronald Reagan Federal Building atrium skylight isometry, Washington, D.C.

1.9 Metric Standards

All projects will be produced using the International System (SI) unless otherwise directed by the Chief Architect. A project is "metric" when:

- Specifications show SI units only.
- Drawings show SI units only.
- Construction takes place in SI units only.
- Inspection occurs in SI units only.
- Cost estimating is based on SI units only.

Reference *Metric Design Guide* (PBS-PQ260).

English and Metric Measurement Reference

A majority of dimensions set by standards and codes currently remain in the English measure system. It is the intent of GSA to support the conversion to metric. Therefore, when a dimensional requirement is stated in this document, the designated dimension by code or regulation will be placed in parenthesis and the corresponding representation in the other measurement system will be placed adjacent to it.

Example: (5') 1.52M diameter clearance for navigation of a wheeled chair in an accessible toilet room.

1.10 Accessibility Design Standards

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

The Architectural Barriers Act Accessibility Standard (ABAAS) is mandatory for all GSA projects. The A/E is responsible for checking to see whether there are local

accessibility requirements. If they exist, the most stringent requirements will prevail between local and ABAAS.

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

Federal Courthouses

Please refer to Chapter 9 (*Design Standards for U.S. Court Facilities*), Section 9.2 (*General Requirements*), *Planning for Accessibility*, and Table 9-1, *Accessibility Requirements*.



Ronald Reagan Building, Washington, D.C.



Site, Landscape, and Community Design

2

United States Courthouse

Erie, Pennsylvania

Architects: DPK&A Architects/ Kingsland Scott Bauer Associates,
A Joint Venture

GSA Project Managers: Edward H. Myers and Lawrence F. Boreali

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<div>30</div> <div>2.0</div>	<div>FACILITIES STANDARDS FOR THE PUBLIC BUILDINGS SERVICE</div> <div>Table of Contents</div>		<div>Revised March 2005 – PBS-P100</div>

2.1 Goals and Objectives



Southeast Federal Center Master Plan, Washington, D.C.

The quality of the site design is a direct result of the building's integration with the site. It represents significant Federal investment and should, wherever possible, 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.

See Chapter 1: *General Requirements* for a complete discussion of model codes and standards adopted by GSA. This section highlights regulations and standards that apply to site design.

2.2 Site Security

Site Design. Federal facilities must be safe and secure, yet still be accessible, welcoming, and effective workplaces. A successful site and landscape design addresses building and personal security while creating a setting that is engaged with the larger context in which it sits. Building setbacks for new construction are required to keep vehicles and other potentially harmful devices away from the main structure of the building, and the resultant spaces must be carefully designed. Security countermeasures shall be customized in each case, based on established principles, criteria, risk analysis, and site conditions. While entrance lobbies, garages, or other non-workspaces may, in some cases, be included within the setback, no building workplaces shall be within the setback without a waiver from the Commissioner of the Public Buildings Service. In establishing secure vehicle setbacks, planters, low walls, water features, trees, hardened street furniture, and landscaped berms may be creatively employed as perimeter barriers. Bollards also are quite acceptable when integrated with the design of the building and its surroundings. Barriers should be visually punctuated and as unobtrusive as possible to pedestrians. Consideration should be given to incorporating security features that allow for flexible use of the site, such as a gathering space away from the building, or a setting for artwork. High blank walls should be avoided; lower walls with sitting edges are preferable. Where feasible, features that provide required security should also provide visual and functional amenities for building users and visitors. Existing building security, where the current setback cannot be achieved, can be addressed through design of landscape elements at the perimeter, removal of on street parking, and expansion or acquisition of additional perimeter space. Security features in these areas must be carefully integrated with

their surroundings, while the acquisition and design must be closely coordinated with local officials early in the process.

Building Entrances. GSA buildings typically should have one primary entrance for staff, visitors and the public. In large facilities, secondary entrances may be created, with appropriate consideration given to impacts on security and building operations. Security screening stations shall be integrated with the building architecture, in close coordination with operational screening needs, and with designs to allow for future flexibility to accommodate improved technology. Designs shall address and accommodate foreseeable public queuing in projects where that is a concern.

Original primary entrances at historic and other existing buildings should be retained. Closure of ceremonial entrances and redirecting public access to below grade and other secondary entrances for security or accessibility purposes is discouraged and other ways to achieve security should be proposed. Wherever possible, access for the disabled to historic buildings should be provided at, or nearby original ceremonial entrances. See Chapter 8 for access controls and intrusion detection systems.

2.3 Site Analysis

Successful site planning and design depends on a thorough review and understanding of existing conditions on and around the site. An on-site investigation must be carried out prior to any design effort. For additional information see the GSA PBS document, *The Site Selection Guide*, found at www.gsa.gov/siteselection.

Site Survey. A complete site survey is required for all new construction projects and for alterations that involve work outside the existing building lines. Survey requirements are listed in Appendix A: *Submission Requirements*.

Geotechnical Investigation. Requirements for all geotechnical investigations are listed in Appendix A: *Submission Requirements*.

Archeological Testing. In some cases, GSA requires specialized testing by a contractor to determine whether archeological sites are present, and if so, to determine their extent, character and significance. If such testing is required, it should be coordinated with geotechnical testing to ensure that such testing does not inadvertently damage archeological resources. The GSA Project Manager will inform the architects and engineers when such archeological investigations may affect the project.

Flood Plains. No buildings shall be built within the 100 year flood plain. Buildings designated as “critical actions” (such as courthouses) shall not be built within the 500 year flood plains. Exceptions must be approved by the customer agency, PBS Assistant Commissioner for Portfolio Management and by the Chief Architect. If the building location is approved, mechanical and electrical equipment rooms must be located 1500mm (5 feet) above the level of the 100 year flood plain. For further information, 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.



Architectural model, U.S. Courthouse and Harborpark, Boston, MA

2.4 General Site Planning Criteria

Existing Site Features and Existing Vegetation. Existing natural features on the site should generally be preserved and be used as a starting point for the overall site design. Efforts should be made to preserve existing vegetation, particularly healthy trees and plant specimens. GSA promotes the protection and integration of existing vegetation and natural terrain into site design.

Energy Conservation. The use of site design to aid energy conservation and sustainability is encouraged. Solar orientation of the building and well placed plant material can be used to increase heat gain in the winter and reduce heat gain during the summer.

Environmentally Sound Practices. GSA promotes practices that are environmentally beneficial and conserve resources. Landscape designs and plant materials should reflect regional environmental concerns and promote minimal use or elimination of both chemicals and potable water for irrigation. Design and construction strategies should reduce stormwater runoff and polluted site water runoff. See www.lowimpactdevelopment.org for guidance.

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

2.5 Grading

Slopes. The slopes of planted areas should permit easy maintenance. Turf areas shall have a slope of no more than 3:1 and no less than 1 percent. A 2 percent minimum slope is desirable. Areas with slopes steeper than 3:1 must be planted with ground cover or constructed with materials specifically designed to control erosion. Slopes steeper than 2:1 are not acceptable. Terracing may be an appropriate solution for sites with large grade differentials, as long as access for lawn mowers and other maintenance equipment is provided.

Grading. Existing trees or other plant materials to be preserved shall be reflected in the grading plan. Where trees are to be preserved, the existing grade within the circle of the tree drip line must not be disturbed by regrading or paving. Snow fencing shall be erected at the drip line of the tree to protect existing trees from construction materials or equipment.

The minimum slope for grassy swales and drainage ways is 1 percent to prevent standing water and muddy conditions.

Slopes for walkways will not exceed 5 percent, unless unavoidable. Slopes greater than 5 percent may make the construction of special ramps for the disabled necessary. The maximum cross-slope is 2 percent. Preferably, walkways should not have steps. Where steps are necessary, cheek walls enclosing the risers and treads should be used to make a smooth transition to planted areas on the sides of the steps if grass is planted.

Parking areas or large entrance plazas should have slopes of 1 percent minimum and 5 percent maximum. Drives within parking lots should not be crowned. In areas with snowfall, provisions should be made for piling snow removed from roads and parking areas.

Drains should be provided at the entrance to ramps into parking structures to minimize the amount of rainwater run-off into the structure.

Paved areas adjacent to buildings will have a minimum 2 percent slope away from the structure to a curb line, inlet or drainage way to provide positive drainage of surface water.

For planted areas adjacent to buildings, the first 3000 mm (10 feet) should be sloped away from the structure to assure no standing water adjacent to basement walls and foundations (which could be detrimental).

No grading will be performed within the boundaries of any wetlands. For additional information see the GSA *PBS Wetlands Impact Management Deskguide* available for download at www.gsa.gov/nepa.

Cut and Fill. From a cost standpoint, it is desirable to minimize grading overall and to balance cut and fill, particularly in campus settings.

Storm Water Detention. Local code requirements for storm water detention must be followed. Detention of storm water on GSA building rooftops is not permitted.

2.6 Site Utilities



Reagan Building Plaza fountain, Washington, D.C.

Utilities/Services

The A/E will contact the local utility companies and/or other providers to determine the following: interest in providing service to the GSA; proposed rate structures and/or rebates; and system capacities, etc. This information will be compiled on the Site Analysis Data Sheets (see Appendix A: Submission Requirements). GSA will seek to negotiate contracts with the local utility companies and/or other providers to fix rates and establish connection charges.

Location of Aboveground Utility Elements. It is the A/E's responsibility to ensure that all utility elements, such as electrical transformers, emergency generators, backflow

preventers and meters, are located with access convenient to the utility companies and where they can be integrated with the building and landscape design without creating a negative visual image.

Water

Local Water Authority. Regulations of local water authorities must be followed. The service connection between building and public water line will be coordinated with the local water authority. Use monitoring points (including data logging functions) on primary water meters controlled by the Building Automation System (BAS). Where municipal graywater is available, service connections should be coordinated with the local water authority.

Dual Service. For large buildings or campuses, a loop system fed from more than one source must be considered. Some occupancies require dual service for the fire protection systems under the provisions of the International Fire Code (IFC).

Locating Water Lines. Water lines shall be located behind curb lines, in unpaved areas if possible, or under sidewalks if not. They shall not be located under foundations and streets, drives, or other areas where access is severely limited.

Fire Protection Water Supplies. A dependable public or private water supply capable of supplying the required fire flow for fire protection shall be provided for all new construction and renovation projects in accordance with the requirements of NFPA 24. See Chapter 7, *Fire Protection & Life Safety*, for additional information.

Special Requirements.

The requirements below supersede the requirements of NFPA 24:

- A secondary water supply for high rise buildings shall be provided in seismic zones 2, 3, and 4 by an on-site reservoir supplying fire pumps installed in accordance with NFPA 20. The supply to the fire pump shall include an auxiliary bypass (normally closed) from the municipal water supply. The secondary water supply shall have enough capacity to supply building fire suppression systems for a 30-minute duration in accordance with appropriate NFPA requirements.
- For buildings located in rural areas where established water supply systems for fire fighting are not available; the water supply shall be obtained from a tank, reservoir or other reliable source. The minimum quantity for adequate water supply shall be determined by the design team fire protection engineer and approved by the GSA regional fire protection engineer. See Chapter 7, *Fire Protection & Life Safety*, for additional information.

Fire Hydrants. Fire hydrants shall be provided for all new construction and renovation projects in accordance with NFPA 24. The local fire department shall be consulted with regard to their specific requirements regarding the locations of fire hydrants and thread types for hydrant outlets.

Sanitary Sewer

Local Sewer Authority. The regulations of the local sewer authority should be followed.

Discharge in Remote Rural Areas. In areas where no public sewers exist, septic tanks and leach fields should be used for sewage discharge. Cesspools are not permitted. Septic systems will have additional land area (in accordance with local and State code requirements) for future expansion of the discharge system.

Locating Sewer Pipes. All sewer lines will be located below unpaved areas if at all possible.

Manholes. Pipe runs between manholes should be straight lines.

Manholes must not be located in the main pedestrian route in walkways. The placement of manholes in other pedestrian areas such as plazas and entry courts should be avoided, particularly in the primary traffic routes across plazas and entry courts.

Cleanouts. Cleanouts will be provided on all service lines, approximately 1500 mm (5 feet) away from the building, and at all line bends where manholes are not used.

Storm Drainage

It is GSA policy to separate storm drains from sanitary sewers within the property limits, even in cities where separate public systems are not yet available. A storm drainage system may consist of vegetated swales, paved

channels or a piped system with inlets and manholes. These site strategies should coordinate with building strategies such as vegetated roofs.

In most cases building roof drainage will be collected by the plumbing system and discharged into the storm drains; exceptions are small buildings in rural areas where gutters and downspouts may discharge directly onto the adjacent ground surface.

Most storm drainage systems will be designed for a 25-year minimum storm frequency, unless local criteria are more stringent.

Gravity Drainage. Storm drainage systems should always use gravity flow.

Location of Storm Drainage Pipes. Storm drainage pipes will be located in unpaved areas wherever possible. It is desirable to offset inlets from main trunk lines to prevent clogging.

Rainwater Harvesting. Strategies for rainwater harvesting may be considered where appropriate, including filtering and retaining rainwater in cisterns for irrigation or flushing of toilets. Rainwater harvesting systems must comply with all local codes and standards.

2.7 Site Circulation Design

Site circulation design for GSA projects will vary greatly depending on the context, which can range from tight urban sites to suburban campuses or isolated rural settings. Yet the basic criteria remain the same in all situations: the site design should segregate, at a minimum, pedestrian access, vehicular access (including parking) and service vehicle access.

Security is an important consideration in site design. Refer to Chapter 8: *Security Design* for detailed criteria related to this matter.

Urban Site with Structured Parking

Service Traffic. Service dock access may be from an alley, from a below-grade ramp or from a site circulation drive. If large trucks are to service the facility, sufficient maneuvering space must be provided, and the service drive shall be screened as much as possible. It should always be separate from the access to the parking garage. Where possible, a one-way design for service traffic is preferable to avoid the need for large truck turning areas. The service area of the facility shall not interfere with public access roadways. See Chapter 3: Architectural and Interior Design for criteria on ramps and service areas.

Public Transportation. GSA encourages the use of public transportation among employees and visitors. The potential need for a bus stop should be considered early in the design of a GSA building in an urban setting and should be discussed with planners of the mass transit system. The project team should consider how to treat the orientation of the building and the site design and landscaping to encourage use of public transit and to address pedestrian traffic ‘desire lines’ between the building entrance and transit stops.



Oakland Federal Building, Oakland, CA

Pedestrian Circulation. The project team should consider neighboring uses, existing pedestrian patterns, local transit, and the building's orientation to anticipate pedestrian 'desire lines' to and from the building from off site. Designers should avoid dead ends, inconvenient routes, and the like and consider how people moving across the site might help to activate sitting areas, outdoor art, programmed events, etc.

Drop-Off. If the security analysis determines it is feasible, a vehicular drop-off area should be located on the street nearest the main entrance and, site conditions permitting, also near the entrance to the child care center, if the project includes one. See *GSA Child Care Center Design Guide* (PBS-P140).

Fire Apparatus Access

Fire department vehicle access shall be provided and maintained to all new construction and alterations in accordance with the requirements of the IFC, NFPA 241, and NFPA 1141.

Fire Apparatus Access Roads. The local fire department shall be consulted with regard to their specific requirements regarding the surface material of the access roadway(s), minimum width of fire lane(s), minimum turning radius for the largest fire department apparatus, weight of largest fire department apparatus, and minimum vertical clearance of largest fire department apparatus.

Aerial Apparatus. Buildings or portions of buildings exceeding 30 feet in height from the lowest point of fire department vehicle access shall be provided with access roads capable of accommodating fire department aerial apparatus. Overhead utility and power lines shall not be within the aerial access roadway. In addition, at least one access road having a minimum unobstructed width of 26



Bruce R. Thompson U.S. Courthouse and Federal Building, Reno, NV

feet shall be located within a minimum of 15 feet and a maximum of 30 feet from the building. Also, at least one side of all buildings shall be accessible to fire apparatus.

Vehicular Drives, Parking Lots and Service Areas

Entrance Drives. Follow local codes for entrance drive-ways within the right-of-way limits of city, county or State maintained roads.

Surface Parking Lots. Parking stalls must be 2700 mm (9 feet) wide and 5400 mm (18 feet, 6 inches) long, with two-way aisles of 7300 mm (24 feet). Where possible, 90-degree parking should be used. Accessible parking spaces must be provided; these shall comply with the UFAS/ADA in quantity, location and size.

Internal islands for landscape planting should occupy no less than 10 percent of the total parking lot area. Curbs should be provided around the parking lot perimeter and around landscape islands.

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

2.8 Pavements and Curbs

Materials. Usually the best wearing paving materials are those that are used extensively in the local area. Pavements and curbs should be designed for ease of long-term maintenance, not just for first cost. Where practical designers shall consider pervious or open grid paving or the use of light-colored/high-albedo materials to avoid a heat sink of dark surfaces.

Curbs. Curbs should be designed per local standard practice. Surface-applied precast concrete curbs or asphalt-type curbs are not allowed as a permanent solution for channeling traffic and/or drainage on site.

Public Streets and Sidewalks. The GSA project may be in an area for which there are no established urban design guidelines, but where such considerations would be valuable. Designs should consider proposing new curb lines, sidewalk widening, or street configurations to enhance pedestrian access, perimeter security, and urban design quality. Although such public works may not ultimately become part of the project scope, the design can be a catalyst for encouraging local action to enhance project quality.

Drives. Drives should meet local code requirements for street design, construction requirements, materials and surface finishes.

Fire Lanes. Grass pavers or open concrete grids are encouraged for fire lanes that do not carry normal vehicular traffic.

Service Areas. Areas for truck maneuvering should have concrete pavements.

Pavement Markings. Follow local street code.

Signage for Roads and Parking Lots. The minimum number of signs necessary to convey the information should be used; these must comply with UFAS/ADA.

2.9 Sustainable Landscape Design

Sustainable projects begin with site design. Issues of local ecology, impact on the surrounding areas, worker health, and building efficiency should be addressed from the initial site conception. The location and orientation of a building on the site will determine potential for natural light and views, shape energy usage, level of site disturbance, impact on neighbors, extent of pedestrian and vehicular movement. Storm water management, extent of paving, and landscape design will impact the local watershed, municipal storm water system, and water usage.

The goal for a sustainable site begins with the site selection. That will determine if the project is in an urban redevelopment area, brownfield, or greenfield; what

alternative methods of transportation and local services are available; and what impact the project might have on the local community and infrastructure.

Some projects are located in a municipality with storm water management controls, design guidelines, or special landscaping requirements; local design guidelines should be followed. Where local government has not designated special districts or guidelines, GSA's project and site design may be a catalyst for encouraging such efforts.

Maintenance Considerations

Site design will influence the operations and maintenance of a facility. Low maintenance materials, non-invasive xeriscape, and carefully designed storm water systems can help reduce costs and effort.

Before initiating the site design, the architect and landscape architect should discuss with the facility manager how the landscaping, including paved and unpaved areas, will be maintained. If this information is not available, assume that only limited maintenance capabilities will be available.

Sustainable design benefits GSA with healthier, longer lived plantings that rely less on pesticides, herbicides and fertilizers, minimize water use, require less maintenance and increase erosion control.

General Design Principles

Sustainable landscape design considers the characteristics of the site and soil, and the intended effect and use of the developed area, in addition to the selection of plants. Where appropriate, regionally-native plants will be used. Zoning or grouping by plant materials may be considered if an irrigation system is to be used. Refer to the seven principles of Xeriscape™ on the Internet at www.xeriscape.org for further information.



Russell B. Long Federal Building and United States Courthouse

Given limited maintenance budgets, GSA conceptually divides the areas in a typical site into two categories. Category I areas have high visibility—such as the building entrance—and consist of highly developed designs. These areas should be sensitive to the architectural features of the building, and can require higher maintenance. Category II areas have lower visibility—such as parking lots, maintenance areas and outlying areas—and are of simpler design and maintenance.

Design teams shall carefully consider how these landscape plans affect the use and feel of adjacent public spaces and properties. Where appropriate, they should coordinate design with local properties and plans—considering input but also encouraging compatible approaches by other developments.

The designer should discuss the appropriate amounts of Category I and II areas with the facility manager, as the proportions will depend on the level of total maintenance capability. As the landscape design is developed, Category I and II areas should be identified on the drawings to clarify the design concept. A preliminary description of the necessary maintenance program should also accompany the Final Concept Submittal. See Appendix A: *Submission Requirements*.

Soils will vary from site to site and even within sites selected by GSA. A soil test based on random samplings will provide the landscape architect with information needed for proper selection of plant materials and, if needed, soil amendments. The design will include those soil amendments to enhance the health and growing capabilities of the landscape.

Landscape Elements

Paths and Paving. Site design that encourages pedestrian activities is beneficial to the environment and to the health of the federal worker and visitors. Consider



Old Post Office historical preservation

walking/jogging trails in campus settings; design urban settings to encourage foot traffic. Consider durable pervious paving where appropriate for light automobile and pedestrian traffic; reduce extent of paving and avoid heat islands where possible.

Outdoor Plazas and Courtyards. Consideration should be given to development of plazas and courtyards for employee and visitor uses, and for both planned and passive activities. It may also be possible to incorporate program requirements into these spaces, for example, for use as outdoor dining or meeting spaces.

Fountains, Reflecting Pools and Ponds. Water may be used as a visual and possibly as an acoustic element. However, water features should not become a maintenance burden. Water consumption should be kept low,

especially in very dry climates with high evaporation rates. Non-potable water sources may be considered for these uses. In colder climates provisions must be made 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 should not be placed over occupied space since leakage problems frequently occur.

Sculpture. Sculpture may be provided as part of the Art-in-Architecture Program and is addressed by the site designer only as a coordination effort. The sculptor is selected under a separate contract; it is crucial, however, that the artist and the A/E coordinate not only the art installation, but how people will move to and from each other’s designed areas and how one might support the other. It is also important to ensure that routine maintenance of the artwork can be performed at reasonable cost and that it does not create safety hazards.

Rocks and Boulders. Lightweight and synthetic rocks or boulders will not be used as landscape elements.

Water Conservation. Consider capturing rainwater or gray water systems for irrigation. See also 2.11 *Irrigation Systems*.

2.10 Plant Materials

Plant selection, including turf, shall be based on the plant’s adaptability to the region. Regionally mature plants are recommended in desert or areas of the country where water is scarce. The use of hearty native turf species or other ground cover is encouraged.

Existing Vegetation. GSA has a commitment to using sustainable design principles in the landscape. Therefore, all existing vegetation should be evaluated for appropriateness to remain. Where appropriate, existing trees and shrubs should be protected and a planting plan be built around them.

Species Selection

Plant selection should be based on the plant’s adaptability to the landscape area, desired effect, color, texture and ultimate plant size. Maximum water conservation can be achieved by selecting appropriate plants that require minimal amounts of supplemental water.

Hardiness and Availability. Plants must be hardy in the climate where they are to be planted.

Demanding Plants. Plants requiring meticulous soil preparation, fertilization and spraying shall be avoided. Exotic and/or invasive species shall not be used.

Growth Habits.

Plants need to be chosen with their mature size and growth habit in mind to avoid over-planting and conflict with other plants, structures or underground utility lines.

Placement

Landscape design should be closely coordinated with the architectural characteristics of the building and the community where the building is located.

Trees should not be planted where potential intruders could use them to climb a wall or reach an upper story window. Care should be taken that the selected plant material in parking lot islands or adjacent to walkways will not grow over time to become hiding places for assailants, or create a traffic hazard by restricting sight lines. Turf should not be used for small islands in parking lots because it is too difficult to maintain. Trees, shrubs in low hedge rows and low-maintenance ground covers are more suitable in these locations.

Shade. Trees should be placed to provide shady sitting areas, reduce heat and glare on hard surfaces, and enhance pedestrian comfort.

Planting Practices

Tagging. For most projects, tagging of plant materials at the nursery should be employed only selectively for specimen plants. Instead, specifications should be tight enough to provide criteria for a rigorous inspection at the project site and rejection of plants if necessary.

Staking. Local conventions for staking, wrapping and guying trees should be followed. Local extension horticulturists can provide good advice.

Warranties. Warranties for the replacement of plant materials must be specified to extend for 1 year after the date of building acceptance by GSA or 1 year after installation of landscaping, whichever is later.

Mulch. Mulch selection should be made upon the basis of local practice. Bark products, pine needles or other organic materials are preferred over inert mulches, such as gravel which reflects heat and can burn plants, in all geographic areas except those where drought tolerant planting (cacti, etc) is proposed. Where hydroseeding is proposed, hydraulic mulch with recycled paper binders should be specified.



Ronald Reagan Courthouse, Santa Ana, CA

2.11 Irrigation for Landscaping

System Design

General Criteria. An irrigation system (if required) will provide water to plants only when needed. High-efficiency irrigation technologies, such as drip irrigation, should be used. Care will be taken so that water can be conserved through the use of a properly designed irrigation system.

Non-potable water should be used as a source for the irrigation system when it is available.

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

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

Metering. Irrigation water should be metered separately from domestic water to avoid expensive user sewage fees.

Zoning. Irrigation systems shall be zoned so different areas can be watered at different times. Avoid mixing different head or nozzle types (such as a spray head and a bubbler) on the same station. Different types of vegetation, such as turf and shrub areas, should also not be placed on the same station.

Application Rates. The system shall be designed to minimize surface run-off. In heavy clay soils, a low application rate may be required. Overspray onto paved surfaces should be avoided.

Controls. Irrigation controls should be easily understood by maintenance personnel. The designer should coordinate with the Building Manager as to the appropriate controls. Provide automatic controls to allow for scheduling of watering times for late night and early morning to reduce water losses due to evaporation.

Rain sensors or soil moisture sensors are essential to prevent unnecessary watering. Freeze sensors should be provided for systems in cold climates.

Maintenance Considerations. All major components shall be installed in protected, accessible locations. Controllers and remote sensing stations should be placed in vandal-proof enclosures. Above-ground components, such as backflow preventers, shall be placed in unobtrusive locations and protected from freezing.

Quick coupling valves should be of two-piece body design and installed throughout the system to allow for hosing down areas and to permit easy access to a source of water. Locate drain valves to permit periodic draining of the system.

2.12 Landscape Lighting

Landscape lighting should be used to ensure safety and security on the site, to provide adequate luminaire placement, light distribution and visual comfort for nighttime visual tasks and to define visual interest by highlighting special site features. See Chapter 6: *Electrical Engineering, Lighting, Exterior Lighting*.

The primary purpose of any particular application of landscape lighting is to determine the hierarchy of requirements for light distribution and intensity. Generally, unobtrusive lighting designs and luminaire placement are preferred. Where the primary intent of the lighting is aesthetic, the A/E is encouraged to consider low-voltage systems.

Light Pollution Reduction. Site lighting should be designed to minimize light trespass from the building or site. In non-urban areas, this helps to reduce the impact of the development on the nocturnal environment. For more information on reducing light pollution consult the IESNA Recommended Practice Manual: Lighting for Exterior Environments, or visit, www.darksky.org.

Color. It is recommended that a consistent lamp correlated color temperature be used throughout the project site.



U.S. Courthouse, Brownsville, TX

Luminaires. Site luminaires should complement and be integrated with other site elements. Luminarie placement should include consideration of direct glare from light source and reduced contrast ratios to allow for proper and consistent use of night vision. To avoid plant damage and fire hazard, high intensity or heat generating luminaires shall not be located immediately adjacent to plant material. The required sleep cycles of plants should also be considered. Luminaires shall be resistant to vandalism and easily replaceable from local sources.

Controls. Landscape lighting and building illumination should be controlled by clock-activated or photocell activated controllers.

2.13 Site Furniture

Useful outdoor spaces require furniture just as much as do rooms in a building. Seating, tables, bollards, bicycle racks, cigarette urns, trash receptacles, flagpoles, lighting standards and tree grates should be considered as part of the initial site design.

Site furniture shall be compatible in design, size and color with the surrounding architecture and landscape design. They should be selected and submitted in the Design Development package (see Appendix A: *Submission Requirements*).



Jacob Javits Plaza, New York, NY

Seating. GSA is committed to providing public amenities such as outdoor seating. The design should consider appropriate locations (bus stops, plazas) where seating could be used. Movable furniture can be an important component in effective public plazas and courtyards. In many intensively-used public spaces, it is an effective supplement to built-in seating. Where appropriate, perimeter walls and stair elements should be designed to provide comfortable height and depth for seating. Seating should be designed and placed on the site to provide choices for employees and visitors, including sun and shade, fixed and movable, etc.

Trash Containers. Locate trash containers at the entrances of buildings, on the path people will take to leave a seating area, and other locations to encourage their use. Provide recycling containers to collect items in keeping with the local recycling opportunities.

Bicycle Racks. The use of bicycle racks shall be considered at all GSA facilities (LEED criteria suggest racks for 5% of building occupants). Bicycle racks shall be placed in a location that is convenient to riders, such as a parking garage, parking lot or near a building entry. This location should be highly visible by building occupants, security personnel or by general traffic or in a secure (locked) area for use only by employees. Racks shall have provisions for locking bicycles to them. Bicycle racks shall be compatible with the architecture and landscape design.

Materials. Materials for outdoor furniture must be very durable and resistant to vandalism. Movable furniture can be an important component in effective public plazas and courtyards. In many intensively-used public spaces, it is an effective supplement to built-in seating. Metals that require repainting shall not be permitted. Consider the use of recycled-content materials for seating, when appropriate.

2.14 Site Signage

A well-designed site should use as few signs as possible. Signs should make the site 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 in keeping with the signage used inside the building. Signs integrated with architectural elements can also be very effective. There shall be a consistency in the font style and color plus 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. See 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

All GSA new construction and prospectus level repair and alteration projects must display an official construction sign on the site, in a prominent location. Construction signs must conform to the following specifications.

All Construction Signs. The size of the sign shall be 3600 mm by 1800 mm (12 feet by 6 feet). It shall be constructed of a durable, weather resistant material, properly and securely framed and mounted. Standard GSA color (blue) with white lettering should be used. Signs shall be mounted at least 1200 mm (4 feet) above the ground,



display the official GSA logo which should be no less than 400 mm (16 inches) square, and 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
- The lettering, graphic style, and format should be compatible with the architectural character of the building.

New Construction Signs. Signs at new construction sites shall 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.

Repair and Alteration Projects. Signs at prospectus level repair and alteration project sites shall include the name of the architect and/or engineers for the major systems work (i.e. structural, mechanical, electrical), if appropriate. In addition, the sign should include the name of the general contractor.



Charles Evans Whittaker United States Courthouse, Kansas City, MO

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 shall be illuminated.

Architectural and Interior Design

3

Federal Building

San Francisco, California

Architect: Morphosis

GSA Project Manager: John N. Nolte

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3.1 Basic Building Planning Principles

Integrated Design. To achieve the Guiding Principles of Federal Architecture, noted in Chapter 1, use a collaborative, integrated design process that:

- Sets specific goals for siting, 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 deconstruction.

Performance Measures and Functional Objectives.

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

Environmental Sensitivity. The natural setting of the site, its contours and vegetation shall be viewed as assets to be preserved and woven into the design as much as possible. In settings including historic buildings, adjoining historic properties, or located near historic properties that will be affected by GSA construction, external design review,

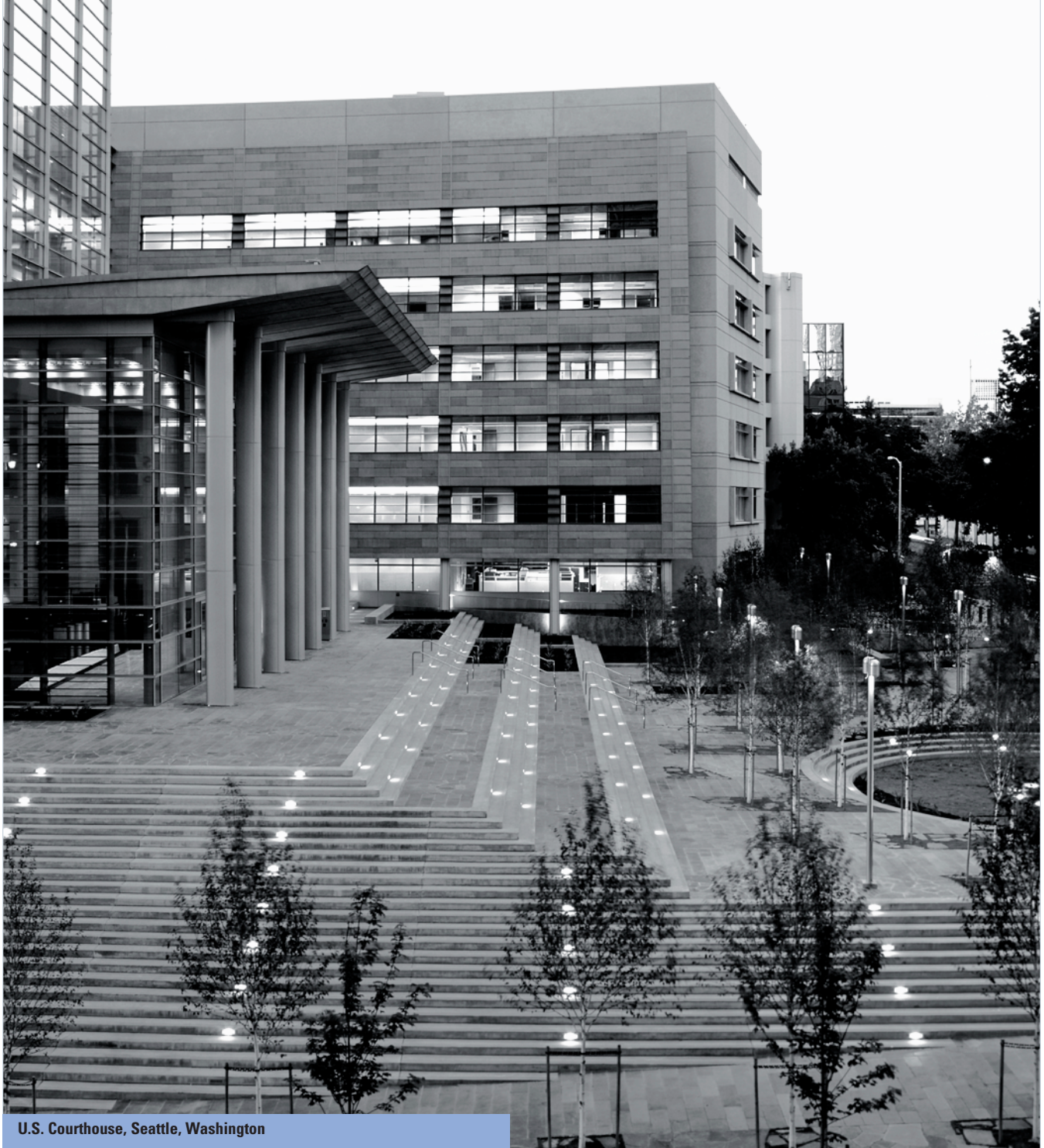
including public participation, is required under the Section 106 of the National Historic Preservation Act and may also be required under the National Environmental Policy Act. Compliance reviews should be coordinated, through the Regional Historic Preservation Officer, early and as frequently as the project complexity warrants, 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.

Basic Configurations and Core Placement. Planning for cores must consider the depth of the occupiable space established by the core and exterior walls. The optimum depth of the occupiable space (the space between core and window wall) in an office building is approximately 12,000 mm (40 feet) for providing access to daylight.

Placement of Core Elements and Distances. In buildings with large floor plates, not all core elements need to be placed at each core location. How often each element needs to be repeated is governed by occupant needs and the following maximum radii and distances:

- **Passenger Elevators** should be grouped in banks of at least two for efficiency. Elevator groups of four or more should be separated into two banks opposite each other for maximum efficiency in passenger loading and minimum hall call notification for accessibility under requirements of UFAS/ADA. Travel distances from a given office or workstation to an elevator should not exceed 61000 mm (200 feet).
- See Chapter 7: *Fire Protection & Life Safety* for additional egress requirements.



U.S. Courthouse, Seattle, Washington

- The location of stairs within buildings should encourage their use, in lieu of elevators, to the fullest extent feasible. This will reinforce the recognition of sustainable energy conservation.
- **Electrical Closets** must be stacked vertically and should be located so that they are no more than 45m (150 feet) from any occupied space. Shallow, secondary closets off permanent corridors may be used for receptacle panelboards where the distance between the riser and the farthest workstation exceeds 45m (150 feet) and a separate riser is not warranted. See section *Space Planning, Building Support Spaces, Mechanical and Electrical Rooms* of this chapter for minimum size requirements.
- **Communications Closets** shall meet the requirements of EIA/TIA Standard 569: *Commercial Building Standard For Telecommunications Pathways And Spaces* (and related bulletins). Communications closets must be provided on each floor, with additional closet for each 930 m² (10,000 square feet). Closets must be stacked vertically and must be placed so that wiring runs do not exceed 90 m (300 feet). Closets must tie into vertical telecommunications backbones. See section *Space Planning, Building Support Spaces, Mechanical and Electrical Rooms* of this chapter for minimum size requirements.

Building Circulation

Federal buildings must have clear circulation systems. Utility system backbone pathways should be routed in circulation spines providing service access to utilities without disrupting other tenant agencies.

Planning Grid

Planning grids shall be used to integrate building interiors to allow more future serviceability, particularly for buildings that will experience extensive reconfiguration

through their life span. A building design shall follow the prescribed planning grid dimension unless the designer can show long term efficiencies using another dimension. Following a standard dimension will allow GSA to maintain standard replacement parts to service the building.

Some structural bay sizes can adversely affect interior parking layout. The 6100 mm by 6100 mm (20-foot by 20-foot) bay is too narrow for a two-way driveway aisle. Some of the larger bays cannot be efficiently adapted to parking layouts. Transfer beams or inclined columns would have to be used to adjust the column spacing. If a major parking facility must be integrated with the office structure, the 9100 mm by 9100 mm (30-foot by 30-foot) bay is recommended.

Technology Infrastructure

A total integration of all building systems will provide for current operations as well as for future changes. A technology infrastructure should be planned in each building to accommodate power systems including normal, emergency and uninterrupted power, mechanical systems and controls, fire detection and suppression systems, security systems, video and television systems, communications systems, including voice and data, lighting controls, plumbing services, and special utility services, such as gas or exhaust systems. It is not intended to provide infinite amounts of space for these systems, but to recognize their dimensional characteristics and the ability to service system components. The infrastructure must provide adequate spare capacity and integrate the utility entrance facilities, equipment rooms, backbone pathways, horizontal distribution pathways and workstation outlets for each system. In part, floor-to-floor heights are determined by the depth of space required for the technology infrastructure, including structural, mechanical, electrical and communications systems.

Five key concepts must be followed in providing technology infrastructure in Federal buildings.

- Equipment rooms and closets should be located together on each floor.
- All walls of equipment rooms and closets should be stacked vertically using the same plan configuration from floor to floor to accommodate vertical risers for backbone systems. When more than one closet is required on each floor, they shall be interconnected by a minimum of two 100 mm (8 inch) conduit passageways.
- Accessible flexible horizontal pathways must be provided from the closets on each floor to the workstation outlets. These pathways may be through underfloor ducts, cellular floor systems, access floor systems, or overhead cable trays and wire ways. Horizontal pathways must provide at least three separate channels for separation of power and different communications systems.
- Excess capacity must be provided in each system for future expansion of services.
- The data/telecommunications closet must be adequately sized to accommodate multiple vendor equipment and for the ease of maintenance of the equipment.

EIA/TIA Standard 569: *Commercial Building Standard For Telecommunications Pathways And Spaces* (and related bulletins) provides specific criteria for infrastructure for communication systems. The criteria covers the communication service entrance pathway, entry point, entrance room, equipment room, vertical backbone pathway, communication closets, and horizontal pathways. Horizontal pathways covered by this standard include underfloor duct, access floor, conduit, cable trays and wire ways, ceiling pathways and perimeter pathways.

Raised Floor Systems. Access floors shall be incorporated into all new construction where office functions will take place. Permanent corridors can be exempted from this requirement. See the GSA PBS *Guidelines for Raised Floor Systems, with and without Underfloor Air Distribution* (RF/UFAD Guidelines) for more information.

The vertical zoning of the floor-to-floor space for horizontal utility distribution must be analyzed. In typical office areas, this can be standardized. In special purpose spaces such as courtrooms, meeting rooms, library stacks, or laboratory spaces, the infrastructure must be given detailed consideration before establishing the final floor-to-floor heights. See the *RF/UFAD Guidelines* for more information.

If floor air plenum distribution is to be considered in offices with raised floors, refer to the *RF/UFAD Guidelines* for more information.

All underfloor and ceiling areas used for horizontal system distribution must be accessible without requiring repair to interior finishes. To the extent possible, avoid routing pathways over areas where it is difficult to bring in hoist or set up scaffolding, such as fixed seating areas and sloped or terraced floors for stairways.

Space Allocations and Classifications

This section describes the methodology and policies for tabulating space requirements for GSA facilities. It also describes application of GSA policies for providing and charging tenant agencies for space in GSA owned or controlled space.

The GSA provides space for Federal agencies and charges the agencies a rental rate for the space they utilize. Therefore, GSA tabulates space for both planning purposes and for charging rent. These two purposes require slightly different application of the same space measurement

information. For planning purposes, GSA converts agency space requirements, expressed as usable area, to gross building area through the application of building efficiency factors. For rental charges, GSA converts the agency space requirements, expressed as usable area, to rentable area through the application of ratios that are unique to each building. Agencies identify the amount of usable area they require within a building for the GSA and request this space on a Standard Form 81 (SF81).

GSA provides a tenant improvement allowance for finishes and features within its rental charge. The A/E must design within that allowance. The agency may fund any costs over the tenant improvement allowance directly through a Reimbursable Work Authorization (RWA).

The GSA uses formalized standards for establishing the area to be allocated to each tenant agency for the rent charge. GSA has adopted the Standard Method for Measuring Floor Area in Office Buildings ANSI/BOMA Z65.1, current edition, issued by the Building Owners and Managers Association (BOMA). This standard is a national standard approved by the American National Standards Institute. The full standard is available from BOMA International.

Certain systems related to security monitoring and building control may be provided as part of the project by GSA, or, if specially requested, by the tenant agencies, with GSA providing the infrastructure support.

Space Measurement for Rental Purposes

A Summary. The following are terms and calculation formulas extracted from the ANSI/BOMA Z65.1. They are provided to assist the user in understanding GSA's space accounting. Individuals responsible for performing space measures must utilize the entire Standard Method for Measuring Floor Area published by BOMA.

The ANSI/BOMA Z65.1 standard uses a two-step process to determine rentable area assessed a tenant. The first step allocates common shared space on each floor to the tenants of that floor. The second step allocates common spaces that support the entire building to all tenants within the building. This explains the use of different ratios for each floor.

Basic Rentable Area. Basic rentable area is the usable area occupied by a tenant plus their proportion of the floor common areas. It is calculated by:

$$\text{Usable Area} \times \text{Floor R/U Ratio} = \text{Basic Rentable Area}$$

Building Common Area. Building common area is usable area allocated to provide services to building tenants but is not included inside a tenant space. Building common areas include lobbies, atrium floor space, concierge areas, security desks located in public areas, conference rooms, lounges or vending areas, food service facilities, health or fitness centers, daycare facilities, locker or shower facilities, mail rooms, fire control rooms, fully enclosed courtyards, and building core and service areas such as mechanical or equipment rooms. Excluded from building common areas are floor common areas, parking spaces and loading dock areas outside the building line.

Building R/U Ratio. Building R/U ratio is the factor used to distribute building common areas to all tenants on a prorated basis. Note that this figure will be constant for the entire building, but could change over time if portions of the ground floor are converted from common areas to store areas.

Building Rentable Area. Building rentable area is the sum of the floor rentable areas. It is also equal to the gross measured area of the building minus vertical penetrations.

Floor Common Area. Floor common area includes toilets/washrooms, janitorial closets, electrical rooms, telephone rooms, mechanical rooms, elevator lobbies, and public corridors that are available primarily for the joint use on that floor. Note that this will vary floor to floor based on public corridor configurations. For single-tenant floors, corridor and lobby spaces may be included in the office or store usable area because they will be for the exclusive use of that floor's only. On main ground floors, floor common areas would only include corridors created because of store area configuration and telephone, janitor closet and electrical closets added because of the addition of store area on the ground floor.

Floor R/U Ratio. Floor R/U ratio gives the basic rentable area. It is calculated by the following formula:

$$\text{Floor Rentable Area/Floor Usable Area} = \text{Floor R/U Ratio}$$

Note that this ratio will vary from floor to floor based on public corridor configurations.

Floor Rentable Area. Floor rentable area is the gross measured area minus the exterior wall and major vertical penetrations. Floor rentable area is calculated by:

$$(\text{sum of Office and Store Usable Areas on the floor}) \times \text{Floor R/U Ratio} = \text{Floor Rentable Area}$$

It is also equal to the sum of the basic rentable areas for that floor. Full floor tenants will be assessed the gross measured area of a floor *minus building common spaces* as their floor rentable area. Note that because it includes building common area, floor rentable area is not necessarily indicative of space demised for a single tenant's use.



Oakland Federal Building, Oakland, CA

Floor Usable Area. Floor usable area is the sum of all office, store and building common usable areas. Floor usable area is the floor rentable area minus floor common areas which are available primarily for the joint use of tenants on that floor.

Gross Building Area or Constructed Area. Gross building area or constructed area is the total constructed area of a building. It is measured to the outside finished surface of permanent outer building walls, without any deductions. This is the area GSA budgets for construction purposes.

Gross Measured Area. Gross measured area is the total area within the building, minus the exterior wall.

Office Area. Office area is the usable area within the tenant space including internal partitions and half of the demising wall separating the space from other tenants. It is measured to the tenant side finished face of all building common areas.

R/U Ratio. R/U ratio is the factor used to convert usable area to rentable area. It is the product of the Floor R/U ratio and the Building R/U ratio. It is derived by the following formula:

$$\text{Floor R/U Ratio} \times \text{Building R/U Ratio} = \text{R/U Ratio}$$

It accounts for the allocation of floor common areas and building common areas. Note that it will be different for each floor.

Rentable Area. This is the figure that will be assessed each tenant for their space charges. Rentable area includes the usable area, the prorated share of the floor common area, and the prorated share of the building common areas. It is calculated by the following formula:

$$\text{Usable Area} \times \text{R/U Ratio} = \text{Rentable Area}$$

It may also be calculated by the following two-step formula:

Step 1)

$$\text{Usable Area} \times \text{Floor R/U Ratio} = \text{Basic Rentable Area}$$

then **Step 2)**

$$\text{Basic Rentable Area} \times \text{Building R/U Ratio} = \text{Rentable Area}$$

Store Area. Store area is the usable area of a structure that is directly served by permanent public lobbies or has direct access from outside. BOMA describes these spaces as suitable for retail occupancies. The term store area was developed for main ground levels to allow the public

lobby and other building common areas to be prorated to all tenant spaces in the building measured in m². Most common space on main ground levels normally falls within building common areas rather than floor common areas, so rentable figures for store areas will not normally be significantly impacted by floor common areas.

Usable Area. Usable area is the actual area the agency occupies in a tenant suite measured in square meters. It is the office area, store area or building common area. It is calculated by measuring from the dominant portion of the exterior wall to the outside face of major vertical penetrations. It includes all structural elements, openings for vertical cables, and vertical penetrations built for the private use of the tenant.

Space Measurement for Planning Purposes

Tenant agencies communicate their space requirements to GSA on the Standard Form 81 (SF81). This form identifies the total area of each space classification required by the agency within an individual building.

Tabulation of space requirements for planning purposes involves four steps:

Step 1 – Tenant agencies must identify the individual room areas they require within a facility or tenant suite.

Step 2 – To calculate the total usable area within an agency's suite, additional area must be added to the individual room areas to account for internal corridors, partitions, structural members, and planning inefficiencies. Traditionally, GSA has instructed the tenants to include 50 percent of an aisle space directly

fronting the individual room area and the partitions enclosing the room area as part of the room area request. GSA then has added to this a factor of 20 percent to convert individual room areas to agency usable area. GSA must report the utilization of space by tenant agencies to the Office of Management and Budget. Target utilization ratios include 3.25 m² (135 square feet) for primary office space with 20 percent additional space for office support areas. The agency may also calculate the usable area from the individual room areas by directly multiplying the area enclosed in the room by a factor. The following minimum planning factors are recommended. For spaces requiring wider aisles or more than one or two cross-aisles, or in buildings with irregular column grids, curved or stepped external walls or odd-shaped floor plans, higher planning factors are recommended.

Rooms size	Factor
Less than 10 m ² (100 sf)	1.4
Less than 15 m ² (150 sf)	1.3
Less than 50 m ² (500 sf)	1.2
Less than 100 m ² (1000 sf)	1.1

Step 3 – Classify space according to the GSA space classification standards, and request space from GSA on the SF81. GSA must have a signed SF81 from the tenant agency to process a space request.

Step 4 – GSA divides the sum of the tenant usable space areas to be housed in the building by a building efficiency factor to convert the usable area tabulations to a gross building area. The gross building area is the size of building Congress will fund. Efficiency factors used by GSA for planning purposes include the following:

Facility Type	Planning Factor
Warehouse	85%
Libraries	77%
Office	75%
Courthouse	67%

The space classification system is divided into general broad categories with subcategories for specialized spaces. The following are classifications currently used by GSA for planning purposes.

Conveying Systems

All elevators must comply with ASME A17.1, the Architectural Barriers Act Accessibility Standard (ABAAS), and Chapter 7: *Fire Protection & Life Safety, Elevator Systems*.

All occupied areas of a GSA multi-story building or facility must be served by at least one passenger elevator. Areas of future expansion must be anticipated as well as future configuration of existing spaces, to ensure all areas are provided elevator service in the future.

The ASME A17.1 current edition applies to the design of all elevators, lifts and escalators. Additionally, the Architectural Barriers Act Accessibility Standard (ABAAS) must be complied with for accessibility.

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.

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. A minimum ceiling height of 2700 mm (9 feet) is required in service elevator cabs. Freight elevators shall have a ceiling height of not less than 3700 mm (12 feet).

Table 3-1

Space Classification

1. Office	Total Office
2. Other General Purpose	ADP, auditorium, light industrial, structurally changed, lab, conference/training, food service, cafeteria, snack bar, health unit, fitness center, judges chambers, childcare
3. General Storage	general storage
4. Tenant floor cut	TFC
5. Residence & Quarters	quarters and residence
6. Outlease Retail	
7. Courtroom	judicial hearing rooms, courtrooms
8. Non-Building Charges*	railroad crossing, antennas, boat dock, land

*(square footages associated with this category, if they exist, fall outside the ANSI/BOMA total, and the “Assigned” total)

In large or high-rise buildings, the number of freight elevators provided for GSA buildings 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 should provide access to that level.

There may be *Security or specific purpose* elevators to transport designated groups of people such as judges, cabinet members or prisoners. An elevator shall service all maintenance floors.

Lockout should be provided for all floors served by passenger and freight elevators. Key locks, card readers or coded key pads, integral with the elevator control panel, must be provided to override lockout. A non-proprietary control system for elevator security systems should be

used. The extent of control should be defined by the Project Team. See Chapter 8, *Security Design*.

Trap doors and hoist beams shall 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 Traffic Analysis. The A/E must hire an independent consultant to perform objective studies on the number and type of elevators needed at the facility. The traffic analysis shall determine the quantity, capacity and speed requirements of elevators. The capacity and speed are the limiting factors used in determining the minimum number of cars that will meet both the average interval and handling capacity criteria.

Separate calculations must be made for passenger and for freight or service (combination of passenger and freight) traffic. If there are parking levels in the building, a separate analysis should be prepared for the shuttle elevators connecting parking levels with the lobby.

The type of building occupancy will determine the probable number of stops used in the traffic analysis calculations. A single-tenant building will require a greater probable number of stops than a multi-tenant building. This is especially true when balanced two-way traffic is considered because the incidence of inter-floor traffic is much greater in a single-tenant building.

The anticipated elevator population shall be calculated based on the occupiable floor area of the building and a factor of 14 m² (150 ft²) per person. It shall be assumed that 8 to 10 percent of the resulting population would not require elevator service during the peak periods. If the building design requires two or more elevator banks, the population calculation results shall be apportioned by functional layout of the building. These divisions shall then be assigned to the appropriate elevator banks. For this purpose an “elevator bank” is defined as a group of adjacent or opposite elevators that function under a common operational system.

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 a.m. 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 period of up-peak traffic used to measure average interval. GSA buildings shall always be designed for a 16 percent handling capacity, even if the building is designed as a multi-tenant facility.

Elevator Capacities. Capacities of 1590 kg to 1810 kg (3,500 to 4,000 pounds) shall be used for passenger elevators. Elevator cab sizes shall be in accordance with the standards established by the National Elevator Industries, Inc. (NEII). Elevator cabs shall be designed to reflect the architectural character of the building design.

Escalators. Escalators may be installed as supplements to elevators when vertical transportation is required for a large *unpredictable* volume of public traffic. GSA prefers to use escalators only where absolutely necessary because of high maintenance costs. 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.

Fire Protection

See Chapter 2: *Site Planning and Landscape Design* and Chapter 7: *Fire Protection & Life Safety* for additional requirements.

Seismic Design

Seismic design is discussed in detail in Chapter 4: *Structural Engineering*.

Design Issues Affecting Security

Specific criteria for site and building security are described in detail in Chapter 8. Some of the planning concepts are stated here because of their importance to building planning, but architects should familiarize themselves with Chapter 8 before developing schematic design concepts.

Table 3-2
Criteria for Design of Escalators

Nominal Escalator Width	Capacity in Persons Per Hour	Capacity in Persons Per 5 Mins.
820 mm (32 in.)	3,000	250
1200 mm (48 in.)	4,000	400

General Layout. Many 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 shall be planned to allow for future controlled access, both to the entire building and to individual floors.

Site Design. Building entrances shall be designed to make it impossible for cars to drive up and into the lobby. Planters can be provided as barriers; bollards are also acceptable if well integrated with the design of the building entrance. Barriers to vehicle access should be visually punctuated and as unobtrusive as possible to pedestrians. Consideration should be given to incorporating security features that allow for flexible use of the site. If addressed skillfully, planters, trees, or sculpted bollards can be employed to provide amenities while meeting vehicle barrier requirements. High blank wall should be avoided; lower walls with sitting edges are preferable.

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 shall not be used. See Chapter 8 for access controls and intrusion detection systems.

Building Lobby. The building lobby shall always be designed to permit subdivision into a secure and a non-secure area. The two areas could potentially be divided by turnstiles, metal detectors or other devices used to control access to secure areas. There shall 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 shall not be used. See the section *Space Planning, Public Spaces, Entrance Lobby and Atria* of this chapter.

Lobby Security Equipment. The A/E shall incorporate non-prescription 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. See First Impressions Program.

Courts 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., like 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 different areas of a public plaza which would be appropriate for different types and intensities of public activity. Potential users of the space would include not only the building tenants, but also persons in neighboring properties as well as organizations, such as performing arts or vending organizations, that might assist GSA in bringing activities into the space. The treatment of seating, shade, water, art, bollards, and the space's flexibility are important to supporting appropriate uses.

Plazas should be designed with electrical outlets, and other simple infrastructure, to support future flexibility and a wide range of uses.



U.S. Courthouse, Boston, MA

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.

Elevators. See *Building Planning, Conveying Systems* section of this chapter and Chapter 8. Elevator control panels must have lockout provisions for all floors (passenger and freight).

Mechanical and Electrical Spaces. Access to mechanical and electrical spaces should be from the inside of the building, located on the secure side of the (potential) security point in the building lobby.

3.2 Space Planning

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 2700 mm (9 feet) for spaces that are larger than 14 m² (150 square feet). The clear ceiling height of individual office rooms not exceeding an occupiable 14 m² (150 square feet) is a minimum of 2700 mm (9 feet). The clear ceiling height of private toilets and small closets, which are ancillary to other office spaces is a minimum of 2300 mm (8 feet).

Enclosed offices should have the same ceiling height as adjacent open office spaces to allow future reconfiguration flexibility.

Automated Data Processing (ADP) Areas. ADP spaces require access flooring over a plenum space, even if access floors are not used elsewhere in the building. ADP areas are almost exclusively associated with main frame computer equipment. See Chapter 7, *Fire Protection & Life Safety*, for additional essential electronic facilities requirements.

The access flooring of ADP areas shall be level with adjacent related spaces and must always be level with the landings of elevators that serve the ADP facility. Ramps shall only be used where it is impossible to adjust the level of the structural floor. Where ADP areas occupy 33 percent or more of a floor, the entire floor, including internal corridors, shall be designed with raised access flooring to accommodate ADP facility expansion. The floor levels of access flooring should be constant throughout the floor. Designers shall 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 3000 mm (10 feet).

Public Spaces

Public spaces are those accessible to the general public. They include entrances, lobbies, stairways, public elevator and escalator lobbies, and the permanent corridors at each floor level. In historic buildings, new materials should be commensurate in quality with original finishes and compatible in form, detail, and scale with original design.

Entrances and Vestibules. The main entrance to a Federal building must be conveniently located for vehicular and pedestrian traffic. All public entrances shall be accessible to physically challenged individuals. Vestibules must be provided at each main lobby entrance and must include



Reagan Building, Washington, D.C.

an air lock. The distance between inside and outside doors must comply with accessibility criteria.

A canopy, portico, or arcade should be used for weather protection, and to emphasize the main entrance or enhance the building design.

Approaches must be well-lighted and designed to direct the visitor to the entrance. Grade level approaches are preferred over elevated approaches that require steps, but need to be coordinated with overall approach to provide building security. Clear and attractive graphics should be provided to assist visitors with directions.

Entrance Lobbies and Atria. The lobby should be clearly visible from the outside, both day and night.

The main lobby should accommodate visitors by providing information facilities, waiting areas and access to vertical transportation. Since the lobby also serves as the collection point for all employees entering the building, it shall be designed to accommodate the high volume of pedestrian traffic. Areas such as cafeterias, auditoria and exhibition halls should be located near the lobby. Where appropriate, designers should strategize security design to make monumental interiors, atria, and other grand spaces suitable for after hours public use.

Even in non-secure buildings, lobby space shall be planned to be divisible into a non-secure and secure area, with space on the secure side to accommodate a future security station that may include an identity check, bag check, metal detector and turnstiles. Also allow for adequate queuing space on the future non-secure side of the lobby. Refer to Chapter 8 and the section on *Design Issues Affecting Security, Building Lobby* of this chapter for further details.

Access, maintenance and cleaning of the interior and exterior wall and ceiling surfaces (glazing and cladding) of multi-level 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 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.

Elevator and Escalator Lobbies. Like entrance lobbies, elevator and escalator lobbies shall be designed to efficiently accommodate the movement of pedestrian traffic to other parts of the building. Adequate space should be provided to perform this function.

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 shall 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. It is desirable to introduce as much natural light as possible into corridors, through windows, transoms or borrowed light.

Building Support Spaces

Placement of Core Elements and Distances. In buildings with large floor plates not all core elements need to be placed at each core location. How often each element needs to be repeated is governed by occupant needs and the following maximum radii and distances:

- *Elevators* should always be grouped in banks of at least two for efficiency. Travel distances from a given office or work station to an elevator shall not exceed 200 feet. Travel distances to stairs are governed by code.
- *Toilets* should also be placed within 200 feet of every office or work station.
- *Electrical rooms* must be stacked vertically and should be located so that the area of coverage does not exceed 12,000 square feet and the length of the branch circuits do not exceed 150 feet. Shallow, secondary closets off permanent corridors may be used for receptacle panelboards where the distance between the riser and the farthest work station exceeds 150 feet and a separate riser is not warranted.
- *Communication Closets* must be stacked vertically and shall be placed so that wiring runs do not exceed 150 feet.

Toilet Spaces. Toilet space includes general use toilets and associated vestibules, anteroom and contiguous lounge areas.

Toilet rooms for both sexes should also be located adjacent to the cafeteria.

Toilet rooms shall be screened from public view without the use of double door vestibules at entrances. All public and common use toilets must have facilities for the disabled and comply with ABAAS. All other toilets must have provision for future adaptation to accessible requirements.

Table 3-3

Number of Toilet Fixtures

Number of Persons Per Toilet Room	Men			Women	
	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	5	4
97 to 119	5	2	3	7	5
120 to 134	6	3	4	8	5
Above 135	1/20	1/40	1/30	1/15	1/24

To the extent possible, toilets shall be grouped to reduce plumbing runs. The layout of toilets should minimize circulation space. However, toilet rooms for assembly areas, such as training or conference facilities, must accommodate short-term, high-volume traffic. In those areas, there shall be three women's toilets for every two toilets and/or urinals for men. Circulation should be adequate to handle peak traffic. In areas where assembly occupancies exist, provide fixtures consistent with code requirements for this occupancy.

- A fold-down changing table for infants should be available in toilets for public use.
- Feminine product dispensers shall be in each women's restroom.
- Toilet seat covers shall be provided in each restroom.
- Toilets for public usage shall be equipped with the large commercial toilet paper dispensers.

- Verify and get approval from the building management for the selection and placement of the following:
 - Commercial toilet paper dispensers
 - Soap dispensers.
 - Paper towel dispensers.
 - Paper towel trash receptacles.
 - Feminine hygiene products dispenser.
 - Feminine products disposal.
 - Toilet seat cover dispenser.

Toilet Partitions. All toilet partitions must be ceiling hung. They should be metal or similarly durable construction.

Toilet Accessories. Stainless steel is preferred for toilet accessories. Accessories should be integrated into the design of toilet rooms. Recessed and multi-function accessories that do not clutter the room are preferred.

Locker Rooms. Locker rooms shall be finished spaces. The shower area should be separated from the locker area. Regular gypsum wallboard is not to be used as a substrate for any shower room surface.

Custodial Spaces. Custodial spaces are devoted to the operation and maintenance of the building and include building maintenance storage rooms, stockrooms and janitor's closets. Custodial spaces shall be coordinated and approved by building management.

Storage Rooms. Storage rooms are utilitarian spaces. Rooms may be any configuration that will efficiently accommodate the materials to be stored. Access doors and aisles need to be large enough to move the stored materials. The configuration of storage rooms should be coordinated with the Facility Manager.

Janitor's Closets. Janitor's closets should be centrally located on each floor near the toilet facilities and be directly accessed from the corridor, not by going through the restrooms. They should accommodate all the equipment and supplies needed to service the area worked from the closet. All available space within the closet can be put to use to store gear and supplies. As a minimum, the service closet shall have a 600 mm (24-inch) square mop basin, a wall-mounted mop rack, and 900 mm (3 feet) of 250 mm (10-inch) wide wall shelving; the floor area should be a minimum of 1.7 m² (18 square feet).

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.

Equipment Spaces. 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. A minimum of 4 percent of the typical floor's gross floor area shall be provided on each floor for air-handling equipment. A minimum of 1 percent of the building's gross area shall be provided for the central heating and cooling plant (location to be agreed upon during preparation of concept submission.) Mechanical equipment room shall not be less than 3700 mm (12 feet) clear in height. All mechanical equipment room 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 are not permitted as a means of access to mechanical equipment. Mechanical equipment rooms should not be less than 3700 mm (12 feet) clear in height. In some buildings special fire protection measures may be required. See Chapter 7: *Fire Protection & Life Safety*, for additional requirements.

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 *Special Design Considerations, Acoustics, Design Criteria for Building Spaces, Class X Spaces* of this chapter for noise isolation criteria.

Main electrical switchgear shall 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 shall be made to prevent water from flooding the electrical room in the event of a pipe breaking. Automatic sprinkler piping shall not be installed directly over switchgear equipment.

Mechanical rooms as a rule shall open from non-occupied 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.

Equipment Placement. The architect shall coordinate with the mechanical engineer to place mechanical equipment in order to optimize access for maintenance and replacement. Design of equipment placement shall allow maintenance of motors and replacement of filters from the ground. When there is no practicable alternative and equipment must be placed overhead, replacement of filters shall require a standard step ladder requiring one person to safely operate.

Communications Equipment Rooms. In addition to the criteria stated for general mechanical and electrical equipment rooms, equipment rooms for communications equipment must comply with EIA/TIA Standard 569: *Commercial Building Standard For Telecommunications Pathways And Spaces* (and related bulletins).

Equipment rooms shall be sized to accommodate the equipment planned for the room. At a minimum, the room should have 69 660 mm² (0.75 square feet) of equipment room space for every 9.3 m² (100 square feet) of occupiable space. The equipment room should be no smaller than 14 m² (150 square feet). Federal Technology Service (FTS) should determine if tenants will share

equipment rooms or if separate equipment rooms are required for specific tenants.

Equipment rooms shall 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.

Spaces for Uninterruptible Power Systems (UPS) and Batteries. 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 in the design. Allow space for storage of safety equipment, such as goggles and gloves. Special attention shall 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 Closets. Electrical closets must be stacked vertically within the building. Closets shall be designed to contain adequate wall space and clearances for current and future requirements, and should have a minimum size of 1800 mm by 3000 mm (6 feet by 10 feet). Shallow closets must be at least 600 mm (24 inches) deep by 2600 mm (8 feet 6 inches) 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.

Communications Rooms. Communications rooms must be stacked vertically within the building. Rooms shall be sized to contain adequate floor space for frames, racks and working clearances for current need and future expansion. Communications closets shall meet the requirements of EIA/TIA Standard 569: *Commercial Building Standard For Telecommunications Pathways And Spaces* (and related

bulletins). Agency requirements for separate, dedicated communication closets shall be verified.

Vertical Shafts. Vertical shafts for running pipes, ducts and flues shall be located adjacent to other core elements to the maximum extent possible. Be aware of the requirement to locate fire alarm vertical risers remotely. Shafts shall be straight vertical runs. Shafts shall be sized to accommodate planned expansion of the systems. Shafts shall be closed at top and bottom, as well as at the entrance to the mechanical room, for sound isolation.

Loading Docks. Loading docks must be located for easy access by service vehicles and must be separate from the main public entrances to the building. Loading docks must be convenient to freight elevators so that service traffic is segregated from the main passenger elevator lobbies and public corridors. Service route from dock from elevator shall plan for the transport of large items such as rolled carpet goods. Loading docks must accommodate the vehicles used to deliver or pick up materials from the building. If the bed height of vans and trucks varies more than 450 mm (18 inches), at least one loading berth must be equipped with a dock leveler. The dock shall be protected with edge guards and dock bumpers. Open loading docks should be covered at least 1200 mm (4 feet) beyond the edge of the platform over the loading berth. In cold climates dock seals should be used at each loading bay. Alternatively, consideration could be given to enclosing the entire loading bay.

Separate or dedicated loading docks should be considered for food service areas.

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 1:12 and comply with ABAAS, ensuring that it may be easily maneuverable for deliveries on carts and dollies.

If the building size warrants, a dock manager's room or booth should be located so the manager can keep the entire dock area in view and control the entrance and exit from the building.

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. The berth should be 4600 mm (15 feet) wide and at least as long as the longest vehicle to be accommodated. Local zoning regulations or the architectural program may require a longer length. The space should be located adjacent to the enclosed or open loading dock. If additional loading berths are required they need not be wider than 3600 mm (12 feet), as long as they are contiguous to the 4600 mm (15-foot) wide berth.

An apron space shall be provided in front of the loading berth for vehicle maneuvering equal to the length of the berth plus 600 mm (2 feet). This area should be flat, with a minimum slope of 1:50 for drainage. The minimum headroom in the loading berth and apron space is 4600 mm (15 feet). When a steeper slope is required in the apron area, the headroom should increase with a gradient allowance to allow trucks to traverse the grade change.

If the approach to the loading dock is ramped, the design should permit easy snow removal.

Staging Area. A staging area inside the building shall be provided adjacent to the loading dock. It must be protected from the weather. The staging area shall not interfere with emergency egress from the building.

Trash Rooms. Trash rooms shall be adjacent to loading docks or service entrances. Trash rooms must be sized to accommodate the trash handling equipment required and provide storage for packaged trash generated during a three day occupancy of the building. Space shall be

allowed for sorting recycling of paper, glass and metals. Facilities that use trash containers that are picked up by vendors must have at least one loading berth for the trash container.

Building Engineer's Space. Even if not included in the building program, an office space for the building engineer should be evaluated. Most GSA buildings require such a space, which houses the consoles for the Building Automation System. This space is normally located near the loading dock or main mechanical spaces.

Security Control Center. All GSA buildings with a local security force should have a control center. In the event that the building will not be served by a local security force, this room could be combined with the building engineer's office or the fire control center.

The security control center should be located adjacent to the main lobby. Approximately 21 m² (225 square feet) 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.

Fire Command Center. See Chapter 7: *Fire Protection & Life Safety*, for additional requirements.

Food Service Areas. The entrances to the dining area should be visible from the main circulation paths, but should not impede lobby traffic.

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

Dining Areas. Dining areas should be located to take advantage of natural light and outdoor eating areas in climates where this is feasible.

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

In most cases, food service areas perform better when not isolated within a facility. Designers shall consider making food service directly accessible to the public and integrated with the site design. GSA has had success mitigating security concerns by a variety of means including placing food service within freestanding structures, and hardened partitions.

Child Care Centers. See *GSA Child Care Center Design Guide (PBS-P140)*. Child care centers will usually be operated by organizations outside the Federal Government. The GSA Office of Child Care Development Programs shall be consulted before design concepts are finalized.



Robert A. Young Federal Building Child Care Center, St. Louis, MO

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

Outleased Space. 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.

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 shall 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. See Chapter 2, *Site Planning and Landscape Design, Landscape Elements* and Chapter 8.

Structured Parking

The building program will stipulate the numbers and types of vehicle parking spaces. The program will also state whether parking is to be exterior on-grade parking or interior, structured parking. 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. When locating entrances and ramps, consider internal and



Food and Drug Administration District Headquarters

external traffic flow, queuing during peak periods of ingress and egress, and required security features.

Drive Aisles. Two-way aisles must have a minimum width of 7000 mm (23 feet). One-way aisles and aisles with stalls on only one side are less efficient and should be avoided if possible.

Vehicle Stalls. Stalls to accommodate regular passenger cars should have be sized to comply with local zoning requirements. When there are no zoning requirements then parking spaces should be a minimum size of 2600 mm (8 feet 6 inches) wide and 5500 mm (18 feet) long. No special consideration should be given to compact vehicles. No structural element may intrude upon the required stall dimension, and columns must not be located within 610 mm (2 feet) of the required aisle except where the aisle has no stalls perpendicular to it. Each stall must have access to an aisle.

Accessible parking spaces must be provided; these must comply with ABAAS for quantity, location and size.

Accessible parking spaces shall be adjacent to access aisles that are part of an accessible route to the building or facility entrance. Accessible routes shall not be located behind parking spaces.

Ramps. The incline on parking area ramps shall not exceed 12 percent. The break-over angle at changes of plane in ramps shall not exceed 6 percent. The incline on ramp floor garages shall not exceed 5 percent. The entire length of the entrance and exit ramps must be protected so that snow and ice do not accumulate on the ramps if inclement weather is excessive. Snow melting systems should also be considered. Careful consideration needs to be given to providing proper drainage of the parking deck.

Garage Openings. Overhead doors or grilles at vehicular entries to structured parking garages may be provided for security purposes. The operation of overhead doors or grilles must utilize advanced technology (use of sensors or incorporating sallyports) to prevent entry by unauthorized persons. These overhead grilles or doors shall be electric and operated by card-readers or other means of remote control. The control devices and doors or grilles shall be suited for high frequency operation, and should open and close quickly to avoid impact damage to vehicles; they must also have a sensor edge to detect a vehicle or other object below it and reverse operation. These openings should be monitored by camera.

These openings shall be a minimum of 3600 mm (12 feet) wide with minimum height of 2400 mm (8 feet). A headache bar shall be provided in front of each opening; this shall be mounted 100 mm (4 inches) lower than the height of the clear opening.

Walkways. Pedestrian walkways shall link the parking area with the building entrance. Provide curbs, bollards, other barriers or low walls to prevent vehicles from encroaching upon pedestrian walkways. Identify pedestrian crossings of vehicular traffic lanes by painted crosswalks and signage.

3.3 Commissioning

The design architect shall identify and coordinate commissioning practices with the Construction Manager, Project Manager, and (if contracted separately) the Commissioning Authority, for the project's programmed performance goals. As appropriate, coordinate with other disciplines to fully enable required testing and certifications. Incorporate into construction specifications those testing and certification requirements that involve construction contractors. Examples of possible programmed performance goals include:

- Assigned Annual Energy Consumption Goal
- Attainment of Programmed LEED rating
- Assured Envelope Thermal Integrity, Certified by Hot-Box and/or Infra-red (thermographic) Imaging
- Water Penetration and/or Moisture Control
- Blast Resistance Glazing Performance
- Seismic Response
- Acoustic Performance
- High-wind Impact Resistance
- Accessibility Requirements
- Functionality of Applied Innovative Technologies

3.4 Special Design Considerations

Incorporation of Recycled-Content Materials

The GSA is committed to maximizing the use of recycled-content materials specified in the construction of Federal building projects. Many commonly used products are now available with recycled content, including steel, aluminum, concrete, masonry, acoustic tile, paint, carpet, ceramic tile, and insulation.

To support markets for the materials collected in recycling programs, the Resource Conservation and Recovery Act

requires agencies to buy recycled-content products designated by EPA. Through the Comprehensive Procurement Guidelines (CPG), EPA designates items that must contain recycled materials when purchased by Federal agencies, or government contractors, using appropriated Federal funds. Refer to Chapter 1, *Recycled-Content Products*.

Information on specifying and purchasing recycled-content products can be found on the Internet at www.epa.gov/cpg.

The CPG items listed in Table 3-4 are frequently found in buildings. Product specifications and standards that might exclude the use of recovered materials should be revised to allow the use of these items.

Daylight and View

All buildings receive daylight. A daylit building, however, is specifically designed to efficiently use daylight through adapted components and control strategies. The goal of daylighting design is to minimize energy use and maximize human comfort. The benefits of daylighting are far reaching and include the physiological and psychological benefits of daylight, e.g. circadian rhythms; but also the little thought of benefits of view of the natural environment.

Although daylight and access to an outdoor view have typically been considered as part of the standard for windows and skylights, GSA had determine that these should be given additional consideration as a special design consideration upon both the structural design of the building. All building orientations have daylighting potential. It is a matter of using the appropriate techniques and technologies to take advantage of daylight.

Contrary to what is commonly believed, North America has year-round access to sufficient daylight for lighting



U.S. Courthouse, Seattle, Washington

Table 3-4

Examples from the CPG List of Designated Products

Building Insulation Thermal insulation made from recovered materials is available in several forms including rolls, loose-fill, and spray foam. Insulation can include a range of recovered materials such as glass, slag, paper fiber, and plastics.

Carpet Recycled-content polyester carpet is available for light- and moderate-wear applications. Recycled fiber polyester carpet is manufactured from PET recovered soda bottles.

Carpet Cushion Carpet cushion, also known as carpet underlay, is padding placed beneath carpet. Carpet cushions made from bonded urethane, jute, synthetic fiber, and rubber can be made from recovered materials.

Cement and Concrete Coal fly ash and ground granulated blast furnace (GGBF) slag are recovered materials that can be used as ingredients in cement or concrete. Coal fly ash is a byproduct of coal burning at electric utility plants. Slag is a byproduct of iron blast furnaces. The slag is ground into granules finer than Portland cement and can be used as an ingredient in concrete. The level of coal fly ash in concrete typically ranges from 15 to 35 percent of total cementitious material, but can reach 70 percent for use in massive walls and girders. The level of GGBF slag usually ranges from 25 to 50 percent.

Reprocessed and Consolidated Latex Paints For Specified Uses Reprocessed paint is postconsumer latex paint that has been sorted by a variety of characteristics including type (i.e., interior or exterior), light and dark colors, and finish (e.g., high-gloss versus flat). Reprocessed paint is available in various colors and is suitable for both interior and exterior applications.

Consolidated paint consists of postconsumer latex paint with similar characteristics (e.g., type, color family, and finish) that is consolidated at the point of collection. Consolidated paint is typically used for exterior applications or as an undercoat.

Structural Fiberboard and Laminated Paperboard Structural fiberboard is a panel made from wood, cane, or paper fibers matted together which is used for sheathing, structural, and insulating purposes. Laminated paperboard is made from one or more plies of kraft paper bonded together and is used for decorative, structural, or insulating purposes. Examples of these products include building board, insulating formboard, sheathing, and acoustical and non-acoustical ceiling tile.

Floor Tiles and Patio Blocks Floor tiles for heavy duty or commercial specialty applications can contain up to 100 percent postconsumer rubber. Floor tiles containing 90 to 100 percent recovered plastic are also readily available. Patio blocks made from 90 to 100 percent recovered plastic and 90 to 100 percent postconsumer rubber are used for walkways and trails.

Shower and Restroom Dividers / Partitions Shower and restroom dividers/partitions are made of 20 to 100 percent recovered plastic or steel. They are used to separate individual shower, toilet, and urinal compartments in commercial and institutional facilities.

Signage Signs made from recovered materials are used inside and outside of office buildings and other public places. EPA's designation pertains to plastic signs used for nonroad applications and covers any associated plastic or steel supports.

commercial buildings. Only in the extreme north of Alaska or Canada, due to the dark winter months, is there a lack of sufficient sunlight for daylighting purposes. The average illumination level under overcast skies at latitude of 50° is 7500 lux. This is about 15 times more illumination than that required to perform average indoor tasks.

Daylight in building design is recognized as a valuable means of improving energy effectiveness in commercial buildings. Refer to IESNA RP-5-99: *Daylighting Conference Proceedings*, May 1998. The research and design communities recognize it as a valuable way of providing tenants access to outside views. It has been identified in case studies and research that humans value their ability to maintain a visual link to the outside. This linkage re-enforces individuals with the sense of connectedness and comfort that the temporal and physical natural environment provides.

Daylight Design Criteria. Daylighting is essentially a systems integration challenge for a multi-disciplinary design team. It is important that daylighting considerations involve the participation and cooperation of the owner/tenant, architect, electrical lighting designer, mechanical systems engineer, interior designer, operation and maintenance staff and the construction team. Daylighting is unique in that it requires designers to address multi-disciplinary qualitative issues, in addition to the usual technical issues. For lighting to be truly effective, it must provide a comfortable and healthy visual environment that will support 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 and commissioning.

Daylight Design Concept and Integration Process. The daylight design process shall include 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, e.g. BDA
- Mechanical Coordination
- Auxiliary Lighting Integration
- Commissioning

Acoustics

The standards in this section have been established to ensure adequate acoustic qualities in Federal buildings.

Design Criteria for Building Spaces. Every element of a built space, including its shape, surfaces, furniture, light fixtures and mechanical systems contribute to its acoustical characteristics. Four key concepts govern the perceived quality of office acoustics:

- **Appropriate levels of speech privacy.** Speech privacy refers to the degree to which a conversation cannot be overheard in an adjacent space. Lawyers, doctors, human resources officers, executives and others whose position requires them to discuss sensitive information require confidential speech privacy, that is, a setting where, when a door is closed, the content of a conversation cannot be overheard. Professional staff members whose position requires extended periods of concentration require normal speech privacy, where the content of conversation in adjacent spaces cannot be overheard without making an effort, providing freedom from distraction. Little or no

speech privacy is needed for receptionists, clerical staff, and team-oriented workgroups where overheard conversation can actually be beneficial.

- **Appropriate levels of background sound.** Continuous background sound in offices is mostly generated by heating, ventilation, and air conditioning (HVAC) equipment. In conference spaces, courtrooms and auditoria, it is important that this background sound not interfere with the intelligibility of speech. In enclosed offices, HVAC background sound is 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.
- **Control of intrusive noise, vibration, and reverberation.** Office equipment generating noise levels above the background should be located away from primary work areas or should be surrounded by acoustically isolating panels. Noise induced by mechanical equipment should be controlled through vibration isolation devices, appropriate placement of equipment and noise attenuators in ducts. Reverberation and echoes must be controlled in courtrooms, auditoria, conference, team, and training room spaces. Sound absorbing materials are used to help control reflected sound energy and echoes. Particular attention must be paid to rooms with parallel walls (causes “flutter” echoes) and rooms with curved or concave ceilings (leads to acoustical focusing effects).

Isolation from exterior noise sources. Buildings located near airports, highways, rail corridors or other sources of significant environmental noise levels must have exterior wall and window assemblies controlling noise intrusions.

Closed Offices Versus Open Plan. Required levels of acoustic privacy should be included as a design criterion. For work that does not require acoustic and/or visual privacy, an open plan environment with low or no partitions between workstations is appropriate. 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. A protocol that encourages lowered voice levels is also recommended. Closed offices are encouraged 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.

Parameters Used in Acoustical Design. The following parameters are used to specify acoustical standards for GSA buildings:

Background Noise— the continuous noise within a space. The loudness of noise is quantified by several assessment schemes, including noise criteria (NC), balanced noise criteria (NC-B) and room criteria (RC) contours. These contours are published in the *ASHRAE Handbook of Fundamentals*. Lower values are quieter.

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. *Noise Isolation Class* (NIC) quantifies the field-tested sound isolation between two enclosed spaces separated by a partition when tested in accordance with ASTM E336. NIC accounts for both the sound insulating performance of the partition, and unintentional paths (“flanking paths”) between the spaces (e.g. wall/ceiling connections, partition penetrations, etc.). The numerical value of NIC is usually less than that of the STC for the separating partition. NIC should only be tested in fully furnished spaces. *Ceiling attenuation class* (CAC) quantifies the sound insulating performance of a ceiling assembly spanning across rooms that share a common plenum when tested in accordance with ASTM E1414. *Field Impact Insulation Class* (FIIC) quantifies the field-tested impact sound insulating properties of a floor/ceiling assembly when tested in accordance with ASTM E1007. Greater STC, NIC, CAC or FIIC values represent better performance.

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 (SAA replaces the earlier noise reduction coefficient or NRC). SAA/NRC is a single number rating between 0 and 1. Greater SAA/NRC values represent a more effective sound absorber. An excessive amount of reflected sound (reverberation) tends to degrade speech communication.

Speech Privacy— the amount of speech that can be understood in a space adjacent to the location where a conversation is occurring. Articulation Index (AI) is a measure of the intelligibility of speech, which is related to the level of the speech relative to the level of the background noise at a particular location. When tested in open plan offices in accordance with ASTM E1130, AI takes into account the noise reduction of partitions between spaces, the absorption in spaces, the distance between source (talker) and receiver (listener), the level of the background noise, and typical voice levels. AI is a single number rating between 0 and 1; lower AI values mean fewer words can be understood, indicating increased privacy. An AI value of .05 indicates less than 8% of speech in an adjacent space can be understood and is considered the upper threshold of “confidential” speech privacy. An AI of .15 means indicates that, with concentrated effort, nearly two-thirds of speech in an adjacent space can be understood. Recent research indicates that above this level, intruding conversation may become distracting. An AI of .20 is considered the upper threshold for “normal” speech privacy.

Design Criteria for Building Spaces. Acceptable acoustics are determined by the use of a space and the requirements of its occupants. It is the responsibility of the design team to meet the following minimum standards governing the acoustical performance of various space usage categories.

Environmental Noise. The impact of site noise on a building’s interior spaces shall be mitigated under any of the following conditions:

- Building is located within an airport noise contour of DNL 60 or greater
- Building is located within 500 feet of a freeway or railroad right-of-way
- DNL at the building’s property line exceeds 70 dB

Table 3-5

	1	2	3	4	5
Space	Maximum Mechanical Noise (RC/NC)	Minimum Absorption: Ceiling (SAA/NRC)	Minimum Absorption: Walls (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
Private offices, normal speech privacy, sound masking	35 ³	n/a	0.8/ 25%	35	n/a
Private offices, normal speech privacy, 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 shall achieve the required NIC rating for the spaces that they are separating.

³ Steady state background noise provided by electronic sound masking system: 40-42 dBA.

⁴ Steady state background noise provided by electronic sound masking system: 45-8 dBA.

In such locations, an acoustical report shall be submitted showing that the building’s acoustical design mitigates the intrusion of exterior noise to no more than 5 dBA over the maximum mechanical noise levels (Table 3-5, Column 1).

For locations where a railroad runs beneath or abuts the site, a newly constructed building shall contain provisions that minimize vibration transmitted to office spaces within the building, including feelable vibrations and vibrations in the form of audible noise.

Mechanical and Plumbing Noise. All mechanical equipment shall be vibration isolated per ASHRAE standards and guidelines, including spring isolators, inertia bases as well as ancillary items such as flexible piping and electrical connections. In seismic areas, acoustical vibration isolation must not compromise seismic code requirements and vice-versa. As such, housed springs should be avoided; instead, un-housed springs with separate seismic snubbers should be used.

Ambient noise from mechanical equipment shall not exceed noise criteria (NC) values shown in Table 3-5, Column 1, “*Mechanical Noise*”. Diffusers with an NC rating 5 points less than the noise criterion for the space being served are required.

Where occupied space occurs adjacent to, above or below mechanical, electrical equipment, or machine rooms, or adjacent to HVAC or elevator shafts, the intervening structure (partitions, shaft walls, doors, floor and ceiling assemblies, etc.) shall be sufficient to control noise intrusion to no greater than the maximum noise criteria (NC) or room criteria (RC) values shown in Table 3-5, Column 1, “*Mechanical Noise*”. 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 shall be limited to 5 dB below the maximum NC/RC for the space in all octave bands.

All hot-water heating, supply, waste, and drain piping shall be vibration isolated from the structure, as well as from other piping, ductwork, gypsum board, etc. in the walls, ceilings and floors enclosing noise sensitive spaces (Table 3-5, Column 2, NC/RC 35 or less). All stud and joist spaces where such piping is located shall have R-11 (3-½-inch thick) batt insulation installed, and piping shall not be closer than one-inch to gypsum board.

Noise isolation, room acoustics and speech privacy. Absorptive materials are required in speech sensitive spaces to control reverberation and echoes. Table 3-5, Columns 2 and 3 lists 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/Ceiling assemblies separating office spaces shall achieve an NIC of not less than 50 (when furnished) and Field Impact Isolation Class (FIIC) of not less than 50. Table 3-5, 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 will satisfy the minimum specified NIC requirements, with the offices furnished typically. Doors and other holes in the walls will degrade the overall performance. These wall examples are not the only constructions that will satisfy the performance criteria, but are intended solely to provide guidance on projects that do not require a qualified acoustical consultant during the design phase.



U.S. Courthouse at Foley Square, New York, NY

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 six-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 six-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 six-inches above acoustical tile ceiling (minimum CAC 44).

NIC 31 (private offices, normal speech privacy, low voice level; misc. 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).

Commissioning. Verification that the above acoustical requirements have been met is required as part of contract documents. Acceptable documentation includes either a report by an acoustical engineer, stating that the intent of these requirements has been met, or other documentation showing that these acoustical requirements have been incorporated as contractual requirements. Contracting Officer may require, at no cost to the Government, test reports by a qualified acoustical consultant showing that acoustical requirements have been met by as-built construction.

3.5 Building Elements

This section establishes design guidelines for the various building elements, which are defined as the physical parts of building construction. These may be individual materials, assemblies of materials, equipment, or assemblies of materials and equipment.

It is the architect's responsibility to specify construction materials and systems appropriate to the final design. For additional requirements on fire protection and building construction (e.g., types of construction, panel and curtain walls, fire stopping, and spray-applied fire resistive materials), see Chapter 7: *Fire Protection & Life Safety*.

Substructure

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 shall be provided at grade to facilitate washing out the system.

Waterproofing. Membrane waterproofing should follow the recommendations of the National Roofing Contractors Association (NRCA) as contained in *The NRCA Waterproofing Manual*.

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.

Exterior Closure

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 m² (1.5 ounces per square foot) of surface or other equivalent protection.

Exterior Wall Construction. Brick masonry design shall follow the recommendations of the Brick Institute of America (BIA) contained in the publications, *Technical Notes on Brick Construction*.

Concrete masonry design shall follow the recommendations of the National Concrete Masonry Association (NCMA) contained in the publication, *TEK Notes*.

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

Exterior limestone veneer design shall follow the guidelines of the *Handbook on Indiana Limestone* published by the Indiana Limestone Institute of America.

Marble veneer design shall follow the recommendations in *Exterior Marble Used in Curtain or Panel Walls* published by the Marble Institute of America.

Vapor retarder must be provided in a building envelope where heat loss calculations identify a dewpoint within the wall construction and in any building or part of any building that is mechanically humidified.

Exterior Cladding and Articulation. 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 opportunities provided for birds to roost ("bird roosts") on the exterior of the building. "Bird



Sam Gibbons U.S. Courthouse, Tampa, FL

roosts” can create both maintenance and visual problems, particularly in high-rise buildings.

Such opportunities for ‘bird roosts’ must be identified in the design phase and alternatives ways to address this be pursued. 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 address this issue. See the *Sun Control Devices* section of this chapter.

Sun Control Devices. Projecting exterior sunscreens may be used in addition to interior daylight control devices where they are beneficial for building operation and energy conservation. Design elements such as steeply angled fins or large scale gratings, instead of horizontal fins and flat planes, should be considered for sun screen components to provide shading and heat control for a building.

Consideration shall be given to operable and fixed sun control devices for maintenance, repair and replacement. Window washing systems used for the facility must also be compatible with any sunscreens or sun control devices.

Glazing, shading devices, and sources of illumination should be analyzed in detail to minimize heat gain and maximize direct day light into all spaces to produce the best microclimate for tenants in building perimeter spaces.

Daylight shading controls should be programmable and calibrated with a daylight sensor to maximize daylight and minimize energy consumption where possible.

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.

Exterior Windows. Although fixed windows are customary in large, environmentally controlled GSA buildings, in certain circumstances operable windows may be appropriate. Sometimes operable windows can also be used as a means of smoke control. In addition, operable windows may be used where they provide for window washing operations. In such cases, the operable windows should be able to be washed from the interior side.

Replacement of windows in historic structures should exactly match original frame and muntin profiles. First consideration should be given to rehabilitating the existing windows.

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

Aluminum windows shall meet the requirements of ANSI/AAMA Standard 101-85. Only Optional Performance Classes may be used. Metal windows other than aluminum shall 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.

Aluminum frames must have thermal barriers where there are more than 1670 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.

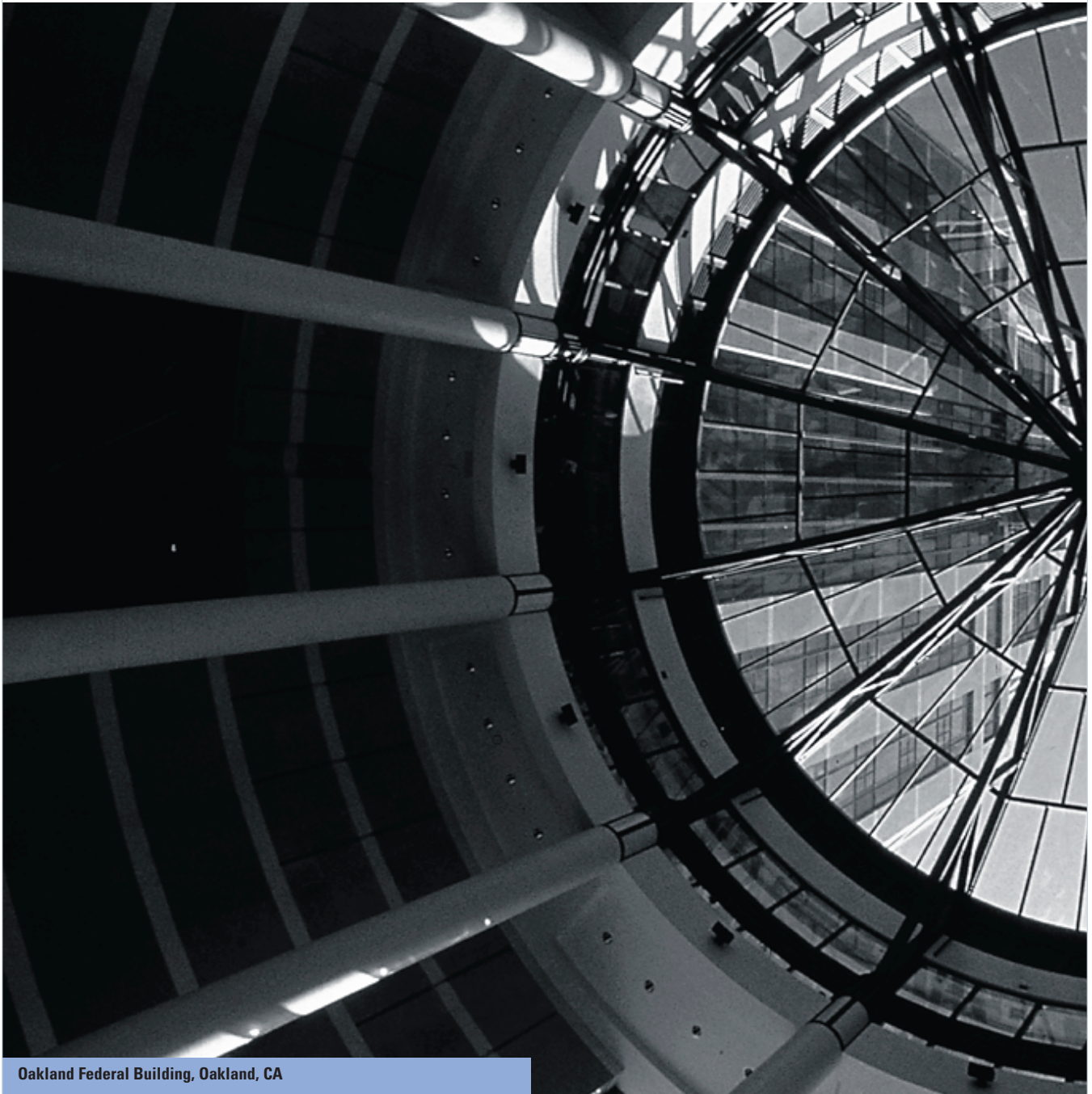
Glazing. The choice of single, double or triple glazed windows should be based on climate and energy conservation and security requirements. Use thermally broken frames when double and triple glazing units are specified. Highly reflective glass that produces mirror images should be used with care to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

Condensation Resistance. Windows should have a condensation resistance factor (CRF) adequate 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*. Where a CRF in excess of 60 is required, do not use windows unless some condensation can be tolerated or other methods are used to prevent or remove condensation.

Window cleaning. The design of the building must include provisions for cleaning the interior and exterior surfaces of all windows. Window washing systems used in the region must be considered and a preferred system and equipment identified during design. In large and/or high-rise buildings, such glass surfaces as atrium walls and skylight, sloped glazing, pavilion structures, and windows at intermediate design surfaces must be addressed. See also the *Building Specialties, Window Washing Equipment* section of this chapter.



Robert C. Byrd Courthouse, Charleston, WV



Oakland Federal Building, Oakland, CA

Exterior Doors. Entrance doors may be aluminum and/or glass of heavy duty construction. Glazed exterior doors and frames shall 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.

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, hinge pins 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 shall have a lock guard or astragal to prevent jimmying of the latch hardware. Doors used for egress only should not have any operable exterior hardware. See Chapters 7 and 8 for additional information.

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

Roofing. Roofing design shall 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 shall follow the recommendations of the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) publication, *Architectural Sheet Metal Manual*.

Roof Drainage. Dead level roofs are not permitted. Roof drains or scuppers are the only low points permitted. Provide a minimum slope to drains of 1:50 on roofing surfaces. When providing roof slope, consider sloping the structural roof deck. Over the life of the building this may be less expensive than providing tapered insulation each time the roof is replaced. Roofs shall not be used to retain water.

Insulation. Roof insulation should be installed in a minimum of two layers to minimize thermal breaks in the roof system.

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

Roof-Mounted Equipment. Roof-mounted equipment shall 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. Pitch pocket details should not be used.

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.

Skylights and Sloped Glazing. Skylights are defined as pre-fabricated assemblies shipped ready for installation, while sloped glazing is defined as field-assembled. Skylights design shall follow the guidelines of the 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.

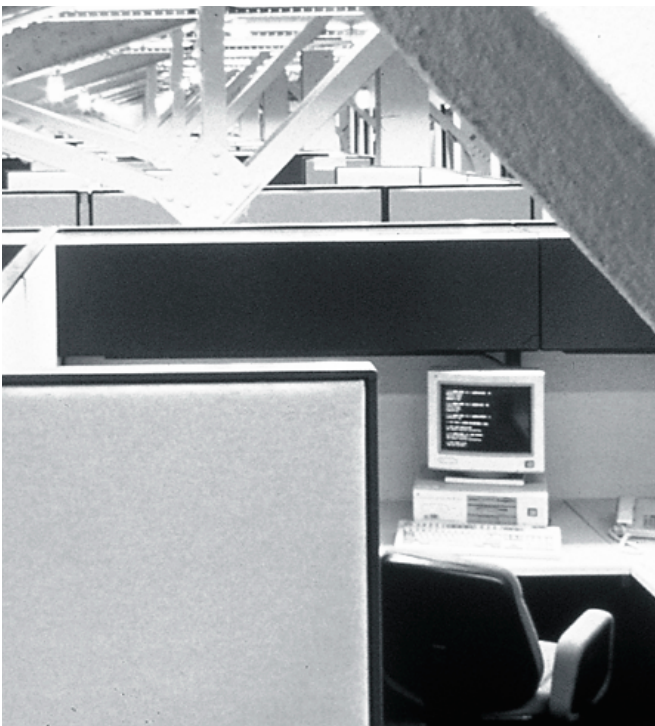
Consideration shall be given to cleaning of all sloped glazing and skylights, including access and equipment required for both exterior and interior faces. See also *Building Elements, Cladding and Articulation* and *The Buildings Specialties, Window Washing Equipment* sections of this chapter.

Thermographic Testing. In order to verify performance related to the design intent of the exterior building envelope, regarding thermal resistivity, thermographic testing shall be performed at various conditions on the finished construction and before occupancy. This testing will verify that the actual construction meets the requirements as specified.

Cornerstone

A cornerstone is required for all new buildings as a part of the exterior wall. The cornerstone should 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). The words, UNITED STATES OF AMERICA, should be in letters 50 mm (2 inches) high and other letters should be proportionally sized by rank.

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



Postal Square, AOC Workstation

Interior Construction

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 pre-finished, 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 Finishes. Refer to the section on *Interior Finishes* in this chapter.

Interior Doors. Interior doors in tenant spaces should be flush, solid-core wood doors. Steel door frames 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 door frames 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. When designing a suspended ceiling system with drop-in components, such as lighting fixtures, specifications may not be incorporated that can only be satisfied by hard metric versions of recessed lighting fixtures unless market research of cost and availability has been done as outlined in Chapter One; *General Requirements, Metric Standards, Metric Policy Guidelines*.

Building Specialties

Window Washing Equipment. Generally, window washing and exterior maintenance are performed by maintenance contracting firms that provide their own powered platforms, scaffolding, or chair lifts to perform these functions. To accommodate the use of maintenance equipment, suitable engineered systems shall be designed and incorporated into the building design. The design will be for buildings three stories or 12,200 mm (40 feet) and higher, and shall conform to OSHA Standard 29 CFR 1910.66, Subpart F - *Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms*, ANSI Standard A120.1, *Safety Requirements for Powered Platforms for Building Maintenance*, and ANSI Standard A39.1, *Safety Requirements for Window Cleaning*.

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 pick-up 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, glass and metals). Waste handling stations must be completely screened by walls and doors or gates constructed of materials complementary to that of the building.

Certain buildings may require additional waste handling equipment such as incinerators or compactors. All incinerator designs must be approved by the Environmental Protection Agency. GSA will coordinate this review.

Flagpoles. See Chapter 2: *Site Planning and Landscape Design, Landscape Design, Landscape Elements*.

Telephone Enclosures. Enclosures for public telephones should be provided in the main lobby, near the cafeteria, near the auditorium and in other building areas serving the public. Accessible public phones must be provided; they must comply with the UFAS/ADA *Accessibility Guidelines* for number, location type and design.

Shelves shall be provided at phone locations, and shall be designed and constructed to accommodate the weight of persons sitting or leaning on them. Assume a 113 kg (250 pound) load per 300 mm (1 foot) of shelf length. In historic buildings where original telephone enclosures exist, reuse original enclosures to the extent possible and design alterations to be visually compatible with original finishes.

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, shall be accessible to disabled persons per ADAAG Guidelines. 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.

Window Coverings. All GSA buildings should be equipped with adjustable window coverings. Describe the controls for coverings on clerestory and atria windows, and how they will be serviced for cleaning, maintenance, repair and replacement. In some instances it may be possible to consider automated blinds that respond to sun angle and internal temperatures. This may be particularly beneficial in the southern and southwestern areas of the country.

Artwork, Signage, and Registry of Designers

Artwork. The process of commissioning art for Federal buildings and courthouses is a collaboration between GSA, the architect of the building, art professionals and community advisors. The Art-in-Architecture Program strives for a holistic integration of art and architecture. Through collaboration – from the initial concept through construction – the artist, architect, landscape architect, engineer, lighting specialist, and practitioners of other disciplines can work as a team to create new expressions of the relationships between contemporary art and Federal architecture. The focus on integrating art with the design of new Federal buildings and courthouses is predicated upon substantial involvement and responsibility of the A/E team. Provisions for cleaning, maintenance and security of the artwork should be coordinated with the Facility Manager.



Ronald Reagan Federal Courthouse, Santa Ana, CA

The Art-in-Architecture project shall begin concurrently with the selection of the A/E and be timed so that the artist(s) have sufficient time to collaborate with the A/E firm on design concepts and that the artist be prepared to discuss their art concept at the Concept Presentation.

Please consult the *Art-in-Architecture Program Guidelines* for additional information.

Fine Arts Program Mission. To manage the portfolio of fine arts assets under GSA’s stewardship to insure their accountability, accessibility, preservation and appropriate use to enhance and promote superior workplaces for federal agencies and the public they serve.

Scope of Collection Statement. The Fine Arts Collection includes commissioned public works of art that enhance the architecture of federal buildings; portable works of art commissioned under the federal patronage of the New Deal; works of art purchased with Art in Architecture (AiA) funds; and maquettes. The collection includes over 17,000 installed or associated paintings, sculpture, architectural or environmental works of art, and graphics dating from the 1850’s. The collection does not include:

- decorative arts, such as furniture and light fixtures (unless commissioned through the AiA program)
- architectural ornamentation or details, such as historic mosaic flooring, stenciled borders, ceiling medallions, coffered ceilings, cast eagles, and ornamental molding (unless commissioned through the AiA program)
- commemorative works of art, such as busts and portraits
- artwork purchased for office space, such as reproduction prints and posters

Please consult the *Fine Arts Program Desk Guide* for additional information.

Graphics and Signage. Graphics and signs must be clear and simple, and shall 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 shall comply with all the UFAS/ADA Guidelines; Underwriters Laboratory (UL)—Illuminated Signs Standard; Occupational Safety and Health Administration (OSHA) Standards for safety signs; and Federal Standard 795 for accessibility.

Signage in historic buildings should be compatible with original designs, using historic finishes, colors, and typefaces. Typefaces must be acceptable within ADA requirements where adequate contrast, scale, and other design factors ensure signage legibility.

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.

See sections 2.14 *Site Signage* and 9.3 *Signage and Graphics* for additional requirements.

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

Emergency Evacuation Route Signage

- Emergency evacuation route signage shall 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 shall be 8 1/2 inches by 11 inches. This signage shall be depicted in either landscape or portrait form depending on the architectural layout and orientation of the elevator lobbies at each floor. {Also provide labeling as required in PBS ORDER 3490.1, Paragraph 7.d.(1), dated March 8, 2002.}
- The signage shall 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 signs 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 shall contain a LEGEND for clarification purposes of any additional items shown on these evacuation plans. Also, include the following statement on plans “IN CASE OF FIRE DO NOT USE ELEVATORS - USE STAIRS”.

Registry of Builders and Designers. A plaque shall be placed inside the building with the names of the individuals on the GSA project design team; the consultant architects and engineers; the onsite construction managers; and the construction workers will be inscribed on the plaque. The GSA Project Manager will provide the specifications for the design and construction of the plaque.

3.6 Interior Finishes

Recommended Minimum Standards for Finishes in Tenant Spaces. GSA has set minimum standards for the quality of finishes. GSA provides a tenant improvement allowance for finishes and features within its rental charge. Within this allowance, the choices for interior finishes are the responsibility of the tenant. GSA recommends the following as minimum standards. Where tenants choose finishes below these minimum standards, the tenant is responsible for above standard maintenance costs. Codes may have a bearing on the type of finishes in an area and shall be consulted. For fire safety requirements, see Chapter 7, *Fire Protection & Life Safety, Interior Finishes*. An example is the need to provide carpet tile rather than continuous carpet over access flooring. Architects shall specify, where practicable, finishes that contain recycled, renewable, and/or reusable materials and that eliminate or minimize the release of harmful substances during installation and use. Finishes shall be specified based on the value they provide over their useful life; considerations include maintenance and disposal costs in addition to first costs.

Carpets. Carpets should be used in all areas where acoustics are a concern, most notably in office working areas. Carpet tile should be used whenever there is access flooring, a cellular floor, or a ducted floor system, so that maintenance of systems under the floor can be done without destroying the carpet. Carpet tile is available in hard back or cushion back, which maintains its overall appearance longer and is more comfortable to stand and walk on than hard back.

Six-foot-wide (1800mm) cushion back broadloom carpet can be used in many installations. Twelve-foot-wide (3700mm) broadloom carpet without a cushion back or separate pad is appropriate for use in low traffic areas. In

high traffic areas, a cushion back or carpet pad should be specified.

Off-gassing of harmful chemicals from carpet installations into the interior is a serious health concern. To minimize off-gassing that adversely affects indoor air quality, all carpet materials, including carpet fibers, backing, cushion, and adhesives, shall meet or exceed the Carpet and Rug Institute’s “Green Label” criteria and contain recycled, renewable, and/or reusable materials as much as practicable. Preferred materials for carpet backing and cushioning are those containing natural fibers, polyolefin, polyvinyl butryal (PVB), polypropylene, polyurethane, or urethane.

Carpets that use recovered materials shall be specified (see section 3.2, *Special Design Considerations*) and care should be taken to specify carpet that can be recycled in the future. However, when specifying a carpet that complies with RCRA Section 6002 and Executive Order 13101, care must be taken to verify it also meets all the criteria for its intended use and level of foot traffic.

The amount of foot traffic and soiling should be considered when selecting carpet. The CRI has developed test criteria for rating carpet in each of three classifications: severe traffic, heavy traffic, and moderate traffic. A selection of carpet for a lower foot traffic level than anticipated is discouraged.

Severe traffic level – Extreme foot traffic and soiling. Examples are corridors, entrance areas, lobbies, office circulation, food service areas, etc.

Heavy traffic level – Heavy to medium heavy foot traffic and soiling. Examples are private offices, living quarters, open plan office cubicles and workstations.

Moderate traffic level – Moderate foot traffic. Examples are sleeping areas, conference rooms and consultation areas. Commercial grade carpet should be specified for these areas.

A complete list of usage areas and their minimum use classification is available from the Carpet and Rug Institute, PO Box 2048, Dalton, GA 30722

Carpet pattern can mask or camouflage traffic patterns, spots, and soil, so that its appearance will be maintained for a longer period of time. Pattern performance is:

Random pattern design = excellent

Geometric Pattern = good

Tweed = marginal

Solid Color = Poor

Stains will be the most noticeable when using colors that contrast with soil, dust and spills. Therefore, light and dark colors at the extreme ends of the color spectrum do not perform as well as colors that are in the medium range.

Cushioning carpet adds a shock absorber to the carpet and reduces the crushing of the yarn. This prevents a loss of appearance from creating contrast in the traffic areas, thereby allowing the carpet to provide longer service. It also provides ergonomic benefits by absorbing impact resulting in less stress on the lower legs and feet of the occupants.

Since 80 percent of the soil in the building comes in the entrance areas of the building, it is important to catch the soil at the entry. There are different systems available, including special carpet tiles and entry mats available on GSA Federal Supply Contracts.

Wall Covering. Use wall coverings that will maintain acceptable appearance in the location used for a minimum of 10 years. Preferred wall coverings include those that use natural fibers, polyester, polyethylene, and low-VOC spray-applied polychromatic finishes.



Martin Luther King Courthouse, Newark, NJ

Architectural Woodwork. Work under this section should be certified as meeting the referenced standard under the terms and conditions of the AWI Quality Certification Program.

Resilient Flooring. Resilient flooring materials should be selected based on durability, ease of maintenance, and the effects of their materials, installation and maintenance on indoor environmental quality. Surfaces that require extensive use of volatile cleaning and waxing compounds

should be avoided. Suitable resilient flooring materials include, but are not limited to, linoleum, cork, rubber, or polyolefin.

Base. Where specified, floor perimeters shall use a wall base made of materials that provide long-term durability for the use intended. Preferred base materials include wood, rubber, ceramic tile, marble, and terrazzo.



U.S. Courthouse, White Plains, NY

General Office Space (Open and Enclosed Offices)

This category of space comprises a large proportion of area in Federal buildings. Materials, surfaces, and systems must be chosen with quality and flexibility as primary concerns. Office spaces characteristically change with their occupants, occupancy configurations and utility requirements. Interior finishes should allow these transformations to occur with minimal disturbance and cost.

Resilient flooring should only be used in offices adjacent to utilitarian spaces such as loading docks.

Carpet for Raised Access Floor. Carpet tiles should be used on raised access floor. Both carpet adhered to floor panels and loose-laid carpet tile are permitted.

Ceilings. The majority of the ceiling system for general office space shall 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 shall be used to delineate space and provide relief from open expanses of acoustical tile materials. Drywall ceilings shall be located where is maintenance access is not required.

Doors. The finish for solid core wood doors in general office spaces should be limited to a paint grade finish or wood veneer. Glass doors may be used at entrances to tenant suites.

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 need to be appropriate for the use of the space. In addition, the application of tackable acoustic wall panels, whiteboard wallcoverings 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.

Internal Corridors

Corridors within general office areas should receive the same finishes as the office areas themselves. Color and material changes compatible with the overall palette may be useful in these areas for orientation.

Entrances and Vestibules

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.

It is desirable to integrate the exterior and interior building design in these areas. Materials shall 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 2100 mm (7 feet) to minimize air infiltration.

Floors. All entrance areas require a means to prevent dirt and moisture from accumulating on the entrance lobby floor. It is desirable to have permanent entry way systems (grilles, grates, etc.) to catch dirt and particulates from

entering the building at high volume entry ways. 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 may require only a natural or synthetic fiber floor mat. The entrance vestibule may also have a hard surface flooring surrounding the matted area that would be part of the adjoining main entrance area.

Doors. Doors at building entrances and vestibules should be glazed to facilitate orientation and safe movement in these high traffic areas.

Elevator and Escalator Lobbies

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 continuity.

Floors. Elevator and escalator lobbies should harmonize with the finishes used in the entrance lobby or atrium. Because of their importance in orientation and movement, floor treatments in these areas should be similar throughout the building.

Walls. Use durable, high quality surfaces, and coordinate wall finishes with elevator door and frame finishes.

Ceilings. Special treatments are appropriate to visually distinguish elevator lobbies. Provide either high-end accessible ceiling systems or integral access panels to ease access to elements above the ceiling.

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.

Floors. Elevator floors receive a great amount of wear in a very concentrated area. The flooring surface shall be either extremely durable or easily replaceable. 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. Carpet materials should be selected for low pile height and high density.

Walls. Wall materials shall present a high quality image and should be sufficiently durable to take some abuse. Materials shall be installed on removable panels or other replaceable devices to facilitate maintenance and renewal of finishes.

Ceilings. Ceilings shall be replaceable. In passenger elevators recessed downlights or indirect fixtures should be used.

Doors. Surfaces should be scratch resistant and easily replaced or refinished. Inside and outside finishes should be coordinated with adjacent wall surfaces.

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



National Archives, College Park, MD

Stairways (closed)

General Requirements. Where internal stairways are used for both general vertical circulation and emergency egress, finishes should be consistent with the floors being served by the stair. In stairways used for utility purposes or only for emergency egress, unfinished or minimally finished surfaces are appropriate.

Floors. In general circulation stairs, flooring for stairways, treads, and landings should provide acoustic control. Resilient materials are most appropriate and shall be combined with a non-slip nosing on the treads; these must be non-combustible. These surfaces should be coordinated with materials of the floors, which the stair serves. Utility and egress-only stairs should be of unfinished, sealed concrete or steel. Always provide non-slip nosings.

Walls. Wall surfaces in these areas should be drywall substrate with a simple, straightforward finish such as paint or wall covering. In utility and egress stairs, provide a painted or unfinished surface.

Ceilings. Absorptive materials are desirable in stairways for their acoustic effect. Stair runs should have painted gypsum board soffits where appropriate.

Doors. Doors between adjacent building areas and stairways should match other doors in the building areas. The doors should have the same finish on the interior and the exterior. Utility and egress stair doors should be painted metal.

Stairways (open)

Open stairways that connect lobby and atrium spaces should be appropriately finished in materials that match or relate to the adjacent surfaces in quality and appearance.

Floors. Floor finishes for open stairs should match or coordinate with the adjoining lobby and atrium spaces served by these stairs.

Public Corridors

Floors. Public corridors adjacent to building entrances, atria, etc., which carry significant foot traffic and provide major circulation pathways throughout the building shall have materials selected that shall be extremely durable and require low maintenance. To improve acoustic control in corridors adjacent to work spaces, hard, reflective surfaces should be avoided.

Walls. Walls in public corridors should receive a wall covering over a drywall substrate.

Ceilings. Accessible acoustical ceilings should be selected for corridors. Use a high quality system in public areas. Avoid inaccessible (sealed) ceiling systems. Submit alternative proposals to design team.

Doors. 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. Finish may be wood veneer. 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.

3.7 Building Support Spaces

General Use Toilets

Toilets are part of the permanent building core and should be designed with good quality, long-lived finishes. They are an extension of the public spaces of the building. The most appropriate finish for floors and walls in toilet rooms is ceramic or porcelain tile. In light-use areas, less costly moisture-resistant materials may be substituted. In all cases, carefully chosen patterns and colors will enhance the design image.

Continuous vanities of stone, artificial stone, or solid surface material shall be designed for lavatories. Sinks shall be under mounted. A large, continuous mirror should be provided on at least one wall of each toilet room. See section 3.2, *Space Planning Requirements*.

Equipment Spaces and Maintenance Shops

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. Walls in these areas should be painted.

Floors in mechanical rooms and maintenance shops should be waterproofed. Floors in electrical and communications rooms should be painted or sealed. Communications equipment rooms may also have resilient flooring.

Rooms containing major electrical or environmental equipment must be designed to provide clearance for service including replacement of components or the entire piece of equipment.

Staff Locker Rooms and Custodial Spaces

Storage rooms should receive minimal finishes. As in other support areas, these finishes should be coordinated with adjacent spaces. Janitors' closets should be similarly finished, except those containing sinks, which should be provided with a ceramic tile floor and base. Staff locker rooms should be provided with resilient flooring and vinyl wallcovering (or equivalent), except in "wet" areas, which should be finished similar to general use toilets (ceramic tile floor and walls).

Building Engineer's Office and Security Control Center

If these spaces are included in the building program space requirements, they should be finished like an office. Flooring in the building engineer's office should be vinyl tile if it is located near the central plant or other utilitarian support spaces.

Food Service Areas

Cafeteria Kitchens and Serveries. 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 Other Than Cafeteria Kitchens. 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 wallcovering 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.

Other Specialty Areas

Court buildings, border stations, and child care centers have special requirements for finishes. See the *U.S. Courts Design Guide* and Chapter 9: *Design Standards for U.S. Court Facilities* for Court spaces. See the *U.S. Border Station Design Guide* (PBS-P130), and *GSA Child Care Center Design Guide* (PBS-P140) for finishes for these facilities.



Historic stair, Ariel Rios, Washington, D.C.

3.8 Alterations in Existing Buildings and Historic Structures

The general goal of alteration projects is to meet these facilities 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 (BPP) which identifies zones of architectural importance, specific character-defining elements that should be preserved, and standards to be employed. Refer to pages 1-14 for 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 which convey its historical, cultural, or architectural values.

In general, alterations in historically significant spaces should 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 should be sought to restore original features that have been removed or insensitively altered, to reestablish 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 should be viewed as guidelines and helpful hints to be used when appropriate and disregarded when not.

Evaluation of Existing Systems

Every alteration project includes an evaluation which 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 1.3: *National Codes and Standards, Code Requirements for Alterations*. Code deficiencies that related 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 1.1, *Purpose of 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.

New work in alterations generally should meet current codes, unless a special hazard is created by combining new and old systems. Such conflicts should be resolved with GSA.

See Chapter 7: *Fire Protection & Life Safety*, for additional information.

Placing Mechanical and Electrical Systems in Renovated and Rehabilitated Buildings

Finding space for air conditioning, power and communications cabling is one of the biggest design challenges in remodeling work. Existing systems are usually totally inadequate, shafts are too small and ceiling space is too shallow. See Chapter 5: *Mechanical Engineering, Major Alterations in Existing Buildings and Historic Structures* and Chapter 6: *Electrical Engineering, Major Alterations in Existing Buildings and Historic Structures*.

Vertical Distribution. Space for new shafts can sometimes be found in stairwells, if the stairs are larger than required by code. Any element incorporated must have the appropriate fire-resistive construction and not impose on the accessible pathway. If elevator systems need to be replaced, elevator shafts can become duct shafts or electrical closets. The building exterior also offers possibilities if new vertical elements can be integrated with the façade design.

Original elevator doors should be retained. Design for new hoistway and cab doors should be based upon original door detailing, matching original materials and adapting ornamentation as necessary to comply with code.

Original hardware should be maintained in place and upgraded to remain functional wherever possible. Lobby and corridor floor landing indicators should be scaled to avoid destruction of original ornamental finishes, such as borders in stonework designed to frame original indicators.

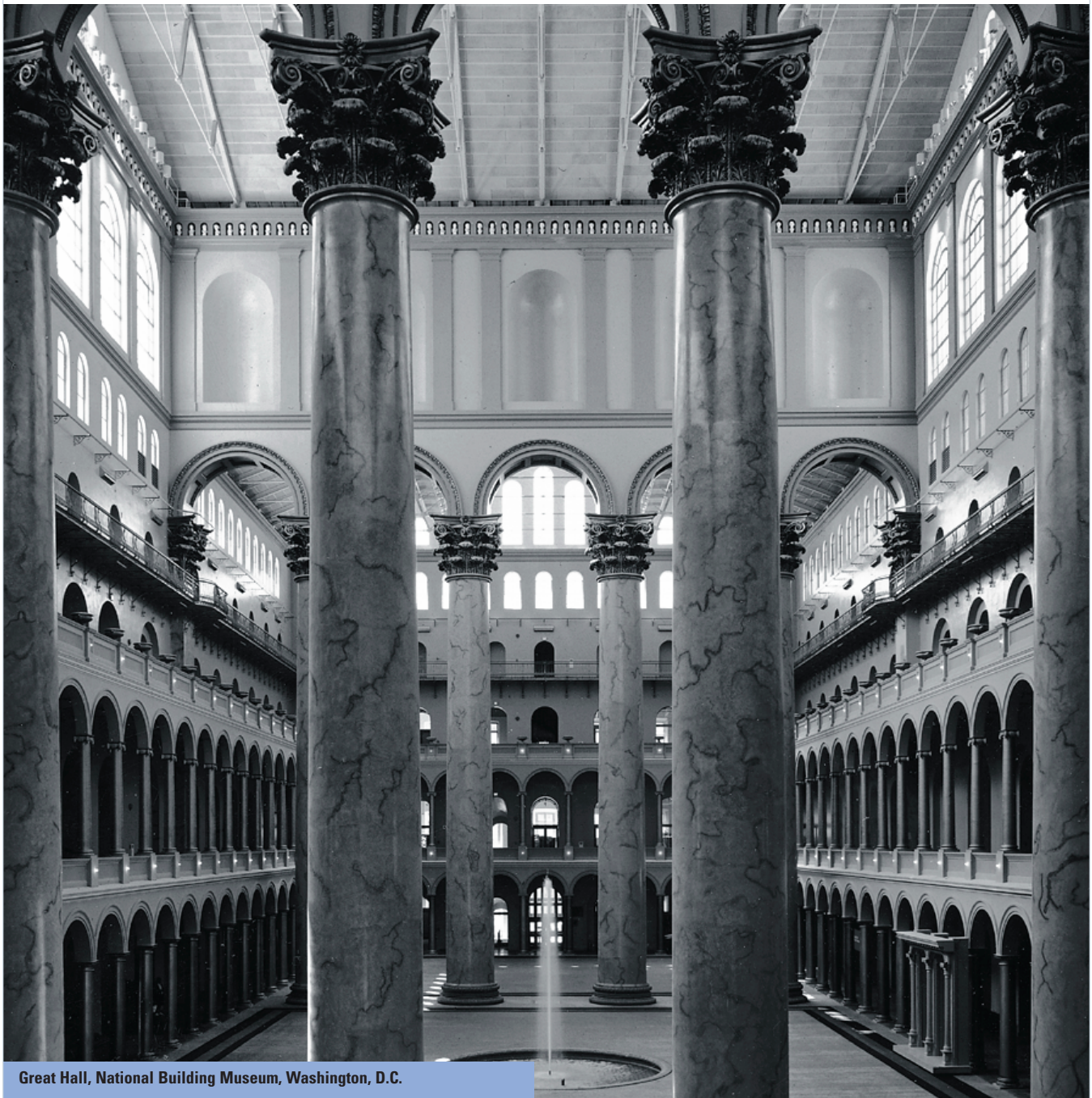
Horizontal Distribution.

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.

If raised access flooring is to be considered, refer to GSA *RF/UFAD Guidelines*.

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 workspace 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.

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.



Great Hall, National Building Museum, Washington, D.C.

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. Pre-wired systems furniture, which is available in wood, is also a very good solution.

Placement of Main Mechanical and Electrical

Equipment. If new equipment is to be placed on the roof, the structural capacity of the framing system must be investigated.

Elevators. For complete building renovations a transportation study should be done, as described earlier in this chapter. If elevators need to be replaced, service can often be improved significantly by selecting higher speed elevators to fit into the existing shafts. New shafts are expensive to build and should be avoided.

Space Planning Strategies

Office Space. It may be necessary to design a slightly larger space allocation - about 12 m² (135 square feet) per person - for office layouts in older buildings. This compensates for less than ideal bay sizes and existing walls configurations. The planning standards described earlier in the section *Space Planning*, should be used as much as possible.

Pre-wired 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.

Food Service. In many older Federal buildings, dining areas are located below grade in cramped, poorly ventilated, poorly lit, and publicly inaccessible spaces. Major renovations are a good opportunity to correct this situation.

Acoustics

Office Space. Where existing office space is altered to an open plan, noise isolation of the ceiling system should be a minimum of NIC 20. Noise isolation class between rooms should be NIC 40 in Class B spaces and NIC 35 in Class C space. See the section *Special Design Considerations, Acoustics, Design Criteria for Building Spaces* of this chapter.

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.

Alteration of Building Elements

Exterior Closure. See Chapter 4: *Structural Engineering, Alterations in Existing Buildings*. Most older buildings lack adequate insulation and vapor barriers, but these can be added from the inside at the time of alteration. Design alterations to avoid damaging original finishes in preservation zones (as defined in the BPP or HSR).

Refer to *Building Elements* Section of this chapter for references regarding treatment of existing windows.

Exterior masonry should be cleaned if necessary and repointed. Joints should be resealed.

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, 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.

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 shall not be excluded provided it possesses like physical characteristics, color and texture."

New equipment should not be installed on existing materials that are very difficult to adapt for proper connections. These may include: structural glass, marble, and ceramic tile.

3.9 Life Cycle Cost Analysis

All life cycle cost analysis work focusing on particular items should consider the impact on other related systems. In other words, it should be a comprehensive effort balancing the impacts on all aspects of the building design.

Methods for performing life cycle cost analysis are discussed in Chapter 1: *General Requirements, Life Cycle Costing*. This section describes: which architectural and interior systems require life cycle cost analysis: the method to be used for analysis: the number of alternatives to be considered: and the factors to be considered. These requirements vary according to the size and type of building. For individual projects, the Scope of Work may define a different level of analysis than recommended in the *Facilities Standards*.

The following systems are to be analyzed depending on the size of the facility. For each system, the factors relate to scale and complexity, and the number of alternatives to be considered.

Tunnels and Bridges. The analysis should consider the costs of the connection versus staff travel time on alternative circulation routes. Travel time can be based on actual contact information between agencies or on assumptions by the planning team. Other factors that cannot be calculated but should be considered in making the selection include climate conditions; security; and construction challenges. The analysis should be performed when connections are considered for small buildings. It is not necessary to perform analysis on any building with a high security classification or on large buildings.

Exterior Wall Construction and Finishes. The analysis shall consider construction costs, known upkeep, maintenance and replacement costs and schedules, thermal resistance effects on heat loss/gain and first cost impacts to HVAC system designs. Other factors that cannot be calculated but should be considered in making the selection include appearance, the ability to match the finish of expansion areas or replacement panels, resistance to moisture, freezing and ultraviolet light damage, seismic and wind resistance, source and manufacture availability and construction requirements.

Sun Control Devices. The analysis should consider: construction costs; solar gain reduction, HVAC system first costs, operating costs; maintenance and replacement costs; and utility costs compared with not providing sun control devices. As previously stated, sun control also relates to maximizing efficient use of natural daylight in the building.

Exterior Windows. The analysis should consider the construction costs, HVAC system first costs, solar transmission and heat gain and insulation characteristics. Other factors that cannot be calculated but should be considered in making the selection include the affect of color tones on the interior environment, exterior views into the building and security. Analysis should be performed on moderately sized and large buildings considering at least one alternative and at up to three alternatives for very large buildings.

Alternative Roof Systems. In typical projects, a life cycle cost analysis is not required. If a new technology is proposed that has a higher initial costs and probable long term cost savings, then an analysis should be used as part of the decision to utilize the new technology.



Sam Gibbons U.S. Courthouse, Tampa, FL



Vincent E. McKelvey Federal Building laboratory wing, Menlo Park, CA

Conveyance Systems. The selection and sizing of elevator and escalator systems must be performed as prescribed in the preceding section *Selecting Conveyance Systems* in this Chapter. No other life cycle cost analysis will be required for conveyance systems.

Interior Wall Systems. The analysis must consider the installation costs including any associated special ceiling, floor, power or communication cabling systems, cost of repairs or refinishing and the percent of the material that can be reused during remodels. The churn factor, or percent of the space disrupted by change within a given year, for space renovation should be established by the GSA region. Other factors that cannot be calculated but should be considered in making the selection include appearance, safety, disruption during moves, manufacturing availability for custom systems, acoustical separation, and security. Analysis should be performed on very large buildings considering at least one alternative.

Interior Protective Finishes. The analysis must consider the installation costs, known cleaning and upkeep costs, known replacement and refinishing costs, any increases in illumination levels because of reflectivity characteristics and remedial acoustical work. Other factors that cannot be calculated but should be considered in making the selection include appearance, safety, disruption during remodeling, ability for the material to be patched, and the release of vapors. The analysis should be performed on finishes covering large areas or high traffic areas.



Structural Engineering

4

United States Courthouse

Buffalo, New York

Architect: Kohn Pedersen Fox Associates PC

GSA Project Manager: Arnold Feinsilber

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4.1 General Approach

This chapter provides structural design criteria for buildings and for building systems constructed of concrete, masonry, steel and wood. The design requirements provided herein, or cited by reference, are based on the International Building Code, and industry 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.

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.

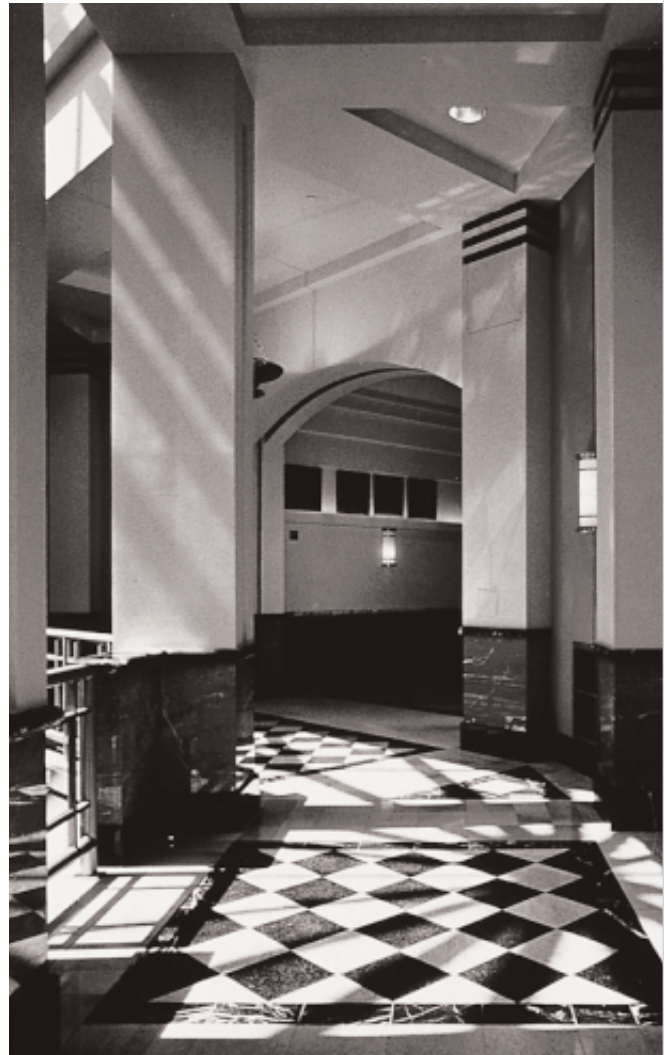
GSA generally owns and operates its buildings much longer than private sector owners. Accordingly, a higher level of durability and serviceability is required for all systems. In terms of structural design, this has resulted in more stringent requirements than those stipulated in model building codes; the floor load capacity requirement of this chapter is an example.

During the life span of a typical GSA building, many minor and major alterations are necessary as the missions of Government agencies and departments 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 increase 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. Refer to Chapter 8: *Security Design* for design criteria related to this matter.

Submission Requirements

Every project will have unique characteristics and requirements for submission and review. The general submission requirements for each phase of project development are described in Appendix A: *Submission Requirements*.



Martin Luther King Courthouse, Newark, NJ

4.2 Codes and Standards

Codes and mandatory standards adopted by GSA for the design of all new buildings are discussed in Chapter 1.

The following FEMA Guidelines shall be incorporated into the structural design for all projects involving new and existing facilities:

- Federal Emergency Management Agency (FEMA) publications:

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).

Structural Design of New Buildings

The structural design (including wind, snow and earthquake) of new buildings, structures and portions thereof shall be in full compliance with the latest edition of the International Building Code (IBC). Unless otherwise specified, all new buildings shall be classified as Category II structures according to Table 1604.5 of the International Building Code.

Use of Recycled Materials

Because concrete is one of the most widely used building products, incorporation of recycled materials that do not impact strength may make a substantial contribution to the nation's recycling effort.



The recently completed Seattle Courthouse Steel Plate/Composite Concrete Shear Wall System during construction.

The following is a list of specifications for cement and concrete containing recovered materials:

Cement Specifications:

- ASTM C 595: Standard Specification for Blended Hydraulic Cements.
- ASTM C 150: Standard Specifications for Portland Cement.

Concrete Specifications:

- ASTM C 618, "Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete."
- ASTM C 311, "Standard Methods of Sampling and Testing Fly Ash and Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete."
- ASTM C 989, "Ground Granulated Blast-Furnace Slag for Use in Concrete Mortars."
- American Concrete Institute Standard Practice ACI 226.R1. "Ground Granulated Blast-Furnace Slag as a Cementitious Constituent in Concrete."

Information on specifying and purchasing recycled-content products can be found on the Internet at www.epa.gov/cpg.



National Building Museum, Washington, D.C.

4.3 Structural Loads

Design loads shall 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 3.8 kPa (80 pounds per square foot) over the entire floor for all elevated slabs unless the tabulated uniform live load required by the International Building Code is higher than 80 psf. This load includes .96 kPa (20 pounds per square foot) of partitions, but excludes heavy loads like the planned use of space saver file systems.

Do not use live load reductions for (1) horizontal framing members, (2) transfer girders supporting columns, and (3) columns or walls supporting the roofs where mechanical equipment can be located. Live load reductions shall be considered in the design of foundation members regardless of the restrictions placed on individual members.

Telecommunication Closets: Use 3.8 kPa (80 pounds per square foot) 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 pounds per square foot). Verify if any equipment will be used that exceeds this floor load requirement.

Equipment Rooms for Telecommunication Equipment: Floor loading capacity of telecommunication equipment rooms shall be sufficient to bear both the distributed and concentrated load of installed equipment. The EIA/TIA Standard 569 prescribes a minimum live load capacity for distributed loads of 12.0 kPa (250 pounds per square foot) and a minimum concentrated live load of 4.5 kN (1,000 pounds) over the area of greatest stress to be specified.



Steel bracing in the Milwaukee Courthouse

4.4 Structural Considerations

The goals in the selection of load resisting systems 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.

LRFD and ASD. 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.

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 only be used 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.

Pre-tensioning and Post-tensioning. As with precast floor framing, these systems should only be used when the design can be demonstrated to not impede future flexibility.

Innovative Methods and Materials. The use of special construction 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, shall evaluate the adequacy of the methods, systems and materials proposed by the engineer.

Base Isolation. Base isolation shall be considered for buildings located in Regions of High Seismicity for two to fourteen story buildings, particularly on rock and firm soil sites which 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 shall be included in the evaluation of cost effectiveness.

Passive Energy Dissipation Systems. Passive energy dissipation systems shall be considered for buildings located in Regions of High Seismicity.

Progressive Collapse

Refer to Chapter 8: *Security Design*.

Floor Vibration

The floor-framing members shall 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 will be based on T. M. Murray, “Tips for Avoiding Office Building Floor Vibrations,” *Modern Steel Construction*, March 2001. More stringent vibration considerations may be required for fixed seating areas such as those in the courtrooms or judges’ chambers.

Seismic Instrumentation for Buildings

New and existing buildings located in Regions of High Seismicity over six stories in height with an aggregate floor area of 60,000 square feet (5574 m²) or more, and every building located in Regions of High Seismicity over 10 stories in height regardless of floor area, shall be provided



Base isolator installation at the historic Pioneer Courthouse, Portland, OR

with USGS approved recording accelerographs. USGS developed *guidelines* and a *guide specification* for Federal agencies for the seismic instrumentation of their 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://nsmpr.wr.usgs.gov/celebi/gsa_report_instrumentation.pdf.

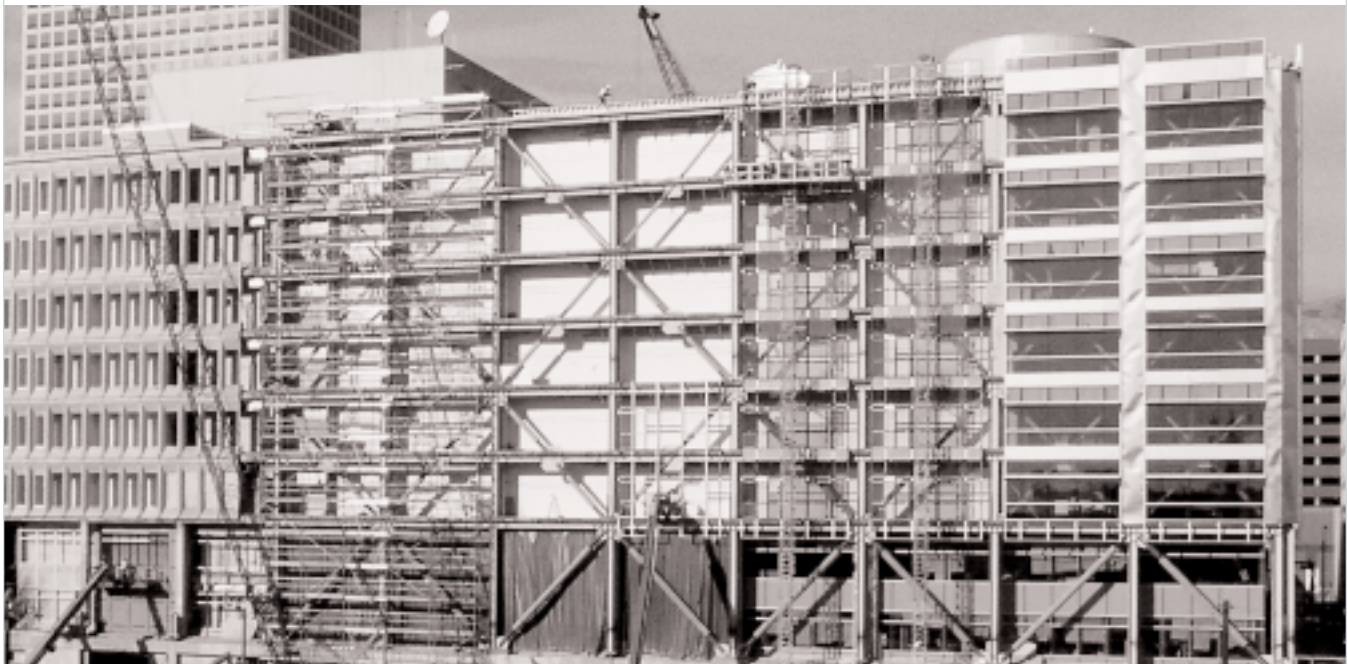
Geotechnical Considerations

The requirements for the geotechnical engineering investigation and report are listed in Appendix A: *Submission Requirements*.

Footings shall not project beyond property lines.

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 FEMA 356 for existing buildings.



The W.F. Bennett Federal Building in Salt Lake City is the first federal building to use buckling-restrained brace technology.

4.5 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, 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 (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*.

General Design Considerations for Structural Upgrading

Seismic Performance. The performance objective of a seismic upgrade is Life Safety, defined as the safeguarding against partial or total building collapse, obstruction of entrance or egress routes and the prevention of falling hazards in a design basis earthquake.

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 code requirements.

Evaluation and mitigation of existing GSA buildings shall 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 shall 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 shall be in accordance with the provisions of Prestandard and Commentary for the Seismic Rehabilitation of Buildings (FEMA 356). **Life-Safety** is the minimum acceptable performance level for existing Federal buildings. FEMA 356 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 FEMA 356, Prestandard and Commentary for the Seismic Rehabilitation of Buildings, provide the basis for defining these performance objectives, evaluation criteria and if necessary, mitigation, are identified.

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 shall substantially satisfy the Basis Safety Objective criteria of FEMA 356, including the use of both the BSE-1 and BSE-2 earthquake criteria.

It should be noted that the hazard level (ground motion) used in ASCE/SEI 31 to evaluate buildings is based on earthquakes with a 2% probability of exceedance in 50

years (2%/50 years). On the other hand, the hazard level used for a rehabilitation design in FEMA 356 is based on compliance with the Basic Safety Objective (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 2/3 of the 2%/50 years earthquake) at the Life-Safety Performance Level. The earthquake accelerations associated with the 2/3 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.

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 should be given to items that represent the greatest life safety risk, such as the lateral force-resisting system, unreinforced masonry bearing walls or both.

Seismic Upgrades for Historic Buildings. Historic buildings should meet the same life safety objective as other buildings. Decisions made to preserve essential historic features should not result in a lesser seismic performance than that required by ICSSC RP 6. See Chapter 1.

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 should be prioritized and those elements with the greatest life safety risk strengthened first to meet current code requirements.

4.6 Seismic Requirements for Leased Buildings

New Construction

New buildings or the construction of an addition to an existing building shall conform to the IBC. For additional information see the latest edition of GSA's Solicitation for Offers (SFO).

Existing Buildings

Existing buildings shall meet the seismic requirements of the *Standards of Seismic Safety for Existing Federally Owned and Leased Building and Commentary*, ICSSC RP 6, as modified by the latest edition of GSA's Solicitation for Offers (SFO).

ICSSC RP 6 can be downloaded as a PDF at <http://fire.nist.gov/bfrlpubs/build01/PDF/b01056.pdf>.



Workmen on the roof of the Winder Building, Washington, D.C. install a window as part of a renovation project.

Mechanical Engineering



5

United States Courthouse

El Paso, Texas

Architect: Antoine Predock Architect, PC

GSA Project Manager: Howard G. Bergman

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5.1 General Requirements

This chapter identifies the mandatory criteria that shall be used to program and design mechanical systems which are defined herein 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.

The design of the mechanical systems and other building components shall all combine together to produce a building that meets the project's programmed sustainability rating (LEED rating) and assigned energy target, as referenced in Chapter 1, *General Requirements*.

Mechanical systems must be coordinated and integrated with all other building systems and features. As addressed in Appendix A, *Submission Requirements*, mechanical systems shall be adapted to support all performance objectives, typically involving sustainability, workplace performance (productivity and efficiency), fire safety, security, historic preservation, and improved operations and maintenance.

Mechanical systems shall generally be designed to exceed the minimum performance requirements of the *ASHRAE Standard 90.1* and *10 CFR 434* standards and incorporate cost effective energy conservation measures that do not compromise building performance or occupant comfort.

Maintainability and reliability are paramount to the operation of Federal buildings. As such, the design and installation of all mechanical systems and equipment shall allow for removal and replacement, including major components such as boilers, chillers, cooling towers, pumps and air-handling equipment.

HVAC systems shall be specifically designed to function at the full load and part load conditions that are associated with the projected occupancies and modes of operations. (Special emphasis shall be placed on the design considerations for U.S. Court Facilities to allow for renovation, relocation, and creation of new Courtrooms and adjunct facilities or retrofitting Courtroom facilities for other Agencies' use. See Chapter 9, *Design Standards for U. S. Court Facilities*, for design criteria.)

HVAC systems shall be designed with standby capacity, enabling continuous service during repair or replacement of a failed piece of equipment or component. Where redundancy is required, it shall generally be accomplished by providing equipment with standby capacity rather than providing stand-alone redundant equipment.

Proposed systems and equipment using advanced technology will be considered by the GSA; however, GSA does not allow use of experimental, unproven, or proprietary equipment or systems. Documented proof of historical capability and adaptability of all equipment and systems proposed for a project shall be made available to GSA.

To facilitate design integration, the designer is encouraged to visit the Whole Building Design Guide website, www.wbdg.org, to identify program goal principles and to consider available technologies.

Refer to Chapter 1 for information regarding commissioning and the role of the mechanical engineer in the commissioning process.

Submission requirements are addressed in Appendix A.3.

5.2 Codes & Standards

Mechanical Codes

As stated in Chapter 1, *General Requirements, Codes and Standards, Building Codes*, facilities shall comply with the ICC's International Mechanical Code and the International Plumbing Code.

Mechanical Design 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 the use of additional guides or standards.

When publications and standards are referenced as mandatory, any recommended practices or features shall be considered as "required." When discrepancies between requirements are encountered, GSA shall determine the requirement.

- ASHRAE: *Handbook of Fundamentals*.
 - HVAC System Duct Design, Chapter 34.
- ASHRAE: *Handbook of HVAC Applications*.
- ASHRAE: *Handbook of HVAC Systems and Equipment*.
- ASHRAE: *Standard 15: Safety Code for Mechanical Refrigeration*.
- ASHRAE: *Standard 52.2: Method of Testing: General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*.
- ASHRAE: *Standard 55: Thermal Environmental Conditions for Human Occupancy*.
- ASHRAE: *Standard 62: Ventilation for Acceptable Indoor Air Quality*.
- ASHRAE: *Standard 90.1: Energy Standard for Buildings Except Low-Rise Residential Buildings*.
- ASHRAE: *Standard 100: Energy Conservation in Existing Buildings*.
- ASHRAE: *Standard 105: Standard Method of Measuring and Expressing Building Energy Performance*.
- ASHRAE: *Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC Systems*.
- ASHRAE: *Standard 114: Energy Management Control Systems Instrumentation*.
- ASHRAE: *Standard 135: BACnet: A Data Communication Protocol for Building Automation and Control Networks*.
- ASHRAE: *Guideline #4: Preparation of Operating and Maintenance Documentation for Building Systems*.
- ASHRAE: *Guideline #12: Minimizing the Risk of Legionellosis Associated with Building Water Systems*.
- American National Standards Association: *ANSI Z 223.1*.
- *National Fuel Gas Code Standard 54*.
- American Society of Mechanical Engineers: *ASME Manuals*.
- American Society of Plumbing Engineers: *ASPE Data Books*.
- Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):
 - *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*.
 - *Seismic Restraint Manual Guidelines for Mechanical Systems*.
- NFPA Standard 96
- 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 Design Criteria

Outdoor Design Criteria

Outdoor air design criteria shall be based on weather data tabulated in the latest edition of the *ASHRAE Handbook of Fundamentals*. Winter design conditions shall be based on the 99.6% column dry bulb temperature. Summer design conditions for sensible heat load calculations shall be based on the 0.4% dry bulb temperature with its mean coincident wet bulb temperature. Design conditions for the summer ventilation load and all dehumidification load calculations shall be based on the 0.4% dew point with its mean coincident dry bulb temperature.

Indoor Design Criteria

Indoor Design Temperatures and Relative Humidity.

Indoor design temperatures and relative humidity requirements are stated in Table 5-1.

It is necessary to maintain a relative humidity (RH) of 30 to 60% for the storage and display of artwork. In a hot and dry geographic region maintain a RH between 30 to 40%. In humid climates a range of 50 to 60% is acceptable.

Please consult Chapter 4.1, *Installation Standards*, of the *Fine Arts Program Desk Guide* for additional information.

Limitation of Supply Air Temperature. Low temperature supply air HVAC systems shall not be permitted. Supply air shall be no less than 10° C (50° F) dry bulb, in order to prevent condensation on the duct surfaces.

Building Pressurization. To keep dry air flowing through building cavities, systems shall be designed with sequence of operations that assure continuous positive pressure with respect to the outdoor environment until the outdoor dew point drops below 2.8°C (37°F), when the

building pressure shall be brought to neutral. The building HVAC systems shall have an active means of measuring and maintaining this positive pressure relationship. Minimum outdoor airflow rates shall be adjusted as necessary to ensure building pressurization.

The BAS shall alarm when the building pressurization drops below a predetermined low limit. In areas where exhaust systems are used or an indoor air quality contaminant source is located, a negative pressure shall be maintained relative to surrounding spaces. Calculations shall be provided that show the minimum outdoor airflow rate required for pressurization.

The following areas shall be kept under negative pressure relative to surrounding building areas: smoking lounge, detention cells, toilets, showers, locker rooms, custodial spaces, battery charging rooms, kitchens and dining areas. Air can be returned from the dining area space. The air from all other spaces must be exhausted directly to the outdoors.

Indoor Air Quality. GSA recognizes the importance of adequate ventilation to maintain indoor air quality. The outdoor air ventilation rates of *ASHRAE Standard 62* are the minimum acceptable in GSA buildings. Instrumentation and controls shall be provided to assure outdoor air intake rates are maintained during occupied hours.

Where occupancy requirements are likely to generate high levels of airborne particles, special air filtration shall be provided on the return air system, or dedicated and localized exhaust systems shall be utilized to contain airborne particulates.

Air filtration shall be provided in every air-handling system. Air-handling units shall have a disposable pre-filter and a final filter. The filter media shall be rated in accordance with *ASHRAE Standard 52.2*. The pre-filters shall have a Minimum Efficiency Reporting Value (MERV) of 8 (30% - 35% efficient with a maximum

Table 5-1

Indoor Design Conditions³



Type of Area	Summer DB ¹	RH ²	Winter DB ¹	RH ²
General Office	24 (75)		22 (72)	
ADP Rooms ⁹	22 (72)	45 ⁴	22 (72)	
Corridors	24 (75)		22 (72)	
Building Lobbies ¹⁰	24 (75)		22 (72)	
Toilets	24 (75)		22 (72)	
Locker Rooms	26 (78)		21 (70)	
Electrical Closets	26 (78)		13 (55)	
Mech. Spaces	35 (95) ⁵		13 (55) ⁸	
Elec. Switchgear	35 (95) ⁵		13 (55)	
Elevator Mach. Room ¹⁰	26 (78) ⁵		13 (55)	
Emerg. Gen. Room	40 (104) ⁶		18 (65)	
Transformer Vaults	40 (104) ⁵			
Stairwells	(none)		18 (65)	
Comm./Tel. Frame Room ⁷	24 (75)	45	22 (72)	30 ¹²
Storage Room	30 (85)		18 (65)	
Conference Room ¹¹	24 (75)		22 (72)	
Auditorium ¹⁰	24 (75)		22 (72)	
Kitchen ¹⁰	24 (75)		22 (72)	
Dining ¹⁰	24 (75)		22 (72)	
Cafeteria ¹⁰	24 (75)		22 (72)	
Courtrooms	24 (75)		22 (72)	454*

*Requires humidification in the winter.

Notes:

- 1 Temperatures are degrees Celsius (Fahrenheit), to be maintained at +/-1 °C (+/-2 °F).
- 2 Relative humidity is minimum permissible, stated in percent. Maximum permissible relative humidity is 60 percent in conditioned areas.
- 3 Dry bulb and relative humidity are to be maintained 150 mm (6 inches) to 1800 mm (6 feet) above the floor.
- 4 Relative humidity should be maintained at +/-5 percent in ADP spaces.
- 5 Maximum temperature. Space 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 temperature in the building must be 13 °C (55 °F) even when unoccupied.
- 9 Confirm 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 shall be designed for process cooling. Cooling system shall be a dedicated independent system.
- 11 Provide independent temperature control.
- 12 Minimum relative humidity requirements may be omitted in moderate southern climate zones upon approval of local GSA representatives.

allowable particle size of 10.0 micron), while the final filters shall have a MERV of 13 (80% - 90% efficient with a maximum particle size of 1.0 micron). Filter racks shall be designed to minimize the bypass of air around the filter media with a maximum bypass leakage of 0.5 percent.

The placement and location of outdoor air intakes are critical to the safety of the occupants inside a building and must be in compliance with the security requirements of the building, as described in Chapter 8, *Security Design*. Table 5-2 provides a guide for minimum separation distances between ventilation air intakes and other building features.

Internal Heat Gain Design Criteria

Occupancy Levels. For office spaces, the average density of the *occupiable floor area* of a GSA building is one person per 9.3 usable m² (100 usable sq.ft.). Within areas occupied by workstations, the occupancy load can be as dense as one person per 7 usable m² (75 usable sq.ft.) in local areas. Sensible and latent loads per person shall be based on the latest edition the *ASHRAE Handbook of Fundamentals*.

For dining areas, auditoriums and other high occupancy spaces, occupancy loads shall represent the number of seats available. Areas such as storage rooms or mechanical rooms do not have occupancy loads.

Equipment Power Densities. Internal heat gain from all appliances-electrical, gas, or steam-shall be taken into account. The rates of heat gain from equipment shall be based on the latest edition of the *ASHRAE Handbook of Fundamentals* or manufacturers' data. For printers and personal computers, 80 percent diversity shall be considered.

The internal heat gains from equipment shall be coordinated with, and based on, the electrical load

Table 5-2
Air Intake Minimum Separation Distances

Object	Minimum Distance	
	m	ft
Property line	1	3
Garage entry, loading dock	7	25
Driveway, street or public way	3	10
Limited access highway	7	25
Grade	14	50
Roof*	0.5	1
Cooling tower or evaporative condensers	5	15
Exhaust fans and plumbing vents	3	10
Kitchen supply and exhaust air	7	25

* Roof intakes must be at least 0.2 m (8 inches) above the average maximum snow depth and the potential for drifts at the intake location must be considered. Outdoor intakes should be covered by 13 mm (0.5 inch) mesh screen. The screen should be of corrosion-resistant material and located outside of or no more than 0.2 m (8 inches) inside of the outside face of the intake grille, louver, or rain hood entry. On buildings of more than four stories the outside air supply louvers shall be located on the fourth level of the building or higher. On buildings of three stories or less, locate the intakes on the roof or as high as possible. Locating intakes high on the exterior wall is preferred to a roof location. Outside air intake is not permitted within seven meters (twenty-five feet) of loading dock or any other fume producing areas.

analysis, and the estimated receptacle demand load outlined in Chapter 6.

Lighting Power Densities. The rates of heat gain from lighting systems shall be based on the latest edition of the *ASHRAE Handbook of Fundamentals* or manufacturers' data.

The internal heat gains from lighting systems shall be coordinated with, and based on, the electrical load analysis outlined in Chapter 6.

Acoustical Design Criteria

All mechanical systems must be designed to satisfy the acoustical design criteria detailed in Chapter 3.

Thermostatic Zoning Design Criteria

Interior thermostatic control zones must not exceed 139 m² (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 shall not exceed 28 m² (300 sq.ft.) and shall be no more than 4.6 m (15 ft) from an outdoor wall along a common exposure. Corner offices shall be a dedicated zone.

If a building program shows that an office building shall have an open plan layout or if the program does not state a preference, it may be assumed that up to 40 percent of the floor plan shall be occupied by closed offices at some point in the future.

Single air-handling units shall not serve multiple floors or scattered building loads. Systems designed for Federal Courthouses shall have no more than two courtrooms served by a single air-handling unit, and that air-handling unit shall be dedicated to serving only those two courtrooms.

HVAC Loads Calculations and Energy Calculations Criteria

HVAC Loads Calculations. The HVAC loads calculations shall be preformed with a computer-based program using the latest *ASHRAE Handbook of Fundamentals* Heat Balance Method (HB), 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 shall be capable of calculating each zone's peak heating and cooling load as well as the whole-building "block" loads. The program shall, 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 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 loads calculations report shall include all input and output used in the heating and cooling calculation program, and shall include zone peak heating and cooling loads results, and whole building "block" loads, air-handling unit coil selections, and psychrometric process charts.

Energy Calculations. A building energy analysis shall be performed 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 requirements.

The building energy analysis shall be performed using the *ASHRAE Standard 90.1 Energy Cost Budget* methodology, and must demonstrate compliance with the latest editions of *ASHRAE Standard 90.1*, *10 CFR 434*, and *10 CFR 435*. The analysis shall be included in each design submission as described in Appendix A.3.

The analysis shall evaluate the energy performance of the building design including the proposed building envelope, HVAC systems and components, the lighting systems, and domestic hot water systems, as well as the proposed control strategies for these building systems.

The analysis shall be based on actual parameters and values found in the proposed building design and not simply on defaults assigned by the simulation program.

The analysis shall be performed using a simulation program. The simulation program shall be a computer-based program for the analysis of energy in buildings. Simulation programs must be capable of simulating: 8,760-hours per year, hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat setpoints, and HVAC system operation defined separately for each day of the week and holidays, thermal mass effects, the number of required HVAC zones, part-load performance curves for mechanical equipment, capacity and efficiency correction curves for mechanical equipment, air-side and water-side economizers, and temperature controls.

Public domain or commercial software shall utilize the EnergyPlus, DOE-2.1E, or DOE2.2 simulation engines. Alternative simulation programs, meeting the above stated requirements, may be used with prior approval of the GSA.

The building energy analysis report shall include all input and output used in the simulation programs, including: established energy goals for the project, detailed descriptions of the budget and proposed building models, actual local utility rates, descriptions of any and all energy conservation measures, an analysis of results with final conclusions and recommendations.

5.4 HVAC Baseline System

Baseline System Requirements

GSA requires the use of the HVAC baseline system described below. Any deviation from the GSA defined baseline HVAC system, or from the directives described herein, shall not be permitted unless previously identified in project programming requirements and submitted directly to, and subsequently authorized by, the GSA.

The following section describes the HVAC Baseline System and sets forth the minimum system requirements for GSA projects.

The baseline HVAC system shall be comprised of the following systems and components:

- Dedicated Outdoor Air Ventilation Systems
- Floor-by-Floor Air-Handling Units
- Perimeter and Interior Heating and Cooling Systems

A detailed description of each of the individual HVAC components is included in section 5.8 *HVAC Components*.

Dedicated Outdoor Air Ventilation Systems. The building shall have dedicated 100-percent outdoor air ventilation systems (DOAVS) sized to meet both the ventilation and pressurization requirements of the building. These physically secure, vertically zoned systems shall provide tempered dehumidified outdoor air to the occupied spaces by either of the two following methods depending on the specific application, the perimeter heating and cooling system proposed, and building configuration:

- Use a dedicated 100-percent outdoor air ventilation distribution system ducted directly to the occupied spaces, or

- Use a dedicated 100-percent outdoor air ventilation distribution system ducted through an air flow control device (air flow measuring station) to the return side of the floor-by-floor air handling units. In this case, the system shall be provided with a means of bypassing the floor-by-floor air-handling unit during unoccupied hours.

The dedicated 100-percent outdoor air ventilation systems shall be completely independent of any other air distribution system. Building exhaust air heat recovery shall be provided to precondition the outdoor air.

When determining the capacity of the dedicated 100-percent outdoor air ventilation system, the designer must consider diversity in the calculation of ventilation demand. In addition, the designer must provide building air balance calculations (including: outdoor air, supply air, return air, and exhaust air) verifying that the largest of the two DOAVS sizing requirements (ventilation or pressurization) has been met.

Supply air dew point leaving the air-handling unit shall be maintained at 10.0°C (50°F) and the supply air dry bulb temperature leaving the air-handling unit shall be a minimum of 12.8°C (55° F) and not greater than 25.6°C (78° F) during occupied hours. During occupied hours, this unit shall operate to deliver conditioned ventilation air directly to the occupied spaces to both supply the required ventilation air flow rates and to maintain positive pressure in the perimeter zones with respect to outdoor air pressure. During unoccupied hours, the DOAVS air-handling unit shall run at reduced capacity (the minimum of either 30-40% of supply capacity or as required by calculation) to provide conditioned air at 10.0°C (50° F) dew point and at least 21.1°C (70°F) to maintain positive pressure in the perimeter zones with respect to outdoor air pressure. When the outdoor air dew

point drops below 2.8°C (37°F), the unit shall have the capacity to maintain neutral pressure in the perimeter zones with respect to the outdoors.

Floor-by-floor Air-Handling Units. The building shall have multiple, horizontally zoned, recirculating, Variable Air Volume (VAV) air-handling units. The air-handling units shall provide all of the required conditioning for the spaces they serve, and shall deliver conditioned supply air to the perimeter and interior heating and cooling systems. Floor-by-floor air-handling units shall utilize VAV terminals or fan-powered VAV terminals.

The VAV supply fan shall be designed for the largest block load, not the sum of the individual peaks. The air-handling unit and associated VAV terminals or fan-powered terminals shall have self-contained microprocessor controls capable of connecting to and interoperating with a BACnet or LONWORKS Direct Digital Control (DDC) Building Automated System.

All underfloor air distribution air-handling units and systems shall be designed in accordance with the GSA *PBS Guidelines for Raised Floor Systems, with and without Underfloor Air Distribution* (RF/UFAD Guidelines). Any design parameters or design criteria contained in the RF/UFAD Guidelines supersede those herein.

Perimeter and Interior Heating and Cooling Systems.

Perimeter and interior zones shall have a baseline perimeter heating and cooling system selected from one of the following four options depending on the specific application and building configuration:

- Use a ducted overhead variable air volume (VAV) air distribution system with VAV terminals with hot water heating coils for cooling and heating, supplemented (where required) with hot water finned-tube radiation, or

- Use a ducted overhead variable air volume (VAV) air distribution system with fan-powered VAV terminals with hot water heating coils for cooling and heating, or
- Use an underfloor VAV air distribution (UFAD/VAV) system designed in accordance with the RF/UFAD Guidelines for cooling, supplemented with two-pipe, above floor perimeter hot water finned-tube radiation for heating, or
- Use a standard, floor mounted four-pipe fan coil unit system for heating and cooling for perimeter zones. Interior zones must be served by one of the previous three VAV system options. Ceiling mounted fan coil units are not permitted.

Electric heating coils shall be permitted only for nominal heating requirements. Requests for use of electric heating coils must be submitted directly to, and subsequently authorized by, the GSA. No reheat is permitted.



5.5 Alternatives Components for the HVAC Baseline System

Life Cycle Costing of Alternatives

A life cycle cost analysis shall be performed to determine the applicability and economic justification of the following alternatives for each project.

Life cycle cost analysis shall comply with requirements addressed in Chapter 1, *General Requirements*. This includes consideration of analysis period, escalation discount rates, and other parameters. The indicated software program, “Buildings Life Cycle Cost”, is recommended when used with provisions that support “Federal Analysis-Projects Subpart to OMB A-94 Guidelines.”

The building energy analysis shall be used to predict the energy cost impact of each of the alternative outdoor air distribution methods and components, as compared to the baseline HVAC system, and shall form the basis of the life cycle cost analysis.

- **Alternative Outdoor Air Distribution Method – Dedicated Perimeter Pressurization System.** For projects where a dedicated 100-percent outdoor air ventilation system, sized to meet both the ventilation and pressurization requirements of the building, is deemed to be infeasible by GSA (supported by a life cycle cost analysis provided by the A/E), the building shall have a dedicated perimeter pressurization system sized to meet only the pressurization requirements of the building. In these cases, the ventilation requirements of the building shall be provided by the floor-by-floor air-handling units. This exception to the dedicated 100-percent outdoor air ventilation system requirement is limited to special applications or modernization projects where the DOAVS approach is infeasible.

- **Alternative Component – Desiccant Cooling.** Desiccant cooling with a solid silica gel desiccant may be used in combination with mechanical cooling for high occupancy applications where moisture removal is required. Natural gas or condenser waste heat shall be used as fuel for reactivation of the desiccant. Lithium chloride liquid desiccants are not permitted. Where these conditions are satisfied, the A/E shall analyze the life cycle cost of this option.
- **Alternative Component – Economizer Cycles.** For floor-by-floor air-handling units with capacities over 1,416 L/s (3,000 cfm), the A/E shall analyze the life cycle cost of providing a full air-side economizer cycle capable of

providing full free cooling, or partial air-side economizer cycle capable of providing some free cooling, and used in conjunction with additional mechanical cooling. The designer must ensure that proposed locations of outdoor air intakes meet the GSA security requirements prior to performing the life cycle cost analysis. If secure outdoor air intakes are not feasible for this alternative, then the alternative shall not be considered. The air-side economizer cycle shall provide leaving air conditions at a maximum of 10.0°C (50°F) dew point and a maximum of 70 percent relative humidity. Where an air-side economizer is not justified on a life-cycle cost basis, the A/E shall analyze the life cycle cost of providing a water-side economizer cycle.



Office of the Chief Architect, Public Building Service, Washington, DC

5.6 Special Area HVAC Systems

Special Area Requirements

Special areas such as atriums, cafeterias, mail rooms, loading docks and elevator machine rooms, shall have a dedicated air-handling unit, separate from all other air-handling units in the building, with individual control to condition these spaces as required.

Lobbies and Entrance Vestibules. A dedicated air-handling unit shall be provided for the main lobby and other entrance vestibules to maintain positive pressurization.

Courtrooms. Generally, each Courtroom and its respective ancillary areas coupled to the operation of the Courtroom shall constitute a primary zone. No more than two Courtrooms and their respective ancillary areas shall be supplied from the same air-handling unit and system. Refer to the U.S. Courts Design Guide published by the Administrative Office of the United States Courts (AOC) for specific requirements.

Auditoriums. Auditoriums shall have dedicated air-handling units. Units shall be designed with 80 percent diversity factor to maintain necessary temperature and humidity conditions under partial loads and partial occupancy. Provide dew point control. Dew point of supply air shall not exceed 10.0°C (50°F) dry bulb.

U.S. Marshals Service Areas. The U.S. Marshals Service area HVAC system shall be designed for continuous operation and shall be independently controlled and zoned. All ductwork and air circulation openings penetrating the secure area envelope, including prisoner circulation areas, shall be provided with security bars. Detainee holding areas shall be negatively pressurized

with regard to adjacent spaces and exhausted directly to the outdoors. Refer also to requirements of U.S. Marshals Service (USMS) Publication 64.

Firing Range. Special HVAC considerations shall be required for firing ranges. A firing range shall be provided with a dedicated air-handling system. Heating and cooling supply air shall 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 area. Powered exhaust air shall be extracted from down range and the target areas in sufficient quantity to remove smoke and maintain a clear line of vision to the target. Sixty percent of the total exhaust shall be extracted at a point approximately one-third the distance from the firing line to the target area, and forty percent shall be extracted from above the target area. All exhaust air shall be filtered to preclude the emission of lead particulates and gunpowder residue into the atmosphere. Discharge of firing range exhaust air to outdoors shall be carefully located to prevent recirculation into the outdoor air intake of any HVAC system. Firing range systems shall be capable of continuous operation, isolated from other building systems.

Kitchens and Dishwashing Areas. Kitchens with cooking ranges, steam kettles, ovens and dishwashers shall be provided with dedicated make-up air and exhaust hoods/exhaust systems in accordance with the latest edition of NFPA Standard 96 and *ASHRAE Applications Handbook*. All components of the ventilation system shall be designed to operate in balance with each other, even under variable loads, to properly capture, contain, and remove the cooking effluent and heat, and maintain proper temperature and pressurization control in the spaces in an efficient and economic manner. The operation of the kitchen exhaust systems shall not affect the pressure relation between the kitchen and

surrounding spaces. Both supply air and makeup air shall be exhausted through the kitchen hood heat recovery system while a maximum of 30 percent of the exhaust air is made up from the space.

Floor drains must be provided at each item of kitchen equipment where accidental spillage can be anticipated, and to facilitate floor-cleaning procedures. Drains to receive indirect wastes for equipment shall be of the floor sink type of stainless construction with a sediment bucket and removable grate.

Areas of Refuge. The area of refuge provided for the Judiciary in the event of emergency conditions shall be provided with adequate ventilation energized from the emergency power distribution system and sufficient heating capacity to maintain space temperature of 21.1°C



United States Courthouse, White Plains, NY

(70°F) with design winter outdoor temperature. Provide separate air-handling unit to maintain positive pressure, relative to surrounding spaces, with heating-cooling coils and differential pressure sensing system.

24-Hour Spaces. All areas designated as requiring 24-hour operations shall be provided with a dedicated and independent HVAC system. All spaces handling BAS computer processing of Fire Alarm Monitor and Control Systems, Security Monitor and Control Systems and/or energy monitoring and control systems shall be provided with dedicated HVAC systems to maintain temperature, humidity and ventilation requirements at all times. Twenty-four hour systems shall have dedicated chiller(s), cooling tower(s) boiler(s), and associated pumping systems. However, central system(s) can be used to provide chilled water and hot water during the normal operating hours, or as a backup for the 24-hour system(s). Twenty-four hour systems with a cooling capacity of up to 176 kW (50 tons) shall be configured with an air-cooled chiller. In the event the building's 24-hour operation load, including the dedicated perimeter ventilation system, exceeds 176 kW (50 tons), the cooling systems may be combined with a central system in which a dedicated central chilled water supply loop shall be provided along with 24-hour chiller.

Computer Rooms. Computer rooms shall be cooled by self-contained units for cooling loads up to 281 kW (80 tons). These units shall be specifically designed for this purpose and contain compressors, filters, humidifiers and controls. They shall be sized to allow for a minimum of 50 percent redundancy, either two units at 75 percent load or three units at 50 percent. If the nature of the computer room is critical (as determined by consulting the GSA's Office of the Chief Information Officer), three units sized at 50 percent of the design load shall be used. Heat rejection from these self-contained units shall be by

air-cooled condensers or recirculating water-cooled condensers connected to a cooling tower or evaporative-cooled condenser. Water-side free cooling shall be utilized when possible.

For cooling loads greater than 281 kW (80 tons), chilled water air-handling systems shall be considered in a life cycle cost analysis. A dedicated chiller(s) is preferred, unless other parts of the building also require 24-hour cooling. The dedicated chiller plant shall provide some means of redundant backup, either by multiple machines or connection to the facility's larger chilled water plant.

In large computer installations [areas of 465 m² (5,000 sq. ft.)] it is recommended to segregate cooling of the sensible load (computer load) and control of the outdoor air ventilation and space relative humidity by using two separate air-handling systems. In this design, one unit recirculates and cools room air without dehumidification capability. This unit is regulated by a room thermostat. The second unit handles the outdoor air load, provides the required number of air changes and humidifies/dehumidifies in response to a humidistat. This scheme avoids the common problem of simultaneously humidifying and dehumidifying the air.

These systems shall be provided with an alternative power source, connected to emergency generators, if the computer room houses critical components. Consult GSA's Office of the Chief Information Officer to determine which computer rooms meet this requirement.

Vehicle Garages. Vehicle garage exhaust fans shall generally be activated based upon carbon monoxide sensors within the garage. Carbon monoxide sensors shall also be located in all floor areas where vertical shafts penetrate the garage areas.

5.7 Mechanical and Service Space Requirements

A minimum of 4 percent of each floor's gross floor area shall be provided on that floor for air-handling equipment. Where additional equipment is required, additional space on that floor shall be provided as needed. A minimum of 1 percent of the building's gross area shall be provided for the central heating and cooling plant (location to be agreed upon during preparation of concept submission). All mechanical equipment rooms shall be a minimum of 3.7m (12 ft.) in height. Space requirements of mechanical and electrical equipment rooms shall be based upon the layout of required equipment drawn to scale within each room.

Service Access. Space shall be provided around all HVAC system equipment as recommended by the manufacturer and in compliance with local code requirements for routine maintenance. Access doors or panels shall be provided in ventilation equipment, ductwork and plenums as required for in-site inspection and cleaning. Equipment access doors or panels shall be readily operable and sized to allow full access. Large central equipment shall be situated to facilitate its replacement. The HVAC design engineer shall be cognizant of the necessity to provide for the replacement of major equipment over the life of the building and shall insure that provisions are made to remove and replace, without damage to the structure, the largest and heaviest component that cannot be further broken down.

In addition, adequate methods of access shall be included for items such as: chillers, boilers, air-handling units, heat exchangers, cooling towers, reheat coils, VAV terminals, pumps, water heaters and all devices that have maintenance service requirements.

To facilitate equipment access, maintenance, removal and replacement, a freight elevator stop shall be provided to serve each floor housing HVAC systems and equipment.

Where stairs are required, they must allow for safe transport of equipment and components. Ship's ladders are not permitted for access and maintenance of any equipment.

Vertical Clearances. Mechanical equipment rooms shall have clear ceiling heights of not less than 3.7 m (12 ft). Catwalks with stairways shall be provided for all equipment that cannot be maintained from floor level. Where maintenance requires the lifting of heavy parts [45 kg (100 lb) or more], hoists and hatchways shall be installed.

Horizontal Clearances. Mechanical rooms shall be configured with clear circulation aisles and adequate access to all equipment. The arrangement shall consider the future removal and replacement of all equipment. The mechanical rooms shall 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 (noted by outlining manufacturer's recommendations) for maintenance and removal of coils, filters, motors, and similar devices shall be provided. Chillers shall be placed to permit pulling of tubes from all units. The clearance shall 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 the sides that filters and coils are accessed, where clearance shall be equal to the length of the coils plus 610 mm (2 ft).

Roof-Mounted Equipment. No mechanical equipment except for cooling towers, air-cooled chillers, evaporative condensers, and exhaust fans shall be permitted on the roof of the building. Access to roof-mounted equipment shall be by stairs, not by ship's ladders.

Housekeeping Pads. Housekeeping pads shall be at least 152 mm (6 in) wider on all sides than the equipment they support and shall be 152 mm (6 in) thick.

Mechanical Rooms. All mechanical rooms must be mechanically ventilated to maintain room space conditions as indicated in *ASHRAE 62*, *ASHRAE 15*, and Table 5-1 of this chapter. Water lines shall not be located above motor control centers or disconnect switches and shall comply with requirements of *NFPA 70* Chapter 1. Mechanical rooms shall have floor drains in proximity to the equipment they serve to reduce water streaks or drain lines extending into aisles. Mechanical rooms shall not be used as return air, outdoor air, or mixing plenums. Mechanical equipment rooms must be designed in accordance with the requirements of *ASHRAE Standard 15: Safety Code for Mechanical Refrigeration*.

Chiller Equipment Rooms. All rooms for refrigerant units shall be constructed and equipped to comply with *ASHRAE Standard 15: Safety Code for Mechanical Refrigeration*. Chiller staging controls shall be capable of DDC communication to the central building Energy Management System.

Electrical Equipment Rooms. No water lines are permitted in electrical rooms, except for fire sprinkler piping. Sprinkler piping lines must not be located directly above any electrical equipment.

Communications Closets. Communications closets must be cooled in accordance with the requirements of EIA/TIA Standard 569. Closets which house critical communications components shall be provided with dedicated air-conditioning systems that shall 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.

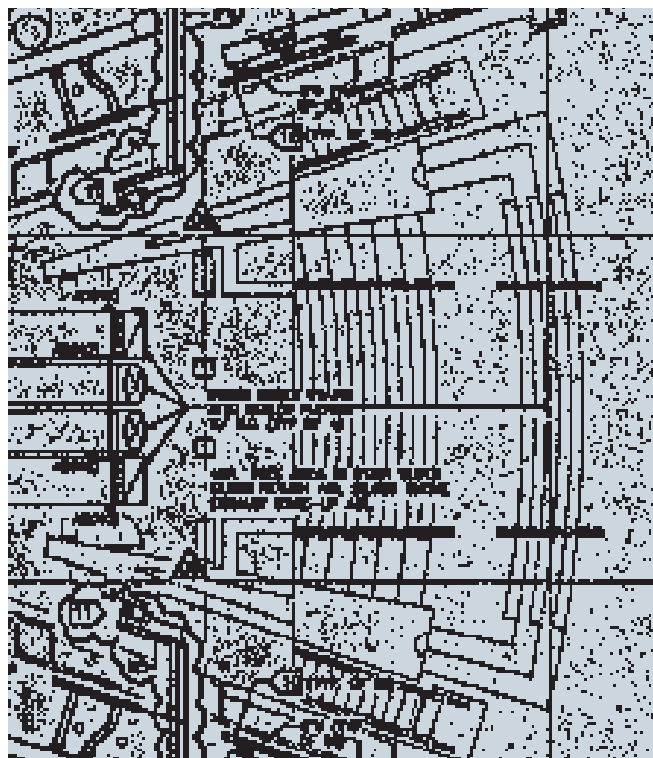
In the event the building is equipped throughout with automatic sprinklers, hoist way venting is not required.

Emergency Generator Rooms. The environmental systems shall meet the requirements of NFPA Standard 110: *Emergency and Standby Power Systems* and meet the combustion air requirements of the equipment. Rooms must be ventilated sufficiently to remove heat gain from equipment operation. The supply and exhaust louvers shall be located to prevent short circuiting. Generator exhaust shall be carried up to roof level (GSA preference) in a flue or exhausted by way of compliance with the generator manufacturer's installation guidelines. Horizontal exhaust through the building wall shall be avoided.

UPS Battery Rooms. 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, shall extend with acid waste piping to an acid neutralization tank prior to discharge to the sanitary sewer or building drain. The battery room must be ventilated/exhausted directly to the outdoors at a rate

calculated to be in compliance with code requirements and manufacturer's recommendations, and the exhaust system must be connected to the emergency power distribution system. Fans shall be spark-resistant, explosion proof, with motor outdoor the air stream, ductwork to be negative pressure system of corrosion-resistant material, with exhaust directly to outdoors in a dedicated system. Acoustical enclosures shall be provided to maintain a maximum NC level of 35. Coordinate with electrical design specifications to include HVAC support equipment in UPS extended servicing agreements.

Loading Docks. The entrances and exits at loading docks and service entrances shall be maintained at negative pressure relative to the rest of the building with a means to reduce infiltration and outdoor debris.



The Federal Triangle Building, Washington, D.C.

5.8 HVAC Components

Air-Handling Units (AHU). All air-handling units, including dedicated outdoor air ventilation units, dedicated perimeter pressurization units, floor-by-floor air-handling units, and air-handling units serving special areas, shall be sized to not exceed 11,800 L/s (25,000 cfm).

Smaller units are encouraged to facilitate flexible zone control, particularly for spaces that involve off-hour or high-load operating conditions. To the extent possible, “plug-n-play” AHU configurations shall be considered, facilitating easy future adaptations to space-load changes.

Psychrometric process charts shall be prepared for each air-handling unit application, characterizing full and part load operating conditions. Air-handling unit/coil designs shall assure that conditioned space temperatures and humidity levels are within an acceptable range, per programmed requirements, Table 5.1, and *ASHRAE Standard 62*.

Depending on sensible heat ratio characteristics, effective moisture control may require cooling coil air discharge dew point temperatures as low as 10.0°C (50°F). As required, provide face-by-pass or heat recovery features to re-heat cooling coil discharge temperatures for acceptable space entry. Provide a direct form of re-heat and/or humidification only if space conditions require tight environmental control, or if recurring day-long periods of unacceptable humidity levels would otherwise result.

Particular attention shall be given to the volume control. Zone loads must be calculated accurately to avoid excessive throttling of air flow due to oversized fans and terminal units. Diffusers shall be high entrainment type (3:1 minimum) to maximize air velocity at low flow rates.

If ventilation air is delivered through the VAV terminal, the minimum volume setting of the VAV terminal shall equal the larger of the following:

- Use 30 percent of the peak supply volume, or
- Use 2 L/s per m² (0.4 cfm/sq.ft.) of conditioned zone area, or
- Use a minimum outdoor airflow to satisfy *ASHRAE Standard 62* ventilation requirements.

Supply, Return and Relief Air Fans: Centrifugal double-width double-inlet forward curved and airfoil fans are preferable for VAV AHUs. All fans shall bear the AMCA seal and performance shall be based on tests made in accordance with AMCA Standard 210. Fans shall be selected on the basis of required horsepower as well as sound power level ratings at full load and at part load conditions. Fan motors shall be sized so they do not run at overload anywhere on their operating curve. Fan operating characteristics must be checked for the entire range of flow conditions, particularly for forward curved fans. Fan drives shall be selected for a 1.5 service factor and fan shafts shall be selected to operate below the first critical speed. Thrust arrestors shall be designed for horizontal discharge fans operating at high static pressure.

Coils: Individual finned tube coils shall generally 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 shall 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 shall be copper tube and copper finned materials. Equipment and other obstructions in the air stream shall be located sufficiently downstream of the coil so that it will not come in contact with the water droplet carryover. Cooling coils shall be selected at or below 2.5 m/s (500 fpm) face

velocity to minimize moisture carryover. Heating coils shall be selected at or below 3.8 m/s (750 fpm) face velocity.

Drains and Drain Pans: Drain pans shall be made of stainless steel, insulated and adequately sloped and trapped to assure drainage. Drains in draw-through configurations shall have traps with a depth and height differential between inlet and outlet equal to the design static pressure plus 25 mm (1 inch) minimum.

Filter Sections: Filters shall be sized at 2.5 m/s (500 fpm) maximum face velocity. Filter media shall be fabricated so that fibrous shedding does not exceed levels prescribed by ASHRAE 52.2. The filter housing and all air-handling components downstream shall not be internally lined with fibrous insulation. Double-wall construction or an externally insulated sheet metal housing is acceptable. 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 shall be placed across each filter bank to allow quick and accurate assessment of filter dust loading as reflected by air-pressure loss through the filter, and sensors shall be connected to building automation system.

UVC Emitters/Lamps: Ultraviolet light (C band) emitters/lamps shall be incorporated downstream of all cooling coils in an air-handling unit, and above all drain pans to control airborne and surface microbial growth and transfer. Applied fixtures/lamps must be specifically manufactured for this purpose. Safety interlocks/features shall be provided to limit hazard to operating staff.

Access Doors: Access doors shall be provided at air-handling units downstream of each coil, upstream of each filter section and adjacent to each drain pan and fan section. Access doors shall be of sufficient size to allow personnel to enter the unit to inspect and service all portions of the equipment components.

Plenum Boxes: Air-handling units shall be provided with plenum boxes where relief air is discharged from the air-handling unit. Plenum boxes may also be used on the return side of the unit in lieu of a mixing box. Air-flow control dampers shall be mounted on the ductwork connecting to the plenum box.

Mixing Boxes: Air-handling units shall be provided with mixing boxes where relief air is discharged from the air-handling unit. Mixing boxes may also be used on the return side of the unit in lieu of a plenum box. Air flow control dampers shall be mounted within the mixing box or on the ductwork connecting to the mixing box.

Terminals. VAV terminals shall be certified under the ARI Standard 880 Certification Program and shall carry the ARI Seal. If fan-powered, the terminals shall be designed, built, and tested as a single unit including motor and fan assembly, primary air damper assembly and any accessories. VAV terminals shall be pressure-independent type units. Air leakage from the casing of a VAV box/terminal shall not exceed 2% of its rated capacity. Units shall have BACnet or LONWORKS self-contained controls.

Fan-powered terminals: Fan-powered terminals shall have ECM motors for speed control to allow continuous fan speed adjustment from maximum to minimum, as a means of setting the fan airflow. Units shall have BACnet or LONWORKS self-contained controls.

Fan-powered terminals shall be equipped with a ducted return, featuring a filter/filter rack assembly with the filters having a Minimum Efficiency Reporting Value (MERV) of 10 (60% - 65% efficient with a maximum allowable particle size of 1.0 micron) and covered on all external exposed sides with two inches of insulation.

The return plenum box for fan-powered terminals shall be a minimum of 610 mm (24 in) in length and shall be double wall with insulation in-between or contain at least one elbow where space allows. Fan-powered terminals

may have hot water heating coils used for maintaining temperature conditions in the space under partial load conditions. Fan-powered terminals located on the perimeter zones and on the top floor of the building shall contain hot water coils for heating.

Air Distribution. Ductwork shall be designed in accordance with *ASHRAE: Handbook of Fundamentals, Duct Design Chapter*, and constructed in accordance with the *ASHRAE: HVAC Systems and Equipment Handbook, Duct Construction Chapter*, and the *SMACNA Design Manuals*. Supply, return and exhaust air ducts shall be designed and constructed to allow no more than 3 percent leakage of total airflow in systems up to 747 Pa (3.0 in WG). In systems from 747 Pa (3.0 in WG) through 2,488 Pa (10.0 in WG) ducts shall be designed and constructed to limit leakage to 0.5 percent of the total air flow. All ductwork joints and all connections to air handling and air distribution devices shall be sealed with mastic-

including all supply and return ducts, any ceiling plenums used as ducts and all exhaust ducts. Energy consumption, security and sound attenuation shall be major considerations in the routing, sizing and material selection for the air distribution ductwork.

Ductwork Pressure: Table 5-3 provides pressure classification and maximum air velocities for all ductwork.

Ductwork construction shall be tested for leakage prior to installation. Each section tested must have a minimum of a 6.1 m (20 ft) length straight-run, a minimum of two elbows and a connection to the terminal. The stated static pressures represent the pressure exerted on the duct system and not the total static pressure developed by the supply fan. The actual design air velocity shall consider the recommended duct velocities in Table 5-4 when noise generation is a controlling factor. Primary air ductwork (fan connections, risers, main distribution ducts) shall be

Table 5-3
Ductwork Classification

Static Pressure		Air Velocity		Duct Class
250 Pa	(1.0 in W.G.)	< 10 m/s DN	< (2000 FPM DN)	Low Pressure
500 Pa	(2.0 in W.G.)	< 10 m/s DN	< (2000 FPM DN)	Low Pressure
750 Pa	(3.0 in W.G.)	< 12.5 m/s DN	< (2500 FPM DN)	Medium Pressure
1000 Pa	(+4.0 in W.G.)	< 10 m/s DN	> (2000 FPM UP)	Medium Pressure
1500 Pa	(+6.0 in W.G.)	< 10 m/s DN	> (2000 FPM UP)	Medium Pressure
2500 Pa	(+10.0 in W.G.)	< 10 m/s DN	> (2000 FPM UP)	High Pressure

medium pressure classification as a minimum. Secondary air ductwork (runouts/branches from main to terminal terminals and distribution devices) shall be low pressure classification as a minimum.

Pressure loss in ductwork shall be designed to comply with the criteria stated above. 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 have to be used, double foil sound attenuating turning vanes shall be provided. Mitered elbows are not permitted where duct velocity exceeds 10.2 m/s (2,000 fpm).

Sizing of Ductwork: Supply and return ductwork shall be sized using the equal friction method except for ductwork upstream of VAV terminals. Duct systems designed using the equal friction method place enough static pressure capacity in the supply and return fans to compensate for improper field installation and changes made to the system layout in the future. In buildings with large areas of open plan space, the main duct size shall be increased for revisions in the future. Air flow diversity shall also be a sizing criterion. Eighty percent diversity can be taken at the air-handling unit and decreased the farther the ductwork is from the source until air flow diversity is reduced to zero for the final portion of the system.

Ductwork Construction: Ductwork shall be fabricated from galvanized steel, aluminum or stainless steel sheet metal depending on applications. Flex duct may be used for low pressure ductwork downstream of the terminal box in office spaces. The length of the flex duct shall 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 shall not exceed 3.0 m (10 ft) nor contain more than two bends. Joint sealing tape for all connections shall be of reinforced fiberglass backed

Table 5-4
Recommended Duct Velocities

Application	Controlling Factor Noise Generation (Main Duct Velocities)	
	m/s	(fpm)
Private Offices Conference Rooms Libraries	6	(1,200)
Theaters Auditoriums	4	(800)
General Offices	7.5	(1,500)
Cafeterias	9	(1,800)

material with field applied mastic. Use of pressure sensitive tape is not permitted.

Air Delivery Devices: Terminal ceiling diffusers or booted-plenum slots shall be specifically designed for VAV air distribution. Booted plenum slots shall not exceed 1.2 m (4 ft) in length unless more than one source of supply is provided. “Dumping” action at reduced air volume and sound power levels at maximum delivery shall be minimized. For VAV systems, the diffuser spacing selection shall not be based on the maximum or design air volumes but rather on the air volume range where the system is expected to operate most of the time. The designer shall consider the expected variation in range in the outlet air volume to ensure the air diffusion performance index (ADPI) values remain above a specified minimum. This is achieved by low temperature

variation, effective air mixing, and no objectionable drafts in the occupied space, typically 152 mm (6 in) to 1,830 mm (6 ft) above the floor. Adequate ventilation requires that the selected diffusers effectively mix the total air in the room with the supplied conditioned air, which is assumed to contain adequate ventilation air.

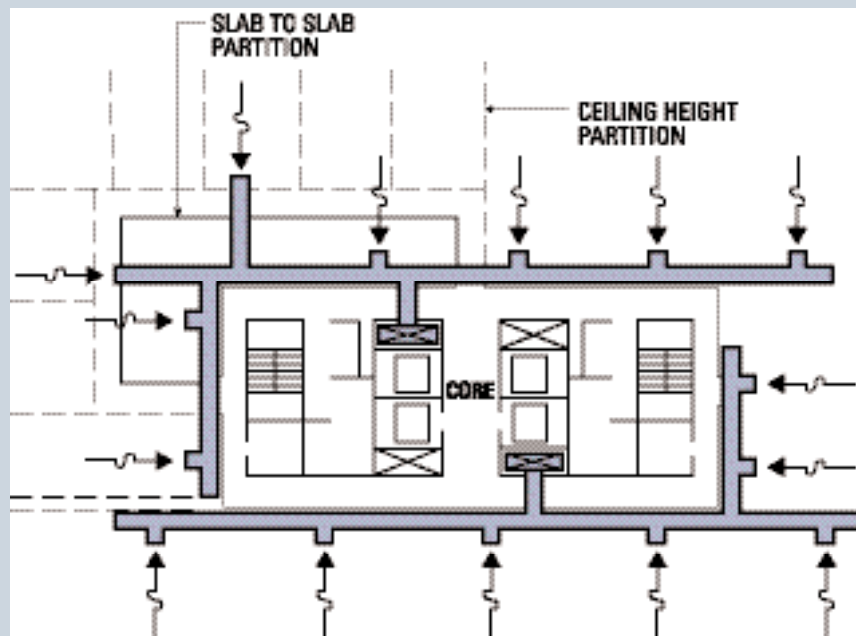
Plenum and Ducted Return Air Distribution. With a return plenum, care must be taken to ensure that the air drawn through the most remote register actually reaches the air-handling unit. The horizontal distance from the farthest point in the plenum to a return duct shall not exceed 15.2 m (50 ft). No more than 944 L/s (2,000 cfm) shall be collected at any one return grille. Figure 5-1

illustrates an example of an open ceiling plenum with return air ductwork. Return air plenums shall be sealed air-tight 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 intrusion of untreated outdoor air. All central multi-floor-type return air risers must be ducted.

Other less flexible building spaces, such as circulation, public spaces, and support spaces, shall have ducted returns. Where fully ducted return systems are used, consider placing returns low in walls or on columns to complement ceiling supply air.

Figure 5-1

Ceiling Return Plenum with Minimal Return Ductwork



Return air ducts in the ceiling plenum of the floor below the roof shall be insulated. Sound attenuator shall be provided, as needed, to connect the return ductwork to the return fan or air-handling unit, in order to minimize noise and vibration.

Fan Coil Units. For perimeter spaces, provide four-pipe fan coil units with cooling coil, heating coil, MERV 10 filters, internal condensate drain, and overflow drain. Unit shall have self-contained microprocessor controls and shall be capable of connecting to and interoperating with a BACnet or LONWORKS Direct Digital Control (DDC) Building Automation System. Fan coil units shall be capable of operating with unit-mounted or remote-mounted temperature sensor. Installation of fan coil units above ceiling is not permitted.

Finned-tube Radiation. Finned-tube radiation shall have individual zone thermostatic control capable of connecting to a self-contained microprocessor that can interface with a BACnet or LONWORKS Direct Digital Control (DCC) Building Automation System.

Heat Recovery Equipment. Heat recovery equipment shall operate at a minimum of 70 percent efficiency. The heat recovery equipment must be capable of connecting to a microprocessor controller that in turn can be connected to a direct digital control (DDC) Building Automation System. Pre-filters shall be provided in all heat recovery equipment.

Heat Pipe: For sensible heat recovery a run-around type heat pipe shall use refrigerant to absorb heat from the air stream at the air intake and reject the heat back into the air stream at the discharge of the air-handling unit. System shall have solenoid valve control to operate under partial load conditions.

Run-around Coil: A glycol run-around coil may be used with control valves and a pump for part load conditions. The run-around coils shall be used at the exhaust

discharge from the building and at the fresh air intake into the building. The run-around coil system shall be capable of connecting to a microprocessor controller that in turn can be connected to a direct digital control (DDC) Building Automation system.

Enthalpy Wheels: A desiccant-impregnated enthalpy wheel with variable speed rotary wheel may be used in the supply and exhaust systems.

Sensible Heat Recovery: For sensible heat recovery, a cross-flow, air-to-air (z-duct) heat exchanger shall recover the heat in the exhaust and supply air streams. Z-ducts shall be constructed entirely of sheet metal. Heat-wheels may also be used for sensible heat recovery. Unit shall have variable speed drive for controlling the temperature leaving the unit.

Kitchen Ventilation Equipment. Products of combustion from kitchen cooking equipment and appliances shall be delivered outdoor of building through the use of kitchen ventilation systems involving exhaust hoods, grease ducts and make-up air systems where required. Commercial kitchen equipment applications shall be served by a Type I hood constructed in compliance with UL 710 and designed in accordance with code having jurisdiction. Grease ducts shall be constructed of black steel not less than 1.4 mm (0.055 in, No. 16 gauge) in thickness or stainless steel not less than 1.1 mm (0.044 in, No. 18 gauge) in thickness. Make-up air systems serving kitchen exhaust hoods shall incorporate air-side heat exchange to recover energy from the exhaust stream to be used for heating the supply air stream.

Motors. All motors shall have premium efficiency as per *ASHRAE Standard 90.1*. Motors that are 0.37 kW ($\frac{1}{2}$ hp) and larger shall be polyphase. Motors smaller than 0.37 kW ($\frac{1}{2}$ hp) shall be single phase. For motors operated with variable speed drives, provide insulation cooling characteristics as per NFPA.

5.9 Humidification and Water Treatment

Make-up water for direct evaporation humidifiers shall originate directly from a potable source that has equal or better water quality with respect to both chemical and microbial contaminants. Humidifiers shall be designed so that microbiocidal chemicals and water treatment additives are not emitted in ventilation air. All components of humidification equipment shall be stainless steel. Air washer systems are not permitted for cooling.

Humidification shall be limited to building areas requiring special conditions. Courtrooms with wall coverings of wood shall be provided with humidification. General office space shall not be humidified unless severe winter conditions are likely to cause indoor relative humidity to fall below 30 percent.

Where humidification is necessary, atomized hot water, clean steam or ultrasound may be used and shall be generated by electronic or steam-to-steam generators. To avoid the potential for oversaturation and condensation at low load, the total humidification load shall be divided between multiple, independently-modulated units. Single-unit humidifiers are not acceptable.

When steam is required during summer seasons for humidification or sterilization, a separate clean steam generator shall be provided and sized for the seasonal

load. Humidifiers shall be centered on the air stream to prevent stratification of the moist air. All associated equipment and piping shall be stainless steel.

The humidification system shall have BACnet or LONWORKS self-contained controls.

Water Treatment. The water treatment for all hydronic systems, including humidification systems, shall be designed by a qualified specialist. The design system shall address the three aspects of water treatment: biological growth, dissolved solids and scaling, and corrosion protection. The performance of the water treatment systems shall produce, as a minimum, the following characteristics; hardness: 0.00; iron content: 0.00; dissolved solids: 1,500 to 1,750 ppm; silica: 610 ppm or less; and a PH of 10.5 or above. The system shall operate with an injection pump transferring chemicals from solution tank(s) as required to maintain the conditions described. The chemical feed system shall have BACnet or LONWORKS self-contained controls.

The methods used to treat the systems' make-up water shall have prior success in existing facilities on the same municipal water supply and follow the guidelines outlined in *ASHRAE Applications Handbook*.

5.10 Primary Heating Systems

GSA prefers low-temperature hot-water heating systems; 207 kPa (30 psi) working pressure and 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 shall not exceed 16.7°C (30°F). The temperature drop for terminal unit heating coils shall be 11.1°C (20°F). Design water velocity in piping shall not exceed 2.4 m/s (8 fps) or design pressure friction loss in piping systems shall not exceed 0.4 kPa/m (4 ft per 100 ft), whichever is larger, and not less than 1.2 m/s (4 fps).

District Steam Heating

GSA buildings are built for the long-term; therefore, it is prudent for GSA to provide the building heating system. District steam heating, if available, may be considered if determined to have long-term reliability and can be economically justified through a life cycle cost analysis. In the event District steam heating is utilized, appropriate space must be provided to allow GSA to install boilers and associated equipment at a later date. If steam is furnished to the building, such as under a district heating plan, it shall be converted to hot water with a heat exchanger in the mechanical room near the entrance into the building. If steam heating is used, the designer shall investigate the use of district steam condensate for pre-heating of domestic hot water. Steam heating is not permitted inside the building other than conversion of steam-to-hot water in the mechanical room.

Also, the use of steam for HVAC applications shall be limited to the conversion of steam heat to hot water heat and for use in providing humidification. Steam shall not be used as a heating medium for distribution throughout a building to terminal units, air-handling units, perimeter heating units, coils, or any other form of heat transfer where steam is converted to a source of heat for use in space comfort control or environmental temperature control.

Steam delivered from any source other than a clean steam generation system shall be prohibited from use in providing humidification. Steam delivered from a central plant, a district steam system, steam boilers, or any equipment where chemicals are delivered into the medium resulting in the final product of steam shall not be used for the purpose of providing humidification to the HVAC system or occupied spaces.

Hot Water Heating Systems

The use of electric resistance and/or electric boilers as the primary heating source for the building is prohibited. Design and layout of hydronic heating systems shall follow the principles outlined in the latest edition of the *ASHRAE Systems and Equipment Handbook*.

Boilers. Boilers for hydronic hot water heating applications shall be dual fuel (natural gas and No. 2 fuel oil) low pressure, with a working pressure and maximum temperature limitation as previously stated, and shall be installed in a dedicated mechanical room with all provisions made for breaching, flue stack and combustion air. For northern climates, a minimum of three equally sized units shall be provided. Each of the three units shall

have equal capacities such that the combined capacity of the three boilers shall satisfy 120 percent of the total peak load of heating and humidification requirements. For southern climates, a minimum of two equally sized units at 60 percent of the peak capacity (each) shall be provided. The units shall be packaged, with all components and controls factory preassembled. Controls and relief valves to limit pressure and temperature must be specified separately. Burner control shall be return water temperature actuated, and control sequences, such as modulating burner control and outdoor air reset, shall be utilized to maximum efficiency and performance. Multiple closet type condensing boilers shall be utilized, if possible. Boilers shall have self-contained microprocessor controls capable of connecting to and interoperating with a BACnet or LONWORKS Direct Digital Control (DDC) Building Automated System. Boilers shall have a minimum efficiency of 80 percent as per *ASHRAE Standard 90.1*.

Individual boilers with ratings higher than 29 MW (99 million Btu/hour) or boiler plants with ratings higher than 75 MW (256 million Btu/hour) are subject to review by the Environmental Protection Agency.

Boilers shall be piped to a common heating water header with provisions to sequence boilers on-line to match the load requirements. All units shall have adequate valving to provide isolation of off-line units without interruption of service. All required auxiliaries for the boiler systems shall be provided with expansion tanks, heat exchangers, water treatment and air separators, as required.

Gas Trains: Boiler gas trains shall be in accordance with International Risk Insurance (IRI) standards.

Automatic Valve Actuators: Gas valve actuators shall not contain NaK (sodium-potassium) elements since these pose a danger to maintenance personnel.

Venting: Products of combustion from fuel-fired appliances and equipment shall be delivered outdoor of the building through the use of breaching, vent, stack and chimney systems. breaching connecting fuel-fired equipment to vents, stacks and chimneys shall generally be horizontal and shall comply with NFPA 54. Vents, stacks and chimneys shall generally be vertical and shall comply with NFPA 54 and 211. breaching, vent, stack, and chimney systems may operate under negative, neutral, or positive pressure and shall be designed relative to the flue gas temperature and dew point, length and configuration of the system, and the value of the insulation techniques applied to the vent. Venting materials may be factory fabricated and assembled in the field and may be double or single wall systems depending on the distance from adjacent combustible or noncombustible materials. Material types, ratings and distances to adjacent building materials shall comply with NFPA 54 and 211.

Hot Water Pumps. Pumps shall be of a centrifugal type and shall generally be selected to operate at 1750 RPM. Both partial load and full load must fall on the pump curve. The number of primary hot water pumps shall correspond to the number of boilers, and a stand-by pump shall be designed for each hot water circuit. Variable volume pumping systems shall be considered for all secondary piping systems with pump horsepower greater than 11.2 kW (15 hp). The specified pump motors shall not overload throughout the entire range of the pump curve. Each boiler group pumps shall be arranged with piping, valves, and controls to allow each boiler group to operate independently of the other boiler groups.

Freeze Protection. Propylene glycol manufactured specifically for HVAC systems shall be used to protect hot water systems from freezing, where extensive runs



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of piping are exposed to weather, where heating operations are intermittent or where coils are exposed to large volumes of outdoor air. Freeze protection circulation pump shall be provided along with polypropylene glycol. Heat tracing systems are not acceptable for systems inside the building. Glycol solutions shall not be used directly in boilers, because of corrosion caused by the chemical breakdown of the glycol. The water make-up line for glycol systems shall be provided with an in-line water meter to monitor and maintain the proper percentage of glycol in the system. Provisions shall be made for drain down, storage and re-injection of the glycol into the system.

Radiant Heat. Radiant heating systems (hot water or gas fired) may be overhead or underfloor type. They may be

considered in lieu of convective or all-air heating systems in areas that experience infiltration loads in excess of two air changes per hour at design heating conditions. Radiant heating systems may also be considered for high bay spaces and loading docks.

Natural Gas Piping. Refer to *Plumbing Systems, Natural Gas Systems* section of this chapter.

Fuel Oil Piping. Refer to *Plumbing Systems, Fuel Oil Systems* section of this chapter.

Underground Fuel Oil. Refer to *Plumbing Systems, Fuel Oil Systems* section of this chapter.

5.11 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 shall 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 shall be between 6.7°C and 8.9°C (12°F and 16°F). The chilled water system shall 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, a 7.8°C (46°F) may be used.

District Chilled Water

GSA buildings are built for the long-term; therefore, it is prudent for GSA to provide the building chilled water system. District chilled water, if available, may be considered for cooling only if it is determined to have long-term reliability and can be economically justified through a life cycle cost analysis. In the event District chilled water is utilized, appropriate space must be provided to allow GSA to install chillers, cooling towers, and associated equipment, at a later date. If chilled water is furnished to the building, such as under a district chilled water plan, it shall be used in conjunction with a heat exchanger in the mechanical room near the entrance into the building.

Chilled Water Systems

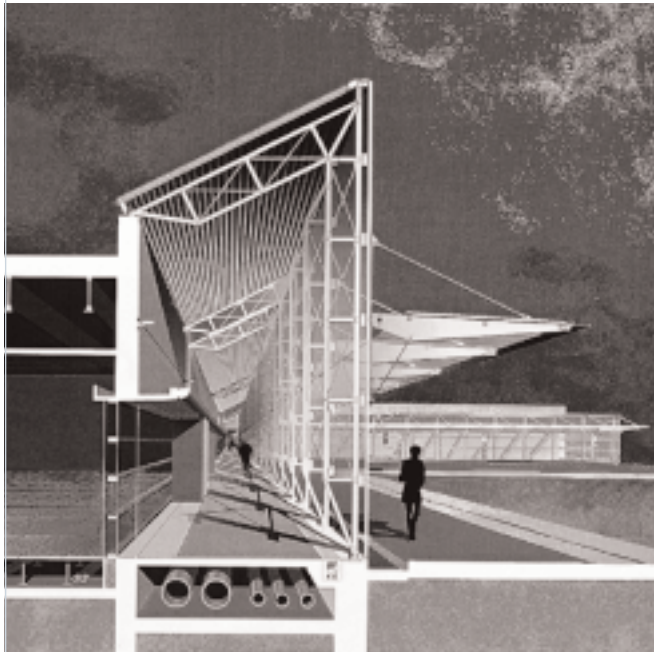
Mechanical equipment rooms must be designed in accordance with the requirements of *ASHRAE Standard 15: Safety Code for Mechanical Refrigeration*. Chiller leak detection and remote alarming shall be connected to the BAS.

Chillers. Chillers shall be specified in accordance with the latest Air-conditioning and Refrigeration Institute (ARI) ratings procedures and latest edition of the *ASHRAE Standard 90.1*. As a part of the life cycle cost analysis, the use of high-efficiency chillers with COP and IPLV ratings that exceed 6.4 (0.55 kW/ton) shall be analyzed. Likewise, the feasibility of gas-engine driven chillers, ice storage chillers, and absorption chillers shall be considered for demand shedding and thermal balancing of the total system.

BACnet or LONWORKS Microprocessor-based controls shall be used. Chiller staging controls shall be capable of DDC communication to the central building Energy Management System. The control panel shall 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 limiting, and output/input-COP [input/output (kW/ton)] information.

When the peak cooling load is 1760 kW (500 tons) or more, a minimum of three chilled water machines shall be provided. The three units shall 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 peak cooling load is less than 1760 kW (500 tons), a minimum of two equally sized machines at 67 percent of the peak capacity (each) shall be provided. All units shall have adequate valving to provide isolation of the off-line unit without interruption of service. Cooling systems with a refrigeration capacity less than 176 kW (50 tons) shall use air-cooled chillers.

Chillers shall be piped to a common chilled water header with provisions to sequence chillers on-line to match the load requirements. All required auxiliaries for the chiller systems shall be provided with expansion tanks, heat exchangers, water treatment and air separators, as



U.S. Census Bureau

required. If multiple chillers are used, automatic shutoff valves shall be provided for each chiller.

Chiller condenser piping shall be equipped with recirculation/bypass control valves to maintain incoming condenser water temperature within chiller manufacturer's minimum.

Part load efficiency must be specified in accordance with ARI Standard 550/590.

The design of refrigeration machines must comply with Clean Air Act amendment Title VI: *Stratospheric Ozone Protection* and *Code of Federal Regulations (CFR) 40, Part 82: Protection of Stratospheric Ozone*.

Chlorofluorocarbon (CFC) refrigerants are not permitted in new chillers. Commonly used refrigerants such as HCFC-22, HCFC-123, HFC-134a, and HFC-410a are acceptable. Except where justified based on life cycle cost, specifications shall not restrict the refrigerant type due to the anti-competitive nature of such restrictions on available chiller products.

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.

Thermal Storage Systems. Ice-on-coil systems shall be considered in locations where the life cycle cost analysis demonstrates economic justification. Thermal storage systems shall include prefabricated tanks with glycol coils and water inside the tank. The tank shall be insulated and its capacity and performance shall be guaranteed by the vendor. Self-contained, fabricated ice storage system shall have self-contained BACnet LONWORKS microprocessor controls for charging and discharging the ice storage system and capable of being connected to a central building automation system. Other types of ice storage systems are not permitted.

Condenser Water. All water-cooled condensers must be connected to a recirculating heat-rejecting loop. The heat rejection loop system shall be designed for a 5.5°C (10°F) temperature differential and a minimum of 3.9°C (7°F) wet bulb approach between the outdoor air temperature and the temperature of the water leaving the heat rejection equipment. Heat tracing shall be provided for piping exposed to weather and for piping down to 0.9 m (3 ft) below grade.

Cooling Towers. Multiple cell towers and isolated basins are required to facilitate operations, maintenance and redundancy. The number of cells shall match the number of chillers. Supply piping shall be connected to a manifold to allow for any combination of equipment use. Multiple towers shall have equalization piping between cell basins. Equalization piping shall include isolation valves and automatic shutoff valves between each cell. Cooling towers shall have ladders and platforms for ease of inspections and replacement of components. Variable speed pumps for multiple cooling towers shall not operate below 30 percent of rated capacity.

Induced draft cooling towers with multiple-speed or variable-speed condenser fan controls shall be provided. Induced draft towers shall have a clear distance equal to the height of the tower on the air intake side(s) to keep the air velocity low. Consideration shall be given to piping arrangement and strainer or filter placement such that accumulated solids are easily removed from the system. Clean-outs for sediment removal and flushing from basin and piping shall be provided.

The cooling tower's foundation, structural elements and connections shall be designed for a 45 m/s (100 mph) wind design load. Cooling tower basins and housing shall be constructed of stainless steel.

If the cooling tower is located on the building structure, vibration and sound isolation must be provided. Cooling towers shall 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 shall be given to de-icing cooling tower fills if they are to operate in sub-freezing weather, such as chilled water systems designed with a water-side

economizer. A manual shutdown for the fan shall be provided. If cooling towers operate intermittently during sub-freezing weather, provisions shall be made for draining all piping during periods of shutdown. For this purpose indoor drain down basins are preferred to heated wet basins at the cooling tower. Cooling towers with waterside economizers and designed for year-round operation shall be equipped with basin heaters. Condenser water piping located above-grade and down to 3 feet below grade shall have heat tracing. Cooling towers shall be provided with BACnet or LONWORKS microprocessor controls, capable of connecting to central building automation systems.

See Chapter 7, *Fire Protection Engineering & Life Safety*, for fire protection provisions for cooling towers.

Chilled Water and Condenser Water Pumps. Pumps shall be of a centrifugal type and shall generally be selected to operate at 1750 RPM. Both partial load and full load must fall on the pump curve. The number of primary chilled water and condenser water pumps shall correspond to the number of chillers, and a stand-by pump shall be designed for each chilled water and condenser water circuit. Variable volume pumping systems shall be considered for all secondary piping systems with pump horsepower greater than 11.2 kW (15 hp). The specified pump motors shall not overload throughout the entire range of the pump curve.

Each boiler cooling tower and chiller group pumps shall be arranged with piping, valves, and controls to allow each chiller-tower group to operate independently of the other chiller and cooling tower groups.

Freeze Protection. Propylene glycol manufactured specifically for HVAC Systems is used for freeze protection, primarily in low temperature chilled water

systems (less than 4.4°C) (less than 40°F). The concentration of antifreeze shall be kept to a practical minimum because of its adverse effect on heat exchange efficiency and pump life. The water make-up line for glycol systems shall be provided with an in-line water meter to monitor and maintain the proper percentage of glycol in the system. All coils exposed to outdoor airflow (at some time) shall be provided with freeze protection thermostats and control cycles. Provisions shall be made for drain down, storage and re-injection of the glycol into the system.

Waterside Economizer Cycle. In certain climate conditions cooling towers are capable of producing condenser water cold enough to cool the chilled water system without chiller operation. This option shall be considered in life cycle cost analysis of water cooled chillers. Waterside economizer cycles are particularly cost effective in the low humidity climates of the western United States. Waterside economizer systems shall be used only in areas where the outdoor air temperature shall be below 4.4°C (40°F) wet bulb. Waterside economizers shall utilize a plate heat exchanger piped in parallel arrangement with its respective chiller.

5.12 Pumping and Piping Systems

All HVAC piping systems shall be designed and sized in accordance with *ASHRAE Fundamentals Handbook* and the *ASHRAE HVAC Systems and Equipment Handbook*. Materials acceptable for piping systems are black steel and copper. No PVC or other types of plastic pipe are permitted.

The hot water and chilled water systems shall utilize a two-pipe main distribution system arranged in a reverse return configuration. Loop piping for terminal or branch circuits shall be equipped with automatic flow control valves. Each terminal unit or coil shall be provided with isolation valves on both the supply and return, and a flow-indicating balance valve on the return line. Isolation valves shall be provided on all major pipe branches, such as at each floor level, building wing or mechanical room.

Hydronic, Closed Loop Systems. Pumps used in closed loop hydronic piping shall be designed to operate to the left of the peak efficiency point on their curves (higher head, less flow), to compensate for variances in pressure drop between calculated and actual values without causing pump overloading. Pumps with steep curves shall not be used, as they tend to limit system flow rates. Flow may be varied by variable speed pumps or staged multiple pumps. Pumps shall operate at no less than 75% efficiency on their performance curve.

Variable Primary Pumping. In this application, the primary circuit serves source equipment (chiller or boiler) and the load. The primary loop and pumps are dedicated and sized to serve the flow and temperature differential requirements of the primary source equipment and the load. Variable primary systems are only recommended for

smaller buildings [circulation of less than 63.1 L/s (1,000 gpm)].

In variable primary applications, many conventional chillers and boilers may experience flow-related heat exchange problems when a minimum flow is not maintained. For this reason, all variable primary applications must follow manufacturers' recommended practices to prevent equipment damage or failure.

Primary/Secondary Pumping. In this application, primary and secondary circuits are separate, with neither having an effect on the pumping head of the other. The primary circuit serves source equipment (chiller or boiler), while the secondary circuit serves the load. The primary loop and pumps are dedicated and sized to serve the flow and temperature differential requirements of the primary source equipment. This permits the secondary pump and loop to be sized and controlled to provide the design flow rate and temperature differential required to satisfy the heating or cooling loads. Primary/secondary systems are recommended for larger buildings [circulation of more than 63.1 L/s (1,000 gpm)] and campus facilities.

Air Control. Pressurized diaphragm expansion tanks shall be used in appropriately sized manufactured products. Air separators and vents must be provided on hot water systems to remove accumulated air within the system. Automatic bleed valves shall only be used in accessible spaces in mechanical rooms where they can be observed by maintenance personnel and must be piped directly to open drains. Manual bleed valves shall be used at terminal units and other less accessible high points in the system. Air vents shall be provided at all localized high points of the piping systems and at each heating coil. Likewise, system drains shall 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.

Dielectric Unions. Dielectric unions must be provided when connecting dissimilar materials in piping systems.

Piping Material. Table 5-5 cites which commercial standard shall be used for piping material.

Isolation of Piping at Equipment. Isolation valves, shutoff valves, by-pass circuits, flanges and unions shall 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 shall also be provided for zones off vertical risers.

Flexible Pipe Connectors. Flexible pipe connectors shall be fabricated from annular close pitched corrugated and braided stainless steel. All pumps, chillers, and cooling towers shall have flexible connectors.

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-coded bands and permanent tags indicating the system type and direction of flow for piping systems or type and number for equipment, per *ASHRAE Handbook*. The identification system shall also tag all valves and other operable fittings. Gas piping and sprinkler lines must be identified as prescribed by NFPA.

Table 5-5
Commercial Standards for Piping Material

Standard Piping Material	Use	Comments
ASTM Schedule 40	Chilled water up to 300 mm (12 in) dia., Condenser water up to 300 mm (12 in) dia.	1035 kPa (150 psi) fittings. Standard weight pipe over 300 mm (12-in) diameter.
	Hot water up to 100 mm (4 in) dia.	Test to 2100 kPa (300 psig)
	Natural gas, fuel oil	Weld and test to 2100 kPa (300 psig)
	Steam (100 kPa (15 psig) to 1035 kPa (150 psi))	
ASTM Schedule 30	Chilled water over 300 mm (12 in) dia Condenser water over 300 mm (12 in) dia.	1035 kPa (150 psi) fittings. Standard weight pipe over 300 mm (12-in) diameter
ASTM Schedule 80	Steam condensate	
Copper Tubing	Chilled water up to 102 mm (4 in) dia, Condenser water up to 102 mm (4 in) dia.	Builder's option. Use type K below ground and type L above.
	Domestic water	Lead-free solder connections.
	Refrigeration	Type ACR.
	Cast Iron Sanitary, waste and vent Storm	

5.13 Thermal Insulation

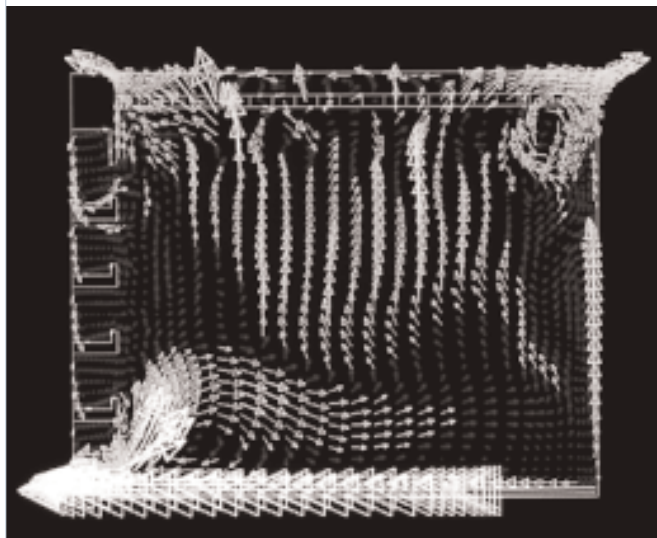
General

All insulation materials shall comply with the fire and smoke hazard ratings (25 for flame spread; 50 for smoke developed) as indicated by ASTM-E84, NFPA 255 and UL 723. Accessories such as adhesives, mastics, cements and tapes shall have the same or better fire and smoke hazard ratings.

Insulation shall be provided in accordance with *ASHRAE Standard 90.1*. Insulation that is subject to damage or reduction in thermal resistivity if wetted shall be enclosed with a vapor seal (such as a vapor barrier jacket).

Duct Insulation. All exposed ductwork shall have sealed canvas jacketing. All concealed ductwork shall have foil face jacketing.

The insulation shall comply with fire and smoke hazard ratings indicated by ASTM-E84, NFPA 255 and UL 723.



Air Flow Diagram, Atrium, Phoenix Courthouse

Accessories such as adhesives, mastics, cements, tapes, etc. shall have the same or better component ratings. All supply air ducts must be insulated, in accordance with *ASHRAE Standard 90.1*. Supply air duct insulation shall have a vapor barrier jacket. The insulation shall cover the duct system with a continuous, unbroken vapor seal.

Return air and exhaust air distribution systems shall be insulated in accordance with *ASHRAE Standard 90.1*. The insulation of return air and exhaust air distribution systems needs to 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. Generally, return air and exhaust air distribution systems do not require insulation if located in a ceiling plenum or mechanical room used as a return air plenum. All equipment, heat exchangers, converters and pumps shall be insulated as per *ASHRAE Standard 90.1*.

Piping Insulation. All insulation material shall comply with the fire and smoke hazard ratings indicated by ASTM-E84, NFPA 255 and UL 723. Accessories such as adhesives, mastics, cements, tapes, etc. shall have the same or better component ratings. All piping systems must be insulated in accordance with *ASHRAE Standard 90.1*. Piping systems conveying fluids having design temperatures less than 18.3°C (65°F) or greater than 40.6°C (105°F) shall be insulated. All piping systems with surface temperatures below the average dew point temperature of the indoor ambient air and where condensate drip will cause damage or create a hazard shall be insulated with a vapor barrier to prevent condensation formation regardless as to whether piping is concealed or exposed. Chilled water piping systems shall be insulated with nonpermeable insulation (of perm rating 0.00) such as cellular glass. All exposed and concealed piping shall have PVC jacketing.

Equipment Insulation. All insulation material shall comply with the fire and smoke hazard ratings indicated by ASTM-E84, NFPA 255 and UL 723. Accessories such as adhesives, mastics, cements, tapes, etc. shall have the same or better component ratings. All equipment including air-handling units, chilled and hot water pumps, and heat exchangers must be insulated in accordance with *ASHRAE Standard 90.1*. All pumps shall have jacketing.

Thermal Pipe Insulation for Plumbing Systems

All sanitary sewer vents terminating through the roof shall be insulated for a minimum of 1.83 meters (6 feet) below the roof line to prevent condensation from forming and include a vapor barrier jacket on this insulation. All Insulation materials and accessories shall comply with the fire and smoke hazard ratings indicated by ASTM-84, NFPA 255 and UL 723.

Domestic water piping shall be insulated in accordance with *ASHRAE Standard 90.1*. All piping exposed in plenums or above ceiling shall be insulated to prevent condensation. All insulation materials and accessories shall comply with the fire and smoke hazard ratings indicated by ASTM-E84, NFPA 255 and UL 723.

5.14 Vibration Isolation, Acoustical Isolation, and Seismic Design for Mechanical Systems

Noise and Vibration Isolation. Refer to and incorporate the basic design techniques as described in Chapter 3 *Acoustics, Design Criteria for Building Spaces* and *ASHRAE Applications Handbook, Sound and Vibration Control*. Isolate all moving equipment in the building.

Mechanical Room Isolation. Floating isolation floors shall be considered for major mechanical rooms located in penthouses or at intermediate levels in mid-rise and high-rise construction.

Mechanical Shafts and Chases. Mechanical shafts and chases shall be continuous and closed at the top and bottom. Any piping and ductwork shall be isolated as it enters the shaft to prevent propagation of vibration to the building structure. All openings for ducts and piping must be sealed. Shafts dedicated to gas piping must be ventilated.

Isolators. Isolators shall 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 shall be worded so that isolation performance becomes the responsibility of the equipment supplier.

Concrete Inertia Bases. Inertia bases shall be provided for reciprocating and centrifugal chillers, air compressors, all pumps, axial fans above 300 RPM, and centrifugal fans above 37.3 kW (50 hp).

Ductwork. Reduce fan-generated noise immediately outside of any mechanical room wall by acoustically coating or wrapping the duct. The ductwork design shall appropriately consider and address airborne equipment noise, equipment vibration, ductborne fan noise, duct breakout noise, airflow generated noise and ductborne crosstalk noise. All ductwork connections to equipment having motors or rotating components shall be made with 6-inch length of flexible connectors. All ductwork within the mechanical room or serving courtrooms shall be supported with isolation hangers.

Piping Hangers and Isolation. Isolation hangers shall 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 shall have the same deflection characteristics as the equipment isolators. Other hangers shall be spring hangers with 19 mm (0.75 in) deflection. Positioning hangers shall be specified for all piping 203 mm (8 in) and larger throughout the building. Spring and rubber isolators are recommended for piping 51 mm (2 in) and larger hung below noise sensitive spaces.

Floor supports for piping may be designed with spring mounts or rubber pad mounts. For pipes subject to large amounts of thermal movement, plates of Teflon or graphite shall be installed above the isolator to permit horizontal sliding.

Anchors and guides for vertical pipe risers usually must be attached rigidly to the structure to control pipe movement. Flexible pipe connectors shall be designed into the piping before it reaches the riser.

Provisions for Piping in Earthquake Zones. In regions of moderate and high seismicity, sleeves for pipes shall be at least 25 mm (1 inch) larger than the pipe, to allow for

movement. Flexible couplings shall be provided at the bottom of pipe risers. Spreaders shall be used to separate adjacent pipes, unless the distance is large enough to prevent contact in an earthquake. See Chapter 4: *Structural Engineering, SMACNA Seismic Restraint Manual and ASHRAE Application Handbook* for more detailed information.

Piping Supports. Provide channel supports for multiple pipes and heavy duty steel trapezes to support multiple pipes. Hanger and support schedule shall have manufacturer's number, type and location. Comply with MSS SP69 for pipe hanger selections. Spring hangers and supports shall be provided in all the mechanical rooms.

Noise Control in Duct Systems. System sound levels at maximum flow must be carefully evaluated to ensure acoustic levels required in Chapter 3. Duct noise control shall be achieved by controlling air velocity, by the use of sound attenuators, by the use of double wall ductwork with insulation in-between (only on courtroom return air transfer grilles) and by not oversizing terminal units. Duct liners are not permitted as a means of sound attenuation. Terminal units shall be selected so that design air volume is approximately three-quarters of the terminal box's maximum capacity. Volume dampers in terminal units shall be located at least 1.8 m (6 ft) from the closest diffuser and the use of grille mounted balance dampers shall be restricted except for those applications with accessibility problems.

Noise Transmission Attenuation (Courthouses).

Attenuate noise transmission to and from courtrooms, judges' chambers, jury rooms, prisoner consulting rooms and from prisoner detention areas.

5.15 Meters, Gauges, and Flow Measuring Devices

Thermometers and Gauges. Each piece of mechanical equipment shall be provided with the instrumentation or test ports to verify critical parameters, such as capacity, pressures, temperatures, and flow rates. Following are the general instrumentation requirements:

- 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 may 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 shall be made.
- Duct static pressure gauges shall be provided for the central air-handling unit air supply fan discharge, branch take-offs 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 shall be placed across filters in air-handling units and to measure building pressure relative to the outdoors. A temperature gauge is required at the outdoor air intake to each air-handling unit.

Flow Measuring Devices. Airflow measuring grids are required for all central air-handling units. Measuring grids shall be provided at the supply air duct, return air duct,

and the 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.

Water flow or energy measuring devices are required for each chilled water refrigeration machine, hot water boiler, pump, and connections to district energy plants. Individual water flow or energy measuring devices shall be provided for chilled water lines serving computer rooms and chilled water and hot water lines to outleased spaces. Flow measuring devices shall be capable of communicating with the central BAS. Water flow and air flow measuring devices shall confirm to *ASHRAE Standard 90.1* requirements.

Testing Stations. Permanent or temporary testing stations shall be provided for start up and testing of building systems. Connections shall be designed so temporary testing equipment can be installed and removed without shutting down the system.



College Park, Maryland chilled water supply and return

5.16 Building Automation Systems (BAS)

The BAS shall be Direct Digital Control (DDC) for providing lower operating costs and ease of operation. The BAS shall adjust building systems to optimize their performance and the performance with other systems in order to minimize overall power and fuel consumption of the facility.

BAS shall utilize 'open' communication protocols, such as BACnet or LONWORKS, to minimize the costs of providing integration and to allow interoperability between building systems and control vendors. Other open protocol language systems, such as LonTalk, may also be used, provided there is compatibility with overall regional and/or central monitoring and central strategies. A/E to specify and include functional design manual, hardware manual, software manual, operation manual, and maintenance manual. BAS shall have energy management and monitoring software.

In retrofits with an existing old-proprietary system in place, it is recommended that life cycle cost analysis determine between the complete replacement of the existing system or integrating the existing system with customized gateways. In the long term, with hardware and software costs falling as capabilities increase, energy savings are producing the paybacks required to justify the complete control retrofit.

The system shall consist of series of direct digital controllers interconnected by a local area network. BAS system shall be accessible through a web browser. System shall have a graphical user interface and must offer 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.

BAS is required for large facilities, both new facilities and major modernizations, [above 9,290 gross m² (100,000 gross sq. ft)]. Smaller projects shall be evaluated to determine the need for a BAS. The size of the building, number of pieces of equipment, expected energy savings and availability of trained staff shall all be considered.

Level of Integration

When planning BAS systems with a high level of integration, the necessary training will be required for the operating staff.

Lighting systems shall not be controlled by a BAS. These systems shall have independent control panels and networks. The BAS system shall monitor the status of the lighting systems only.

Fire alarm systems, security systems and elevator systems shall not be controlled by a BAS. These systems shall have independent control panels and networks. The BAS system shall monitor the status of these systems only, in order to prompt emergency operating modes of HVAC and lighting systems. See Chapter 7: *Fire Protection & Life Safety, Electrical Requirements, Fire Alarm Systems*, and Chapter 8: *Security Design*.

Automatic Temperature and Humidity Controls

A direct digital control (DDC) system with host computer monitoring and control shall be provided.

Temperature Controls. Pre-programmed stand-alone single or multiple loop microprocessor PID controllers shall be used to control all HVAC and plumbing subsystems.

PID loops shall be utilized. All chillers, boilers, terminal units and air-handling units shall have self-contained BACnet or LONWORKS controllers, capable of communicating with the Building Automation System.

Heating and cooling energy in each zone shall be controlled by a thermostat or temperature sensor located in that zone. Independent perimeter systems must have at least one thermostat or temperature sensor for each perimeter zone.

A 2.8°C (5°F) dead band shall be used between independent heating and cooling operations within the same zone.

Night set-back and set-up 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 must be part of the control system. Controls for the various operating conditions must include maintaining pressurization requirements.

Humidity Controls. Indoor and outdoor humidity sensors shall be calibrated in-place during system startup and at least annually thereafter. Dew point control is preferred because it tends to provide more stable humidity levels. However, RH sensors are acceptable, provided they have been calibrated in-place, and provided that they have co-located with dry bulb sensors so that the BAS can convert these two signals to a dew point value for control purposes.

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 also 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 shall include optimized start/stop for chillers, boilers, air-handling units and all associated equipment and feed forward controls based on predicted weather patterns. Lighting control shall be accomplished by use of separate control equipment, which allows BAS monitoring and reporting and control settings. Optimal start/stop calculates the earliest time systems can be shut down prior to the end of occupancy hours and the latest time systems can start up in the morning with the aim of minimizing equipment run time without letting space conditions drift outside of the comfort setpoints. Weather prediction programs store historic weather data in the processor memory and use this information to anticipate peaks or part load conditions. Programs also run economizer cycles and heat recovery equipment.

The BAS shall have the capability to allow building staff to measure energy consumption and monitor performance , which is critical to the overall success of the system. Electrical values, such as V, A, kW, KVAR, KVA, PF, kWh, KVARH, Frequency and Percent THD, shall be measured. See also Chapter 6: *Electrical Engineering*, for separate metering of power consumption.

Energy management measurements shall be totaled and trended in both instantaneous and time-based numbers for chillers, boilers, air-handling units and pumps. Energy

monitoring data shall be automatically converted to standard database and spreadsheet format and transmitted to a designated workstation. Energy points are those points that are monitored to ensure compliance with *ASHRAE Standard 90.1*.


Maintenance Scheduling

The BAS shall include programs for control that switch pumps and compressors from operating equipment to stand-by on a scheduled basis. Also, programs that provide maintenance schedules for equipment in every building system shall be included, complete with information on what parts and tools are needed to perform each task.

System Design Considerations

BAS’s require measurements at key points in the building system to monitor part-load operation and adjust system setpoints to match system capacity to load demands. Table 5-6 of the previous section outlines the minimum control and monitor points for typical HVAC equipment. Controls cannot correct inadequate source equipment, poorly selected components, or mismatched systems. Energy efficiency requires a design that is optimized by realistic prediction of loads, careful system selection, and full control provisions. System ability must include logs of data created by user selectable features. In new buildings and major renovations, the BAS shall have approximately 20 percent spare capacity for future expansion. The system must provide for stand-alone operation of subordinate components. The primary operator workstation shall 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.

Table 5-6
Minimum Control and Monitoring Points for Typical HVAC Equipment

	Central Air Handling Units Start/Stop Heating Control Cooling Control Humidification Control Supply Air Reset Static Pressure Reset Building and Zone Pressurization Control Damper Position (economizer) Supply Air Discharge Temp Return Air Temp Mixed Air Temp Supply Air Flow Rate Filter Differential Pressure Air Flow Measuring Station	Refrigeration Equipment Start/Stop Leave Water Temp Reset Demand Limiting Isolation Valve Position Leaving Water Temp Entering Water Temp kW Draw Flow Return Air Flow Rate	Hot Water Boilers Start/Stop Leaving Water Temp Reset Reset Isolation Valve Position Leaving Water Temp Entering Water Temp Flow BTU Draw
	Cooling Towers Start/Stop Leaving Water Temp Reset Flow Isolation Valve Position Entering Water Temp Leaving Water Temp	Terminal Boxes Start/Stop Discharge Temp Reset Supply Volume Reset Heating Control Zone Temp Reset Minimum Volume Reset Zone Temp Supply Air Reset Zone Pressurization Control	Pumps Start/Stop Discharge Pressure Reset Differential Pressure Flow
	Utilities Natural Gas Consumption Electricity Consumption & Demand Water Consumption Fuel Oil Quantity		

5.17 Testing and Balancing

Startup. The A/E shall specify that factory representatives be present for startup of all major equipment, such as boilers, chillers, air-handling units, packaged pump systems, and automatic control systems.

Testing and Balancing. It shall be the responsibility of the A/E to adequately specify testing, adjusting and balancing resulting in not only proper operation of individual pieces of equipment, but also the proper operation of the overall HVAC and Plumbing systems, in accordance with the design intent. The Testing and Balancing contractor shall have up to date certification by Associated Air Balance Council (AABC), the National Environmental Balance Bureau (NEBB), or the Testing, Adjusting, and Balancing Bureau (TABB).

Performance Testing. A/E to specify performance testing of all systems and equipment including chillers, boilers, air-handling units, exhaust fans, water heaters, and other systems for part load and full load during summer, winter, spring and fall season as per the schedules specified by the designer. The A/E shall specify the services of an organization certified by NEBB or AABC. Performance testing of domestic water heating systems shall include heater and remote outlet temperature maintenance, system and circuit pressure equalization (without over pressurization, excess pressure loss, or return pump dead-head), and control of water hammer at peak draw. Test for compliance with specifications and design intent for operation of water heater(s), mixing valve(s), circuit setters/balancing valves, return pump(s), and pressure reducing/regulating valves.

Ductwork Pressure and Leak Testing. Tests shall be conducted at static pressures equal to maximum design pressure of system and maximum leakage allowable shall not exceed 50 percent of that allowed in SMACNA's *HVAC Air Duct Leakage Manual*.

Piping and Equipment Pressure and Leak Testing. Leak testing shall be conducted at static pressures as required by code (or as 120 percent of maximum design working pressure of system where no code requirement exists), with maximum permissible leakage.



National Building Museum, Washington, D.C.

5.18 Plumbing Systems

Water conservation shall be a requirement of all plumbing systems. Use water-saving plumbing fixtures.

Domestic Water Supply Systems

Domestic Cold Water Service. Domestic potable cold water service shall 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.

Water service meters shall be located inside the building, utilizing meters (generally) furnished by the water utility purveyor, to maintain security and supervision within the security perimeter. Exterior water meter crocks or vaults shall not be permitted. Water meters shall be remote reading type with transponder signal transmitted by telephone line. Irrigation systems, and similar water supply/make-up systems that do not discharge to the sanitary sewer, shall be sub-metered (remote read) for utility billing rate deduction of sanitary service not utilized. The water service shall have a code and water purveyor compliant reduced pressure zone backflow prevention device immediately downstream of the service water meter(s) prior to all other connections and branches. Maintain manufacturer and water purveyor required access and service clearances for meters and backflow preventers.

Internal distribution shall consist of a piping system that supplies domestic potable cold water to all plumbing fixtures, plumbing equipment, water heaters, mechanical make-up, and cold water equipment/system demands.

Domestic Water Service Pressure Maintenance.

Distribution water pressure shall provide fixture, equipment, and outlet required pressures at the hydraulically most demanding (generally the topmost/highest and most remote) outlet. Required outlet pressure shall be minimum requirements of code, or higher requirements of the fixture, equipment, or outlet demand as identified by the manufacturer or warrantee.

Distribution water pressures shall not exceed system material, piping, and device rated maximum working pressures, or maximum pressures at the fixture, equipment, or outlet as required by code. The A/E shall schedule and specify pressure regulating valves or valve stations where pressures at maximum working pressure (High HGL, plus booster pump shut-off pressure for boosted systems) may exceed code maximum, or manufacturer/warranty maximum operating pressures (generally lower than code maximums. Pilot operated pressure reducing valves (or valve stations) with expansion by-pass (for domestic hot water) shall be utilized to regulate supply water pressures within distribution zones. Individual outlets may utilize pressure reducing valves compliant with code requirements and as recommended by the outlet use manufacturer. Pressure reducing valves shall be specified to operate at peak flow within the entire range of Low HGL and maximum working pressure of the system (High HGL, plus pump shut-off head for pressure boosted systems).

A packaged and third party tested triplex (three pump) booster pumping system or duplex (two pump) with 120-170 gallon hydropneumatic storage pressure tank, shall be utilized 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 shall 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 shall not be pumped. The entire water service shall 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, shall be utilized for determining 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 shut-off head for boosted systems (system maximum working pressure), adjusted for static pressure head losses/gains, shall be utilized for determining maximum system working pressures.

Domestic Hot Water Service. Domestic potable hot water shall be generated by water heaters utilizing natural gas, electricity, or steam as the energy source. Selection shall be supported by an economic evaluation incorporating first cost, operating costs and life cycle costs in conjunction with the HVAC energy provisions.

Cold (or preheated) water supply to water heaters shall include service valve, check valve, expansion tank (sized for expansion of storage capacity only), 27" heat trap, mixing valve by-pass primer, and hot water return connection as a minimum. 27" trap height minimum shall 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 shall obtain, from the water utility purveyor, seasonal cold water service temperatures supplied by the water utility purveyor (past three year minimum preferred). Low temperature (lowest of past three years) seasonal cold water service temperatures shall be utilized in calculation and application of water heating, water heating energy source (steam, heating hot water, gas), and for make-up to the water heating energy source. Preheating of domestic cold water supply to the domestic water heater and cold water make-up to water heating energy source shall be considered utilizing steam condensate or heating hot water return.

Instantaneous water heaters are not permitted as a primary source. For incidental use, sporadic equipment demands, or remote individual fixtures (i.e. 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 shall 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 state code. Hand washing, lavatory, sink and similar fixtures accessible to the disabled, elderly, or children shall 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) shall be tempered to deliver "tempered water" 29°C (85°F) - 49°C (120°F) water temperatures at the fixture or group of battery fixtures. Individual fixture or battery thermostatic mixing valves shall be provided where distributed, or zone, outlet temperatures may exceed 51°C (124°F). Hot water supply to dishwashers shall be at 60°C (140°F), and the

temperature shall be boosted from 60°C (140°F) to 82°C (180°F) for final sanitizing rinse. Heat pump hot water heaters shall be used where possible to save energy.

Emergency fixtures: eyewash (0.4 gpm per fountain), face wash (3 gpm each), or shower (20 gpm each) shall be tempered immediately at the fixture or group of fixtures (within 25 feet) to deliver “tepid water” 29°C (85°F) - <37.8°C (100°F), at 0.207 megapascal (30 psi), within 10 seconds, for a minimum period of 15 minutes, and shall account for temperature drop across the valve (generally 7°C or 20°F) at flow.

There shall be no dead legs or capped spurs within the potable domestic water plumbing system, without return circulation. Rubber fittings and device components shall not be 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 Center 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”) and ANSI Standard Z358.1 (1999) “Emergency Eyewash and Shower Equipment.” Distribution system shall consist of a piping system that connects water heater(s) to all fixtures, equipment, and outlet demands requiring potable domestic hot water. Circulation return systems with circuit setters/balancing valves, or temperature maintenance systems shall be provided for all branches in excess of 25 feet from the water heater or circulated distribution main. Domestic hot water shall 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 result of pressure zoning or static head cannot successfully be joined to a single pressure zone water heater. Locate individual pressure zone water heater(s) within the pressure zone(s), where return pressures would vary substantially causing dead head on the lower pressure return circuits. Hot water return systems shall have circuit setters (balancing valves) and test plugs at each return circuit, and systems shall be balanced.

Domestic Water Supply Equipment. Domestic water supply equipment and components shall 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 shall be compliant with ASME, stamped and rated.

Water hammer arrestors shall be provided at each elevation change of every horizontal branch to fixture batteries, at all quick-closing automatic valves (mechanical make-up, 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 shall be compliant with the Plumbing and Drainage Institute (PDI) Standard PDI-WH201, ANSI/ASME A112.26.1M, or as required by code, and as recommended/required by fixture and equipment manufacturer, or warranty.

Domestic cold and hot water distribution systems shall be insulated per *ASHRAE Standard 90.1* with vapor barrier for concealed and above ceiling piping, canvas jacketing and vapor barrier where exposed in mechanical areas, and vapor barrier with PVC jacketing where exposed in other than mechanical areas.

Sanitary (Soil and Waste), and Vent System

Sanitary Pipe and Fittings. A complete sanitary building drainage system shall 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 shall be designed in compliance with applicable codes and standards. Piping shall be service weight cast iron soil pipe with hub and spigot fittings and joints with elastomeric gasket (by pipe manufacturer). Above ground piping shall 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 shall be service weight cast iron soil pipe with hub and spigot fittings and joints with elastomeric gasket (by pipe manufacturer). Above ground piping shall 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 shall be provided in multi-toilet fixture restrooms, kitchen areas, mechanical equipment rooms, and locations where interior floor drainage accumulates wastes. Single fixture toilet rooms do not require floor drains.

In general, floor drains shall 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 shall have 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 shall be rated for expected wheel loading, and shall include drain adapters, extensions, receivers, deck clamps, and similar as required by building construction. Drain strainer free area shall be equal to or greater than the free area of the calculated outlet pipe size area. Drain strainers in pedestrian areas shall be heel-proof type. Every drain and system opening shall have 1/4" maximum strainer openings for rodent-proofing. Discharges shall be elastomeric pinch valves or similar for rodent-proofing. Receptor drains outlets shall be two-times the area of combined inlet pipe areas. Equipment room areas shall require large diameter cast iron strainers, and parking garages shall require large diameter tractor grates rated for expected wheel loading. Drainage for ramps shall require either trench drains or roadway inlets when exposed to rainfall. Trap primers shall 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, shall discharge to a grease interceptor prior to connecting into the sanitary sewer. Grease interceptors

shall be sized compliant with requirements of the local authority. Where permitted by the local authority, grease interceptors shall be compliant with the Plumbing and Drainage Institute (PDI) PDI-G101. Drains, fixtures, and equipment required to discharge to the grease interceptor shall be as required by the state health department and local authorities. Generally food grinders, vegetable sinks, fish scaling sinks (provide separator), meat cutting sinks, and clear water wastes are prohibited by the local authority from extending to the grease interceptor, and shall not be employed except where otherwise required by the local authority.

Sand/Oil Separator. Floor drains and/or trench drains in vehicle repair garages shall discharge to a sand/oil separator prior to discharge to the sanitary sewer.

Automatic Sewage Ejectors. Sewage ejectors shall only be used where gravity drainage is not possible. Only sanitary drainage from the lowest floors of the building shall be connected to the sewage ejector; fixtures on upper floors shall use gravity flow to the public sewer. Sewage ejectors shall be non-clog, screen-less, alternating duplex pumps, capable of passing a 2-inch solid, with each discharge not less than 102 mm (4 in) in diameter. They shall be connected to the emergency power system.

Sanitary Drainage. Clearwater drainage: storm rain water, cooling coil condensate drainage, and similar clearwater drainage shall not discharge to the sanitary drainage system.

Chemically treated mechanical discharge from cooling towers, boilers, chillers, and other mechanical equipment shall discharge to the sanitary drainage system for treatment and protection of the environment and waterways. Purified steam (i.e. humidification) shall not discharge to the sanitary drainage system

Rainwater Drainage System

Rainwater Drainage (Storm) Pipe and Fittings. A complete rainwater (storm) building drainage system shall be provided for all rainwater (storm) drainage for roofs, plazas, balconies, decks, area wells, parking structures, parking garages, and similar. Clearwater drainage (cooling coil condensate drainage, evaporation pan drainage, ice makers) and similar clear, non-chemically treated drainage shall discharge to the rainwater (storm) drainage system, and not the sanitary drainage system. Clearwater drainage without chemical, vegetable, human, animal, protein, fecal, oil, grease or similar pollutants may be discharge to the rainwater (storm) drainage system where approved by code, state, local authority, and Environmental Protection Agency.

The rainwater (storm) and vent system shall be designed in compliance with applicable codes and standards. P-traps and house-traps shall only be provided on storm systems where required by code, state, or local authority.

Piping shall be service weight cast iron soil pipe with hub and spigot fittings and joints with elastomeric gasket (by pipe manufacturer). Above ground piping shall 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).

Rainwater (Storm) Vent Piping and Fittings. Storm vent piping, where required for P-traps, sumps, interceptors, and separators, shall be service weight cast iron soil pipe with hub and spigot fittings and joints with elastomeric gasket (by pipe manufacturer). Above ground piping shall 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 non pedestrian/vehicle areas shall have high dome strainers. Receptors, hub drains, trench drains, and similar drains shall have 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 shall be rated for expected wheel loading, and shall include drain adapters, extensions, receivers, deck clamps, gravel stops and similar as required by building construction. Drain strainer free area shall be equal to or greater than the free area of the calculated outlet pipe size area. Drain strainers in pedestrian areas shall be heel-proof type. Every drain and system opening shall have 1/4" maximum strainer openings for rodent-proofing. Discharges shall be elastomeric pinch valves or similar for rodent-proofing. In general, drains shall 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 shall require large diameter strainers. Drainage for ramps shall require either trench drains or roadway inlets when exposed to rainfall. Trap primers shall be provided for P-traps (where P-traps are required by code, state, or local authority).

Rainwater (Storm) Equipment

Sand/Oil Separator. Drains in parking structures and garage shall discharge to a sand/oil separator prior to discharge to the storm sewer when required by code, state, or local authority.

Automatic Sump Pumps. Sump pumps shall only be used where gravity drainage is not possible. Only rainwater, storm, and clear water drainage from the lowest floors of the building shall be connected to the sump pump; drainage from upper floors shall use gravity flow to the public sewer. Sump pumps shall be alternating duplex pumps. Sump pumps shall be connected to the emergency power system.

Foundation and sub-soil drainage system shall be provided with emergency power source, backwater prevention, perforated drain tile piping in washed gravel bed with filter fabric shall extend to duplex sump pumping system as required by the applicable codes.

The requirements of the foundation and sub-soil drainage system shall 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) shall 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 shall be identified on the plumbing drawings.

Sanitary Drainage. Clearwater drainage: storm rain water, cooling coil condensate drainage, foundation, sub-soil, groundwater, and similar clear water drainage shall not discharge to the sanitary drainage system.

Chemically treated mechanical discharge from cooling towers, boilers, chillers, and blow down shall discharge to the sanitary drainage system for treatment and protection of the environment and waterways. Purified steam (i.e. humidification) shall not discharge to the sanitary drainage system

Secondary (Overflow) Roof Drainage. Secondary (overflow) roof drainage shall be accomplished by sidewall scuppers, scupper drains, or a secondary (overflow) roof drainage system. Secondary (overflow) roof drains shall be the same as roof drains except with integral standpipe or damming weir extension 3-inches above the waterproofing membrane and located within 5-feet of (adjacent to) the primary roof drain, and extended to discharge above grade. Termination above grade shall include a concealed elastomeric pinch valve or similar for rodent proofing, near the discharge, and finished discharge in high finish areas. Discharge shall be in a non-occupied, non-pedestrian 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 shall discharge to a sand/oil interceptor prior to discharge to the storm sewer.

Plumbing Fixtures

General. Provide all code, user, occupancy, safety, and emergency required plumbing fixtures, including those indicated in the U.S. Courts Design Guide. Plumbing fixtures shall be manufactured by companies that are approved by the General Services Administration or their representatives and compliant with code and state requirements. All plumbing fixtures shall have motion/user sensing devices (with manual by-pass) for fixture operation and shall be water conserving/saving type fixtures, faucets, and valves.

Plumbing fixture accessibility clearances, installation, and accessories shall be compliant with the Americans with Disabilities Act; Americans with Disabilities Act

Accessibility Guidelines (latest edition); and the Uniform Federal Accessibility Standard (latest edition).

Plumbing fixture and accessory support shall be compliant with code, state requirements, ADA/ADAAG, UFAS, and manufacturers requirements.

Natural Gas Systems

Service Entrance. Natural gas service utility piping entering the building shall be protected from accidental damage by vehicles, foundation settlement or vibration. Wall penetrations shall 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 shall be within a schedule 80 black steel, corrosion protected, sealed and vented, gas pipe sleeve that extends from 10-feet upstream of the building wall penetration exterior (or excavation shoring limits if greater) to 12-inches (minimum) downstream of the building wall penetration. Gas piping shall 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 shall 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, shall be mechanically ventilated and include CO₂ monitoring and alarms. Vertical shafts carrying gas piping shall be ventilated. Gas meters shall be located in a ventilated gas meter room, thus avoiding leakage concerns and providing direct access to the local gas utility. All gas piping inside ceiling spaces shall have plenum rated fittings. Diaphragms and regulators in gas piping must be vented to the outdoors. There shall be no gas valves (concealed or accessible) permitted above ceilings.

Fuel Oil Systems

Fuel Oil Piping. Fuel oil piping systems shall be double-wall containment pipe (pipe-in-pipe) when indoors, outdoors, or buried, and shall be Schedule 40 black steel or black iron piping. Fittings shall be of the same metal grade as the pipe material. Valves shall be bronze, steel, or iron and shall be screwed, welded, flanged or grooved. Duplex fuel-oil pumps with basket strainers and exterior enclosures shall be used for pumping fuel oil to fuel burning equipment.

Underground Fuel Oil Storage Tanks (UST).

Underground fuel oil storage tanks (UST) shall be of double-wall non-metallic construction, or contained in lined vaults to prevent environmental contamination. Tanks shall be sized for actual storage volume for 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 shall be provided in interstitial space of underground tanks, above ground day-tanks, and piping. The installation must comply with local, State and Federal requirements, as well as EPA 40, *CFR 280* and *281*.

5.19 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 that are 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 shall make building systems become more flexible, not less. Parameters of reuse and disruption of service must be clearly specified in construction documents.

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 up-grade/restoration of historic structures.

In the first instance, refurbishment of an area within a building, the aim shall 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 shall 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 shall be provided by GSA to help guide the design of the alterations. The most important of these is the HBPP that identifies zones of architectural importance, specific character-defining elements that shall be preserved, and standards to be employed. See Chapter 1: *General Requirements, General Design Philosophy, Historic Buildings*.

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 guidelines shall 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 must be installed, insure 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 shall be retained, to the extent possible, and modified only as necessary to accommodate horizontal distribution. Use soffits and false beams where necessary to minimize alteration of overall ceiling heights.
- In buildings containing ornamental or inaccessible ceilings, piping and ductwork shall have to be routed in furred wall space or exposed in the occupiable building area. Exposed ducts must be designed to complement the building architecture in forms and materials used. Use of exposed ducts is encouraged in locations where concealing ducts would obscure significant architectural surfaces or details, such as vaulted ceilings. Exposed ducts shall also be considered in historic industrial buildings and open plan, tall ceiling, high window spaces suited to flexible grid/flexible density treatments.
- If new vertical air distribution risers are required, they shall preferably be located adjacent to existing shafts.
- Reduce heating and cooling loads to minimize size and other impacts of modern equipment.
- Calculate the effect of historic building features such as wall thickness, skylights, and porticos, interior design features such as draperies, shutters and window shades, and existing site features such as landscaping.
- Select system types, components, and placement to minimize 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 only permitted 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 shall be retained in place.
- Retain the original type of system where a new one cannot be totally concealed. For example, reuse existing radiators with new distribution piping or replace with modern heating-cooling units, rather than adding another type of system that would require the addition of new ceilings or other non-original elements.
- To the greatest extent possible, insure that space is available to maintain and replace equipment without damaging significant features, selecting components that can be installed without dismantling window or door openings.
- Use custom rather than standard commercial products where elements are exposed in formal areas.
- Select temperature and humidity conditions that do not accelerate deterioration of building materials.
- Where equipment is near significant features, insure that leakage from pipes and HVAC units does not cause deterioration. Use deeper condensate drain pans, lined chases and leak detectors.

Electrical Engineering

6

Robert F. Kennedy Department of Justice Building Restoration

Washington, DC

Architects/Conservators: Heery/Tishman, A Joint Venture;
Burt Hill Kosar Rittleman; Page Conservation, Inc.

GSA Project Managers: Dean E. Smith & Jean S. Hundley

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6.1 General Requirements

This chapter identifies criteria to program and design electrical and communications systems in GSA buildings. The purpose of Chapter 6 is to establish minimum standards, acceptable to the GSA, to be used as the basis of design of electrical and communications systems for the various GSA regions throughout the USA.

Electrical and communications systems shall provide the infrastructure for an efficient work environment for the occupants. These systems must support the many types of equipment used in a modern office setting in a reliable fashion.

There are three characteristics that distinguish GSA buildings: long life span, changing occupancy needs, and the use of a life cycle cost approach to account for total project cost.

During the life span of a typical Federal building, many minor and major alterations are necessary as the missions of Government agencies change. The flexibility to adjust to alterations easily must be designed into the building systems from the outset. Electrical and communications systems shall 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.

It is GSA's goal to build facilities equipped with the latest advances in office technology and communication. This intent shall be extended to include the future evolution of automated office and telecommunications equipment as well. Making this concept a reality requires a

comprehensive design for engineering systems that goes beyond the requirements of the immediate building program. It also requires a higher level of integration between architecture and engineering systems than one would usually expect in an office building.

The Government recognizes that communications needs and technology are growing at an increasingly rapid pace. Work stations are becoming more powerful, requiring faster and easier access to more information. GSA must install the wiring and interfaces to support these requirements. It shall be noted that the design of all communications cabling systems is the responsibility of GSA's Federal Technology Service (FTS).

A computer-based Building Automation System (BAS) that monitors and automatically controls lighting, heating, ventilating and air conditioning is critical to the efficient operation of the modern Federal office building. GSA encourages integration of building automation systems with the exception of fire alarm and security systems, which shall function as stand-alone systems with a monitoring only interface to the BAS.

The design of the electrical systems and other building components shall all combine together to produce a building that meets the project's programmed sustainability rating (LEED rating) and assigned energy target, as referenced in Chapter 1.

Security is an important consideration in electrical engineering systems design. Refer to Chapter 8: *Security Design* for detailed criteria related to this matter.

Consult Chapter 4.1: *Installation Standards of the Fine Arts Program Desk Guide* for additional information.

Submission Requirements are addressed in Appendix A.3.

6.2 Codes and Standards

As stated in Chapter 1, *General Requirements, National Codes and Standards, Building Codes*, facilities shall comply with the ICC's International Building Code, International Fire Code, International Plumbing Code, International Mechanical Code, and International Energy Conservation Code, as well as the Life Safety Code (NFPA 101) and the National Electrical Code (NFPA 70).

The latest editions of publications and standards listed here are intended as guidelines for design. The list is not meant to restrict the use of additional guides or standards.

Electrical Design Standards

The electrical system shall be designed by a professional electrical engineer.

- ANSI: American National Standards Institute
- ASTM: American Society for Testing and Materials
- ASHRAE: Standard 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- CBM: Certified Ballast Manufacturers
- ETL: Electrical Testing Laboratories
- FAA: Federal Aviation Agency
- IESNA: Illuminating Engineering Society of North America
- IEEE: Institute of Electrical and Electronics Engineers
- ICEA: Insulated Cable Engineers Association
- NEMA: National Electrical Manufacturers Association
- NFPA: National Fire Protection Association
- UL: Underwriters' Laboratories

Communication System Pathways and Spaces Design Standards

The communication system pathways and spaces shall be designed by a Registered Communications Distribution Designer (RCDD). The following standards define the minimum allowable requirements.

Electronic Industries Alliance/Telecommunications Industry Association (EIA/TIA) Standards:

- EIA/TIA Standard 568: *Commercial Building Telecommunications 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: *Telecommunication Standards for Customer Owned OSP* (outside plant)

6.3 Design Criteria

Whole Building Energy Performance

A whole building energy analysis shall be performed to demonstrate that the building design meets or exceeds the energy performance goals established for the project. The requirements for this analysis are described in Chapter 5.

Load Studies

In establishing 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. The minimum connected receptacle loads indicated in Table 6-1 combined with other building loads multiplied by appropriate demand factors, and with spare capacity added, shall be used for obtaining the overall electrical load of the building. If the load requirements stated in the program are higher, the program requirements must be satisfied.

Load Groups:

- Lighting
- Receptacle Loads
- Motor and Equipment Loads
- Elevator Loads
- Miscellaneous Loads

Lighting Loads. A summary of the lighting load assumptions are in Table 6-1. These are assumptions for the design of the electrical system that supports the lighting and are not maximum design values for the lighting system. Refer to Section 6.10 for further information on the lighting design conditions and constraints.

Receptacle Loads. A summary of the receptacle load assumptions are in Table 6-2.

Motor and Equipment Loads. Loads associated with motors and equipment must use the rated brake horsepower of specified equipment.

Elevator Loads. Elevator loads must use the rated brake horsepower of the specified equipment. Demand factors identified in *National Electrical Code* Table 620-14 shall be included.

Miscellaneous Loads. These loads include:

- Security, Communication, and Alarm systems
- Heat Tracing
- Kitchen Equipment
- Central Computer Servers and Data Centers

Table 6-1

Lighting Load for Equipment Sizing

Area/Activity	Design Lighting Demand	
	VA/m ²	VA/sq. ft.
Office/Enclosed*	16.1	1.5
Office Open**	14.0	1.3
Conference Meeting/Multipurpose	16.1	1.5
Classroom/Lecture/Trainings	17.2	1.6
Lobby	19.4	1.8
Atrium—first three floors	14.0	1.3
Atrium—each additional floor	2.2	0.2
Lounge/Recreation	15.1	1.4
Dining Area	15.1	1.4
Food Preparation	23.7	2.2
Restrooms	10.8	1.0
Corridor/Transition	7.5	0.7
Stairs	9.7	0.9
Active Storage	11.8	1.1
Inactive Storage	3.2	0.3
Electrical/Mechanical/Technology/Server Rooms	14.0	1.3
* This number is based on a 125 sq.ft. office module. **Load is based on an 80 sq.ft. furniture module.		

Table 6-2

Minimum Receptacle Load for Equipment Sizing

Area/Activity	Minimum Design Load: Service Equipment		Minimum Design Load: Distribution Equipment	
	VA/m²	VA/sq. ft.	VA/m²	VA/sq. ft.
General Purpose systems				
Office/Enclosed*	14	1.3	27	2.5
Office Open**	14	1.3	35	3.25
Non-Workstation areas (such as public and storage)	5	.5	10	1
Core and Public areas	2.5	0.25	5	0.5
Electronic systems				
Office/Enclosed*	13	1.2	32	3.0
Office Open**	13	1.2	43	4.0
Technology/Server Rooms	540	50	700	65
* This number is based on a 125 sq. ft. office module. **Load is based on an 80 sq. ft. furniture module.				

Standards for Sizing Equipment and Systems

To ensure maximum flexibility for future systems changes, the electrical system must be sized for the demand load with additional spare capacity as follows:

- Panelboards for branch circuits: 50% spare ampacity as well as 25% spare circuit capacity.
- Panelboards serving lighting only: 25% spare ampacity as well as 25% spare circuit capacity.
- Switchboards and distribution panels: 35% spare ampacity and 25% spare circuit capacity.
- Main switchgear: 25% spare ampacity and 25% spare circuit capacity.

Spare overcurrent devices shall be provided as well as bus extension for installation of future protective devices.

Prior to 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 shall apply realistic demand factors by taking into account various energy conserving devices such as variable frequency drives applied to brake horsepower, energy efficient motors, occupancy sensors, etc. The designer shall also avoid adding the load of stand-by motors and shall be careful to distinguish between summer and winter loads by identifying such “non-coincidental” loads. A “diversity factor” shall 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 then the factor for load growth shall 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 shall be closely coordinated with the architectural design. This includes placement and specification of lightning protection system, colors and finishes of lights, outlets, switches, and device plates.

Equipment Grounding Conductor. Except for isolated ground systems, all low voltage power distribution systems shall be supplemented with a separate, insulated equipment grounding conductor.

Lightning Protection. Lightning protection shall be provided in accordance with NFPA 780. The system shall be carefully designed to ensure that static discharges are provided with an adequate path to ground. Surge arrestors on the main electrical service shall also be considered.

Artwork. Museum standards for lighting works of art range from 5 to 10 foot-candles for extremely light sensitive materials such as paper and textiles, to 20 to 40 foot-candles for moderately sensitive materials such as oil paintings and wood.

Please consult Chapter 4.1, *Installation Standards*, of the *Fine Arts Program Desk Guide* for additional information.

6.4 Utility Coordination

Power Company Coordination. See Chapter 2: *Site Planning and Landscape Design, Site Utilities, Utilities Services.*

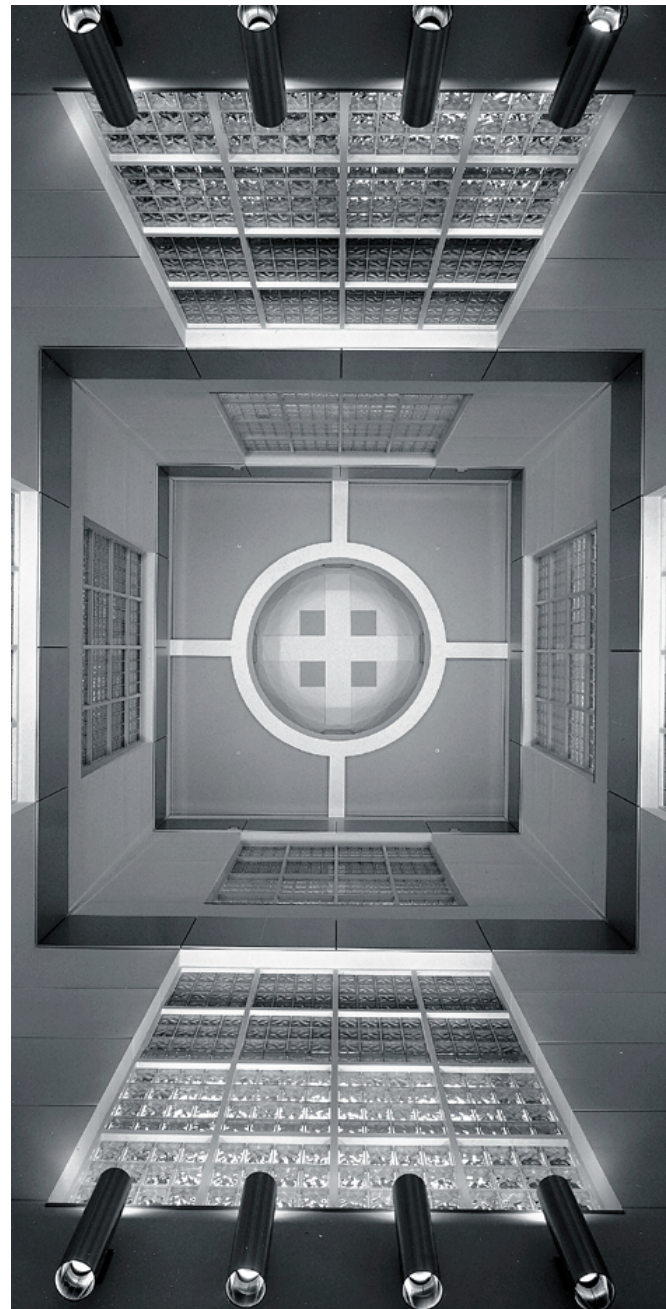
A detailed load study, including connected loads and anticipated maximum demand loads, as well as the estimated size of the largest motor, shall be included in the initial contact with the local utility in order to prepare them for discussions relative to the required capacity of the new electrical service.

The service entrance location for commercial electrical power shall be determined concurrently with the development of conceptual design space planning documents, and standards for equipment furnished by utility companies and shall 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 consider both equipment ventilation and equipment removal.

Site Considerations. The routing of site utilities and location of manholes must be determined early in the design process. The designer shall determine the utility's capability, rate structure options and associated initial costs to the project and shall evaluate the available utility service options.

For small buildings, less than 100,000sf utility power shall be requested at the main utilization voltage, i.e., 480/277V or 208/120V.

For medium size buildings up to 250,000sf, or buildings with large footprints, more than one electrical secondary service shall be considered.



U.S. Courthouse, Kansas City, KS



Oakland Federal Building, Oakland, CA.

For large buildings, greater than 250,000sf or buildings with large footprints and campus situations, more than one electrical service shall be considered, as well as medium voltage distribution, up to 15KV, for primary power distribution to substations.

The routing of site utilities and location of manholes shall be determined early in the design process in coordination with the Site Civil Engineer.

Cable Selection. Cable selection shall be based on all aspects of cable operation and the installation environment, including corrosion, ambient heat, rodent attack, pulling tensions, and potential mechanical abuse and seismic activity.

Direct Buried Conduit. Direct buried PVC, coated intermediate metallic conduit (IMC) or rigid galvanized steel (RGS) shall be used only for the distribution of exterior branch circuits 38 mm (1 1/2") or smaller. Direct buried cable shall not be used.

Concrete-Encased Ductbank. Concrete-encased PVC Schedule 40 ductbanks shall be used where many circuits follow the same route, for runs under permanent hard pavements and where service reliability is paramount, such as service entrances and medium voltage cables.

Concrete encased ducts shall be provided with a cover of at least 600 mm (24 inches). Ductbanks under railroads shall be reinforced. Ducts shall slope toward manholes. Changes in direction shall be by sweeps with a radius of 7.5 m (25 feet) or more. Stub-ups into electrical equipment may be installed with manufactured elbows. Duct line routes shall be selected to avoid foundations of other buildings and other structures. Electrical and communication ducts shall be kept clear of all other underground utilities, especially high temperature water or steam.

Where it is necessary to run communication cables parallel to power cables, two separate systems must be provided with separate manhole compartments. The same holds true for normal and emergency power cables. Ductbanks shall be spaced at least 300 mm (1 foot) apart. Site entrance facilities including ductbanks and manholes must comply with 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) systems alternate, diverse paths and separation shall be maintained.

Duct Sizes. Ducts shall be sized as required for the number and size of cables. All ducts for medium voltage services shall be a minimum of 100 mm (4 inch). Inner ducts must be provided inside communication ducts wherever fiber optic cables will be used. A sufficient number of spare ducts shall be included for planned future expansion; in addition, a minimum of 25 percent spare ducts must be provided for unknown future expansion.

Manholes. Manholes shall be spaced no farther than 150 m (500 feet) apart for straight runs. The distance between the service entrance and the first manhole shall not exceed 30 m (100 feet). Double manholes shall be used where electric power and communication lines follow the same route. Separate manholes shall be provided for low and medium voltage systems. Manholes shall have clear interior dimensions of no less than 1800 mm (6 feet) in depth, 1800 mm (6 feet) in length, and 1800 mm (6 feet) in width with an access opening at the top of not less than 750 mm (30 inches) in diameter. Medium voltage manholes shall be sized in accordance with Utility Company requirements. Manholes must have a minimum

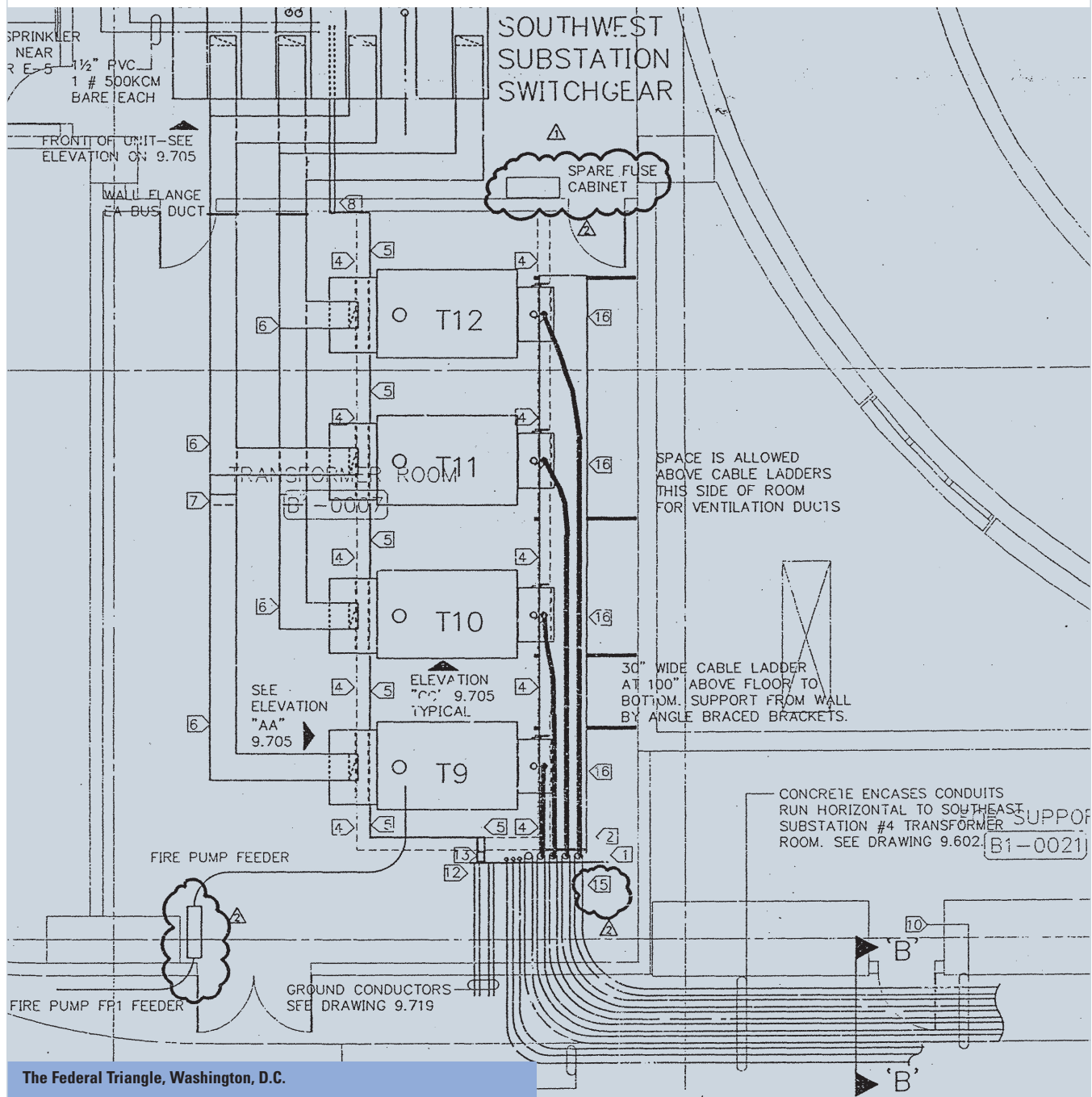
wall space of 1800 mm (6 feet) on all sides where splices are to be racked. Manholes shall be provided with pulling eyes, sumps and grounding provisions as necessary.

Stubs. Minimum of two spare stubs shall 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 Federal Technology Service.

Handholes may be used for low voltage feeders (600V and below), branch circuits or communications circuits. They must be not less than 1200 mm (4 feet) in depth, 1200 mm (4 feet) in length, and 1200 mm (4 feet) in width with a standard manhole cover and sump of the same type provided for manholes. Generally, at least four racks shall be installed. Where more than two splices occur (600V feeders only), a 1800 mm (6 feet) by 1800 mm (6 feet) by 1800 mm (6 feet) manhole shall be required.

Communications Service Coordination. The Telecommunications Design professional shall contact the local telephone company and coordinate with the client agency to determine the size and location of the incoming service and to determine the enclosure and pathway requirements for telecom systems. The Scope of Services varies with each project; it includes as a minimum the design of the infrastructure (pathway and enclosure) and may include full design and specification of the telecommunications system. The design professional shall contact the local telecommunications providers early in the project.

Provision shall also be made to provide cable television (CATV) service to the facility. Typically, CATV service is independent from other communications services.



6.5 Distribution System Alternatives

Where the design alternatives have been thoroughly evaluated, and a medium voltage (15kV) service is selected as the optimal utility service for the application, the design professional shall request that the utility company provide a minimum of three (3) 15 kV (nominal) feeders to serve the facility.

Primary Distribution

The following types of primary distribution systems are listed in terms of increasing flexibility, reliability and cost:

- Looped primary (not recommended)
- Radial primary
- Primary Selective
- Primary Selective-Secondary Selective
- Network

The selection of a primary distribution system shall be based upon 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 transformers.

Medium Voltage Switchgear. Design of the medium voltage switchgear shall meet all of the requirements of the local utility. Switchgear shall be provided with enclosed, draw-out type vacuum interrupter breakers. Provide one (1) per each size fully equipped spare cubicle/breakers up to 1600 Amps. Provide breaker lifting device. Provide Ground and Test device.

Note: Alternate type circuit breakers will be considered. Provide voltmeter, ammeter and watt-hour meter with

demand register on each feeder in addition to utility approved relaying. Meters shall be pulse-type for connection to the BAS.

Medium Voltage Conductors. Conductors shall be copper, insulated with cross linked polyethylene (XLP) or ethylene propylene rubber (EPR). Insulation shall be rated at 133 percent. Conductor size shall not exceed 240 mm² (500 Kcmil).

Network Transformers. Where continuity of service is critical and where even a momentary disruption of service due to the loss of a single incoming feeder cannot be tolerated, then network transformers shall be considered. Network transformers shall be liquid-filled, kVa rating as required, with copper primary and secondary windings. Transformers shall be equipped with provisions for fans and/or dual temperature ratings to increase the rated capacity and shall 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. In addition, transformers shall be provided with voltage taps $\pm 2.5\%$ with on-load tap changer.

Double-ended Substations. Where either a primary selective or primary selective – secondary selective (double-ended substation) is selected, the following paragraphs apply:

If reliability is critical and spot networks are not feasible, double-ended substations shall be used. Transformers shall 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 shall 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 shall be of the electrically operated draw-out type.

Network Substations. Generally speaking, network substations are close-coupled to the secondary switchboards serving the respective loads. All circuit breakers up to and including the secondary switchgear main circuit breaker and accessories shall be of the draw-out type.

Transformers. Substation transformers shall be dry-type with epoxy resin cast coils or liquid filled, 300 degree C insulation, non-petroleum based insulating oil type. Liquid filled transformers shall be used outdoors and for below grade vault construction. Substations shall be located at least 30 m (100 feet) from communications frame equipment to avoid radio frequency interference. 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 Switchgears (480 V service). In the case of double-ended substations all main and secondary feeder breakers are draw-out power type.

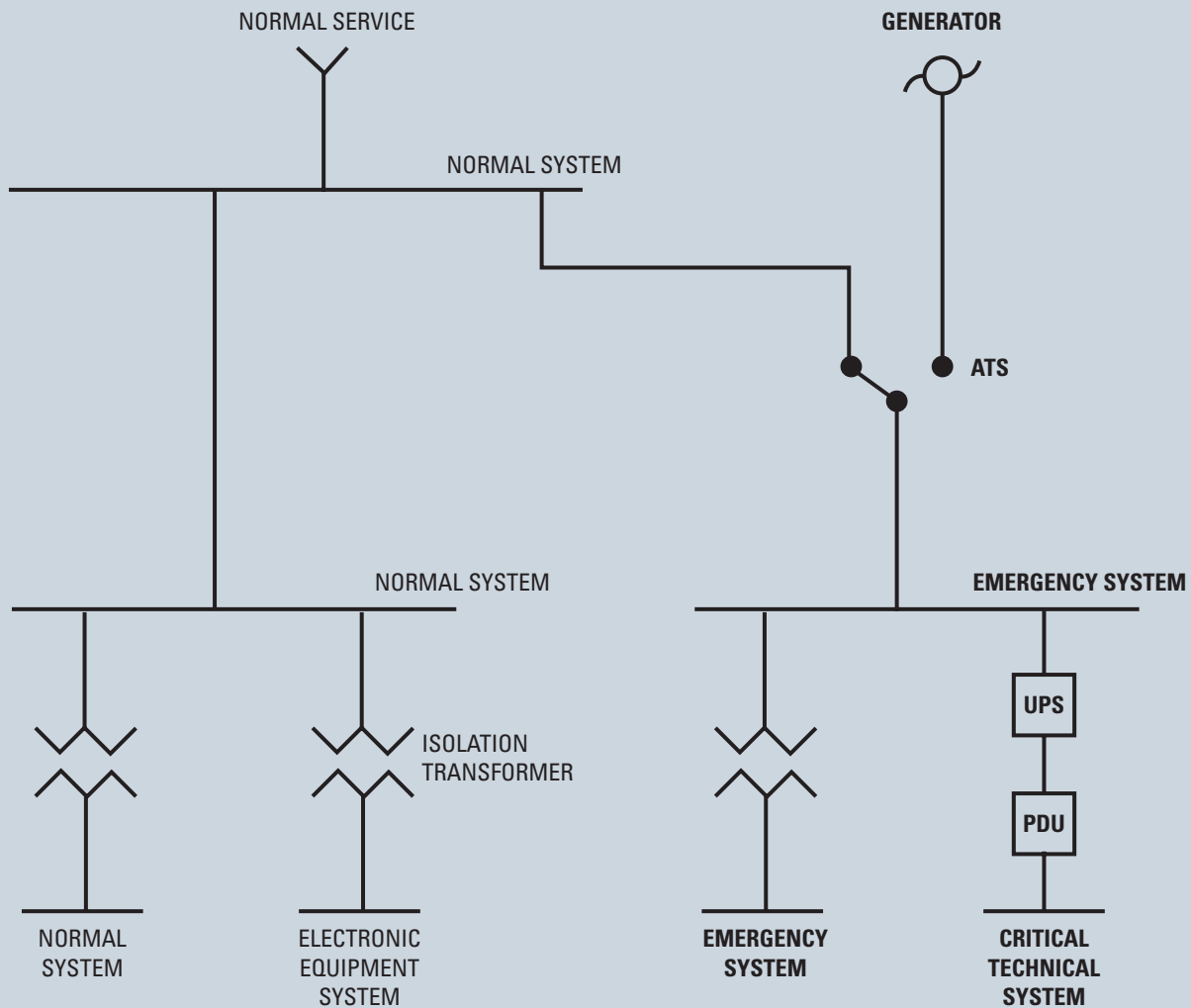
Each metering section shall contain a voltmeter, ammeter and watt-hour meter with demand register. Meters shall be pulse type for connection to the BAS. Switchgear shall be front and rear accessible. Aluminum bus will not be acceptable.

All breakers in the 480 volt rated service main switchgear shall be fully rated. Series rating will not be permitted for this equipment. Main and feeder breakers shall be provided with integral solid-state ground-fault protection tripping elements.

Main Switchgears (208 V service). 208 V service switchboards as well as substation secondary switchboards shall be freestanding and shall be provided with a single main service disconnect device. This main device shall be insulated case, power air circuit breaker or bolted-pressure fusible switch (where appropriate), shall have ground fault protection, and shall be individually mounted, draw-out type (as applicable). Insulated case and power air circuit breakers shall be electrically operated. Branch feeders shall be protected, either by fusible load-break switches or fully rated molded case circuit breakers. Front access only will be acceptable. Aluminum bus will not be acceptable.

Surge Suppression. Provide surge suppression on the main incoming service secondary switchboard.

Figure 6-1 Typical Power Distribution Scheme



6.6 Space Conditions

It is the joint responsibility of the architect and the electrical designer, 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 designer, during the concept phase, to provide detailed space requirements and suggested preferred locations of all critical space requirements for the power and communication systems for the facility. It then requires the cooperation of the architect 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 shall 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 telecom circuitry to exit the assigned spaces. In addition, electrical equipment shall be located at a level above the 100-year flood plain.

Note: The designers shall refer to Chapter 3: *Architectural and Interior Design, Building Planning, Placement of Core Elements and Distances*, 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

Main Equipment Rooms – Electrical and Telecommunications. The size of the Electrical Service Room will depend upon the type of service provided by the local utility. If a secondary (480V or 208V) service is provided, the size of the room shall be approximated by the number of service stubs into the room and the respective number and size of switchgears. In this case the room 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 shall be large enough (width and height) to allow for the removal and replacement of the largest piece of equipment. Both equipment and man doors shall swing out and be provided with panic hardware.

The size and location of the Telecommunications Service Room shall be established in concert with the local telephone service provider and shall be provided with 24-hour HVAC service and protected from contaminants by proper filtration equipment.

Electrical Rooms. Electrical rooms are generally located within the core areas of the facility and shall be stacked vertically. Adequate numbers of electrical rooms shall be provided such that no electrical room serves more than 930 m² (10,000 sq. ft.). Electrical rooms shall be provided with minimum clear dimensions of 1800 mm by 3000 mm (6 feet by 10 feet). If transformers are located in the rooms, ventilation must be provided. Doors shall swing out.

Communications Rooms. Communications rooms are also generally located within the core areas of the facility and shall be stacked vertically. Rooms shall be sized to contain adequate floor space for frames, racks and working clearances in accordance with (EIA/TIA) standards. Provisions shall be made for air conditioning these rooms.

Building Engineer's Office. Even if not included in the building program, office space for the building engineer shall be evaluated. Most GSA buildings require such a space, which houses the consoles for the Building Automation System and satellite 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 shall have a control center. In the event that the building will not be served by a local security force, this room could be combined with the building engineer's office or the fire control center.

The security control center shall be generally located within the most secure area of the building and shall be sized to house the command station for the security guards and their equipment for current as well as 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. In order to establish the proper size, location and environmental requirements for the system, the designer shall arrange to meet with the architect and a representative of the tenant agency to determine the required/estimated load and physical size requirements, and nature of the critical loads. Refer to the UPS and battery manufacturers' installation instruction for weights, dimensions, efficiency, and required clearances in the design.

- For small systems, up to 50kva, the UPS modules and sealed cabinet batteries shall be installed in the room with the equipment being served.

- For medium and large systems, greater than 50kva, the UPS system shall be provided with standby generator back-up to limit the battery capacity. The UPS system equipment and batteries shall be in separate rooms, located on the lowest level, because of the weight of the batteries and the noise of the UPS equipment.

Allow space for storage of safety equipment, such as goggles and gloves. Special attention shall 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. The Fire Command Center (FCC) shall be provided in all high rise Federal buildings. It shall be located so that it will be readily accessible to the local fire department in the event of an alarm. The FCC shall be sized to contain the following equipment:

- Fire, smoke and sprinkler alarm control panels
- Amplifier rack for voice alarms
- Graphic Annunciator
- Fire-fighters smoke control panel in accordance with [F] Section 909 Smoke Control Systems of the ICC including Pars. [F] 909.16, 909.16.1, 909.16.2 & 909.16.3
- Fire alarm system computer and printer
- Status of emergency generator annunciator
- Status of transfer switches annunciator
- Elevator Status Panel

The FCC shall be a minimum of 10 meters square (100 sq.ft.).

See Chapter 7: *Fire Protection & Life Safety* for additional requirements.

6.7 Secondary Branch Power Distribution

Feeder Assignments (Bus Ducts vs. Cable-In-Conduit).

The secondary main branch power distribution system is designed to convey 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 copper bus duct, will affect the following:

- Design of the main switchgears
- Coordination in the lower levels
- Design of the electric rooms
- Flexibility
- Reliability
- Cost

At the early stages of a project, alternate designs comparing the factors listed above would determine the scheme to be recommended. The size of the floor plate (i.e. gross area of the floor) and the height of the building are also important factors in the determination of the recommendation.

Bus Duct. Bus ducts shall be copper, fully rated, 3-phase, 3-wire or 3-phase, 4-wire with 100% neutral and an integral ground bus, sized at 50 percent of the phase bus. Provide calculations supporting the specified short circuit rating.

Conductors. The base bid specifications shall require that copper be utilized throughout, including motor windings, transformer windings, switchgear bussing, switchboard

and panelboard bussing, bus duct, and primary and secondary feeders, branch feeders, and branch circuits.

Note: The use of aluminum may be permitted via a deduct alternate listing the specific items of equipment and material in which the use of aluminum would be permitted. The alternate shall list and address the comparative increase in conductor and conduit sizes. The Contracting Officer shall decide whether or not the alternate is accepted.

Motor Control Centers. Grouped motor controls shall be used where eight (8) or more starters are required in an equipment room. Motor control center (MCC) construction shall be NEMA Class I, Type B, copper, with magnetic (or solid state if appropriate) starters and either molded case circuit breakers or fused switches. Minimum starter size in motor control centers shall be Size 1. Control circuit voltage shall be 120V connected ahead of each starter via fused control transformer. Reduced voltage starters may be used for larger motors to reduce starting KVA.

Time delay relays shall be incorporated in the starters or programmed in the BAS system to reduce inrush currents on the electrical system.

Where variable frequency drives are used on a project, it should be economically evaluated to specify VFDs incorporated into the MCCs. If determined not appropriate, then VFDs should be powered for distribution panels installed for that purpose.

Elevator Power. It is recommended that the load of the elevator feeders be divided among the secondary switchgears, provided that there are 2 or more switchgears, and that alternate elevator machines shall be fed from different switchgears.

Note: One (1) elevator in each bank shall be connected to the emergency generator. Where multiple elevators are in a common bank, provide a common emergency feeder from the Elevator ATS to allow each elevator to be operated individually during an emergency. By interlocking the ATS with the elevator group controller, programming shall be made by the elevator supplier to set up a controlled return to the terminal floor and then limit the number of elevators in that bank that can be run.

Elevator machines shall be powered from circuit breakers with a shunt trip and with padlocking capability, located in the elevator machine rooms. Electrical design standards in Elevator Standard ANSI/ASME A17.1 shall be followed.

Variable Frequency Drives (VFD). VFD's are now in general use on all projects by virtue of their contribution to the energy efficiency of the project. They also generate harmonics which are injected into the secondary power distribution system and need to be minimized through the use of filters tuned to the peak harmonic generated by the drive.

VFDs shall utilize a minimum 12-pulse, pulse width modulation (PWM), design because of their low harmonic output, excellent power factor and high efficiencies. VFDs shall be specified with passive harmonic filters. VFDs shall also be specified with isolation transformers where required.

Specify thermal sensors that interlock with the VFD control circuit for additional solid state motor protection for motors running at low speeds and subject to overheating. This is in addition to the standard over-current protection required.



Ronald Reagan Building, Washington, D.C.



6.8 Interior Lighting, Daylighting, and Control Systems

The lighting and daylighting systems of a building represent one of the most critical components to the architectural aesthetic, the successful completion of tasks, and the annual energy consumption of the building. In order to effectively address all these concerns, the lighting systems must be sensitive to the interior and architectural design while providing an adequate quality and quantity of illumination throughout the building. Yet, the lighting system must maintain an energy efficient design that, at minimum, meets ASHRAE/IES 90.1 lighting power density requirements. In addition, the lighting design shall attempt to minimize maintenance requirements.

General Lighting Design Criteria

The electric lighting design criteria are intended to ensure sufficient visual comfort and performance of the lighting environment provided by the electric lighting systems. Lighting designs must minimize harsh contrasts by employing a combination of direct and indirect lighting sources. This can be accomplished through the use of indirect/direct lighting systems, wall sconces or a combination of uplighting and downlighting. In addition, vertical surface illumination shall be considered, where applicable.

Task/ambient lighting strategies are designs that break down the lighting system by the lighting purpose. Lower levels of even, ambient illumination are provided throughout the space with local task lights providing greater illuminance at the task.

Specific lighting design issues associated with individual space types are discussed later in this chapter in the subsection titled *Specific Lighting Constraints*.

Qualifications of the Lighting Practitioner. Lighting design shall be performed or supervised by a practitioner credentialed as Lighting Certified (LC) by the National Council on Qualifications for the Lighting Professions (NCQLP). Visit www.ncqlp.org for more information.

Illumination Levels. Required illumination level ranges for typical interior spaces are indicated in Table 6-3. These ranges of illumination require the average illumination at the task (workplane) to be greater than the minimum value and less than the maximum value. For those areas not listed in the table, the IES Lighting Handbook may be used as a guide. The design illumination levels shall be confirmed by computer simulation for each of the typical space types throughout the building.

Visual Comfort. The lighting system must be designed to reduce glare, minimize contrast ratios, and provide proper color rendering as recommended in the latest issue of the Illuminating Engineering Society of North America (IES) *Lighting Handbook*.

Energy Efficient Design. At a minimum, lighting design must comply with the current version of ASHRAE/IES Standard 90.1 maximum lighting power densities. Table 6-3 lists the requirements for typical interior spaces; the Standard shall be consulted for other space types. Task lighting is included in the maximum LPDs provided by the Standard.

Accessibility for Servicing. Careful consideration must be taken in the design of lighting systems regarding servicing of the fixtures and replacement of lamps. This issue needs to be discussed with building operation staff to determine the dimensional limits of servicing equipment.

Table 6-3

Lighting Requirements by Space Type

Area/Activity	Required Illumination Levels		Maximum Lighting Power Density	
	Lux (lumens/m ²)	Footcandles (lumens/sq. ft.)	W/m ²	W/sq. ft.
Office – Enclosed ¹	450 – 600	41.8 – 55.8	16.1	1.5
Office – Open ¹	450 – 600	41.8 – 55.8	14.0	1.3
Conference Meeting/Multipurpose	275 – 425	25.6 – 39.5	16.1	1.5
Classroom/Lecture/Trainings	450 – 600	41.8 – 55.8	17.2	1.6
Lobby	175 – 275	16.3 – 25.6	19.4	1.8
Atrium – first three floors	175 – 275	16.3 – 25.6	14.0	1.3
Atrium – each additional floor	n/a	n/a	2.2	0.2
Lounge/Recreation	275 – 425	25.6 – 39.5	15.1	1.4
Dining Area	175 – 275	16.3 – 25.6	15.1	1.4
Food Preparation	450 – 600	41.8 – 55.8	23.7	2.2
Restrooms	175 – 275	16.3 – 25.6	10.8	1.0
Corridor/Transition	175 – 275	16.3 – 25.6	7.5	0.7
Stairs	175 – 275	16.3 – 25.6	9.7	0.9
Active Storage	175 – 275	16.3 – 25.6	11.8	1.1
Inactive Storage	100 – 175	9.3 – 16.3	3.2	0.3
Electrical/Mechanical/ Telecommunication Rooms	175 – 275	16.3 – 25.6	14.0	1.3
¹ Level assumes a combination of task and ceiling lighting where systems furniture is used. (This may include a combination of direct/indirect fixtures at the ceiling for ambient lighting.)				

Technology and Product Criteria

Any lighting that comprises at least 5% of the total building connected load must comply with the following luminaire, ballast and lamp requirements.

Incandescent lighting must be used only sparingly.

Luminaires. All luminaires must be appropriately selected based upon the expected application.

Luminaires shall be recessed, pendant, or surface mounted. Indirect/direct fixtures shall have a minimum 2% indirect component and 50% direct (maximum) component. Fixtures must have a minimum efficiency of 65%.

Where parabolic fixtures are used, louvers shall be semi-specular or diffuse finishes; specular finishes shall not be used.

All recessed downlights must use compact fluorescent or ceramic metal halide lamps as follows. No incandescent technology shall be used:

- Where a general broad distribution is required, downlights shall use CFLs with a minimum fixture efficiency of 50%. No black baffles are allowed.
- Where a narrow distribution or specific cutoff is required, downlights shall use ceramic metal halide PAR lamps with a minimum fixture efficiency of 50%.

Many fixtures have different lamp and ballast options. For ease of maintenance, all similar building luminaires shall use the same lamps and ballasts.

Lamps. Effort shall 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%. Lamp color temperature must be either 3500K or 4100K and be consistent throughout the building. Lamps must have a color rendering index (CRI) greater than or equal to 80. Minimum rated lamp life must be 20,000 hours.

All compact fluorescent lamps (CFL) must have minimum efficacies of 60 lumens/W, maximum lumen depreciation of 15%. Minimum rated lamp life must be 10,000 hours. Lamp color and CRI must be consistent with the linear fluorescent lamps. No CFLs below 13W shall be used; these lamps typically have lower efficacy, poor PF, and no electronic ballast options. In addition, lamps with integrated ballasts or screw bases shall not be used.

All ceramic metal halide lamps used in finished spaces shall have a CRI greater than 75.

In retrofit scenarios, all fluorescent lighting lamps and ballasts must be disposed of through specialized disposal firms that destroy the PCBs and recover the mercury that is contained in the lamps.

Ballasts. Ballasts for linear and compact fluorescent lamps shall be electronic with a minimum power factor (PF) of 0.95 and a maximum total harmonic distortion (THD) of 15%. When applicable, programmed start ballasts shall be specified for use in linear fixtures that are frequently switched on/off, such as with occupancy controls.

Ballasts shall have a sound rating of “A” for 430 MA lamps, “B” for 800 MA lamps and “C” for 1500 MA lamps. Electronic ballasts shall be used. Special consideration shall be given to the ballast types where an electronic clock system is also specified to confirm compatibility of application.

Daylighting

Daylighting typically refers to two separate concepts: the ability of regular occupants to see outside and the displacement of electric lighting due to the harvesting of daylight.

In order to maintain a relationship between the building occupants and the outdoors, direct views of the outside must be provided for at least 75% of the regularly occupied area on above grade levels.

If daylighting systems, beyond just windows, are to be included in the design for daylight harvesting, special daylighting consultants must be engaged to ensure adequate daylight illumination, avoid common glare issues, and assist in the integration of the lighting and mechanical systems with the architectural, interior, and daylighting designs.

Circuiting and Switching

Lighting circuits shall 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 smaller than 100 m² (1,100 sq. ft.) or one 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.

For general illumination, fixtures with more than 2 lamps shall be provided with two ballasts for A/B switching or dimming ballasts that allow the lighting output to be reduced to at least 50%. There maximum power penalty due to dimming shall be no greater than 20% of the full power input.

Where applicable, tandem wiring shall be implemented to reduce number of ballasts.

Lighting Controls

Manual, automatic, or programmable microprocessor lighting controls shall be provided for all lighting, with the exception of exit sign branch circuitry and life safety egress lighting defined by NFPA 101. The application of these controls and the controlled zones depend on a number of space factors such as: space type, frequency of use, available daylighting, and typical schedule.

Microprocessor controls range from simple line voltage automated switches to complex low-voltage lighting control panels. Lighting control systems typically include standard or astronomical time clocks, occupancy sensors, photosensors (light level), and override switches, but can include a myriad of options such as ID card readers and individual PC-based lighting controls.

Time Clocks. 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 shall incorporate lighting sweeps, warning flashes, or other methods to insure lighting is off in unoccupied spaces during scheduled unoccupied times.

Occupancy Controls. Occupancy sensors shall be provided for the following space and occupancy types:

- Offices smaller than 30 m² (325 sq. ft.) or with less than 4 people.
- All pantries and conference rooms.
- Restrooms with 3 or fewer toilets/urinals.
- All storage and file rooms smaller than 60 m² (650 sq. ft.).
- Any other regularly unoccupied spaces not mentioned.

Occupancy sensors shall be ultrasonic, or passive dual sensors based on the application. Each occupancy sensor shall have a manual override and shall control no more than one enclosed space, though some applications may



U.S. Census Bureau, Bowie, MD

require multiple occupancy sensors to adequately control a single space. Each occupancy sensor shall be marked by a label identifying the panel and circuit number.

No occupancy controls shall be used in mechanical or electrical rooms or other spaces where occupants could be in physical danger due to loss of light (see discussion in *Specific Lighting Constraints*).

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 shall 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 1,000 full load hours per year.

In addition, integrated photo/occupancy sensors shall be provided for the following space and occupancy types:

- Perimeter offices smaller than 10 m² (108 sq. ft.).

Photo control system shall reduce the electric lighting by simple on/off, stepped dimming, or full dimming controls. Control strategy can be either open-loop or closed loop, but needs to be programmed to minimize lamp cycling and occupant distraction.

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 space located timer switch, 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 allowed.

Safety Lighting Design Criteria

Security Lighting. Security lighting is lighting that remains on during unoccupied hours per applicable code. Security lighting in daylit spaces must be controlled by the photosensors. If security lighting is doubling for emergency lighting, then separate circuits and emergency ballasts are required.

Exit Signs. Exit signs shall be of the LED type, have an EnergyStar rating, and meet the requirements of NFPA 101.

Emergency Lighting. Emergency lighting shall be provided in accordance with the requirements of NFPA 101, and the applicable building code. At a minimum, unswitched emergency lighting shall be provided in the following areas:

- Lighting in zones covered by CCTV cameras
- Security zones
- Stairways
- Exit signs
- Egress corridors
- UPS and battery rooms

Emergency lighting may be switched in the following areas:

- Communication equipment rooms
- Electrical rooms
- Fire command centers
- Security control centers
- Technology/server rooms
- Building exits (switched by photocell)
- Engineer's office

Supplemental battery powered emergency lighting is recommended in the following spaces to bridge the generator startup time:

- Generator Rooms
- Main mechanical and electrical rooms

Specific Lighting Constraints

Mechanical and Electrical Spaces. Lighting in equipment rooms or rooms shall be provided by industrial-type fluorescent fixtures. Care shall be taken to locate light fixtures so that lighting is not obstructed by tall or suspended pieces of equipment. Physical protection such as wireguards or fixture location shall be provided for light fixtures to prevent lamp/fixture damage.

High Bay Lighting. Lighting in shop, supply, or warehouse areas with ceiling above 5.0 m (16.4 ft) must be metal halide pendant hung fixtures or T5HO reflectorized fixtures. Metal halide fixtures with prismatic lenses can only be used with a minimum mounting height of 7.5 m (25 ft). No high pressure sodium lamps are allowed.

Conference Rooms and Training Rooms. These spaces shall have a combination of lighting options to provide multiple scenes for space flexibility. Typical scenes would be table illumination for facial rendering at meetings, higher light at the front for speakers illumination, and lower light at front for media presentations.

Other Special Areas. Special lighting design concepts are encouraged in these spaces. The lighting design shall 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, 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

Criteria on courtrooms and judges' chambers can be found in Chapter 9, *Design Standards for U.S. Court Facilities*.



Atrium, Sandra Day O'Connor U.S. Courthouse, Phoenix, AZ

6.9 Exterior Lighting and Control Systems

Exterior Lighting Design Criteria

An exterior lighting system shall be provided to ensure the security and safety of the occupants and passersby, as well as to support the architectural aesthetic of the building. The properly designed exterior lighting system must provide the minimum required illumination while simultaneously preventing light pollution and light trespass, minimizing glare, and avoiding over lighting. Exterior luminaires must comply with all local zoning laws and lighting levels for exterior spaces must be as indicated by the IES *Lighting Handbook*.



U.S. Courthouse, Erie, Pennsylvania

Architectural Lighting. Architectural lighting is considered to be any lighting that illuminates the architectural building form, and is typically uplighting from the ground with minimum use of downlighting from the building to minimize light pollution. The following guidelines must be met.

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 shall use a higher rated lamp 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 shall 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 any exterior lighting that illuminates the area around the building, defines entrances and exits, or provides traffic flow. Site lighting must adhere to the following guidelines.

- Luminaires selected must have a minimum cutoff of 80°.
- Illumination shall be well controlled and no light can trespass off the building property.
- Implement bollards for pathway illumination.

Lighting fixtures at all entrances and exits shall be connected to the emergency lighting system. Where security lighting is required and HID restrike time is not acceptable, UPS backup, HID capacitive/ridethrough circuitry or instant-on lamp sources may be required.

Parking and Roadway Lighting. Parking lots and roadway lighting shall be designed with high-efficiency, pole-mounted luminaries with a maximum cutoff of 80°. Illumination ratios shall not exceed a 10 to 1 maximum to minimum ratio and a 4 to 1 average to minimum ratio.

Structured Parking. Fixtures for parking areas must be either fluorescent or HID. Care must be taken in locating fixtures to conform to the traffic patterns and maintain the required vehicle clearance.

Exterior Lighting Controls

Exterior lighting circuits shall be controlled by photocell and a time clock controller, with an astronomical dial, to include both all-night and part-night lighting circuits. A minimum of 75% of the architectural, site, and parking lighting shall be switched off three hours after the building is typically unoccupied or 11:00 pm, whichever is later.

6.10 Branch Wiring Distribution Systems

Lighting – Circuit Loading

- 120 volt circuits shall be limited to a maximum of 1400 volt-amperes.
- 277 volt circuits shall be limited to a maximum of 3200 volt-amperes.

Receptacles – Circuit Loading

- 120 volt circuits for convenience receptacles shall be limited to a maximum of 1440 volt-amperes (8 receptacles @ 180 watts).
- Each special purpose receptacle shall be circuited on a dedicated circuit to a protective device to match the rating of the receptacle.

In GSA buildings, general wiring devices shall be specification grade. Emergency receptacles shall be red. Isolated grounding receptacles shall be orange. Special purpose receptacles shall be brown. The color of standard receptacles and switches shall be coordinated with the architectural color scheme; for example, white, not ivory, devices shall be used if walls are white or light gray.

Building standard receptacle shall be duplex, specification grade NEMA 5-20R. Special purpose receptacles shall be provided as required. Device plates shall be plastic, colored to match the receptacles.

Placement of Receptacles

Corridors. Receptacles in corridors shall be located 15 m (50 feet) on center and 7.5 m (25 feet) from corridor ends.

Office Space. Receptacles for housekeeping shall be placed in exterior walls and walls around permanent cores or

corridors. Except for these, placement of receptacles in walls shall be avoided where raised floors are utilized to the maximum extent possible. See Chapter 3: *Architectural and Interior Design, Building Planning, Planning Module, Floor-to-Floor Heights and Vertical Building Zoning, and Space Planning, Office Space, Utility Placement.*

Raised Access Floor. All wiring beneath a raised access floor shall be routed in rigid metal or flexible conduit to underfloor distribution boxes. One distribution box per bay is recommended (see section *Placing Electrical Systems in Buildings, Horizontal Distribution of Power and Communications*). Flush-mounted access floor service boxes shall be attached to the underfloor distribution boxes by means of a modular, prewired system to facilitate easy relocation.

Conference Rooms. Conference rooms shall be served in the same fashion as general office space, except where specifically outfitted for audio-visual equipment.

Maintenance Shops. Maintenance shops require plug-mold strips above work benches with duplex outlets 900 mm (36 inches) on center. Receptacles shall be wired on alternating circuits. Receptacles or circuit breakers shall be of the GFI type. Provide EPO (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. The communications room will 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 convenience outlets at 1800mm (6 foot) intervals around the walls and direct connection to the main building grounding system. If

uninterruptible power is required in communications rooms, it will be furnished as part of the communications system.

Main Mechanical and Electrical Rooms. Main mechanical and electrical equipment rooms shall each have, at a minimum, one emergency power receptacle that is identified as Emergency Power at the receptacle.

Exterior Mechanical Equipment. Provide one receptacle adjacent to mechanical equipment exterior to the building, including each roof. Receptacles shall be of the weatherproof GFI type. Receptacles must be located within 25 ft. (7.62m) of each piece of equipment in accordance with NEC 210-63.

Toilet Rooms. Each toilet room shall 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 two (2) categories:

- A cellular metal deck framing the concrete floor slabs in a steel building, in which 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 (2 1/2”).
- A conventional 3-cell underfloor duct system placed in a 100 mm (4”) concrete fill over the concrete slab in an all concrete building. The cells are generally located on 1500mm (5’) to 1800 (6’) centers. Note: This type of raceway system is frequently found in existing buildings selected for modernization.

The cell assignments in 3-cell systems are generally designated as: (1) power; (2) voice/data; (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. Neither of these cables can tolerate the proximity to the power cables or the sharp bends from the header ducts to the cells to the outlets, which significantly diminishes the practical use of these systems.

Panelboards

- Panelboards shall be constructed to comply with the requirements of UL 67 and UL 50.
- All panelboard interiors shall be constructed using hard-drawn copper of 98% conductivity, with AIC bracing greater than the calculated available fault current. Minimum short circuit rating for 208/120v panelboards shall be 10,000 amperes symmetrical. Minimum short circuit rating for 480/277v panelboards shall be 14,000 amperes symmetrical. A 200% neutral shall be provided for panelboards serving office loads served from the secondaries of K-rated transformers or harmonic canceling transformers. A full size copper ground bus for connecting ground conductors shall be bonded to the steel cabinet. Provide isolated ground bus where required.
- Branch circuit breakers shall be bolt-on designed for replacement without disturbing adjacent units. Breakers shall comply with the requirements of UL 489, thermal magnetic type with short-circuit rating greater than the calculated available fault current. Panels shall be specified with “door-in-door” trim.

Power Distribution Panels. In general, circuit breaker type panels will be the standard of construction for federal buildings. With the exception of lighting and receptacle panel boards, 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 shall be circuit breaker type. Provide minimum 30 poles for 100 amps panelboards and minimum 42 poles for 225 amp panelboards.

Conduit Systems. The specification shall list the various types of conduit systems which 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
- 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 (compression 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 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 exposed.

6.11 Voice and Data Distribution System

The configuration and type of the voice and data cabling distribution systems shall 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 a Registered Communications Distribution Designer (RCDD).

Communications Raceways

Raised Access Floor. The standard option for delivering communications services in Federal buildings is 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 shall be grounded.

Alternate Raceways.

- Exposed cable trays
- Conduits in hung ceiling



U.S. Custom House, New Orleans, LA

6.12 Emergency Power Systems

Emergency power systems must be designed to comply with the requirements of NFPA 110, *Emergency and Standby Power Systems*. See Chapter 7: *Fire Protection & Life Safety* for additional requirements. Unless otherwise specifically authorized by the Contracting Officer all facilities shall be provided with a standby generator to supply power to the facility in the event of a sudden loss of power.

Generator Systems

The system shall consist of a central engine generator and a separate distribution system with automatic transfer switch(es), distribution panels, and 480/277V lighting panel (if applicable) with dry-type transformers feeding 208/120V panels as required. Effort must be made to ensure proper coordination of mechanical engineering elements of the generator systems design.

Service Conditions. If the unit is to be installed outdoors, it shall 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 unit 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 shall be provided if necessary. Temperature and ventilation shall be maintained within the manufacturer's recommendations to assure 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 shall be provided by the design engineer.

Radiators shall be unit-mounted if possible. If ventilation is restricted in indoor applications, remote installation is acceptable. Heat recovery and load shedding shall not be considered. Remote location of radiators shall be designed to avoid excess pressure on the piping seals.

Provide permanently installed load bank sized at 50% of generator rating. Load bank shall be factory mounted to the radiator.

Capacity. The engine generator shall be sized to serve approximately 110 percent of design load; ideally it shall run at 60 percent to 80 percent of its rated capacity after the effect of the inrush current declines. When sizing the generator, consider the inrush current of the motors that are automatically started simultaneously. The initial voltage drop on generator output due to starting currents of loads must not exceed 15 percent. Day tanks shall 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. Piping shall not be connected into the boiler transfer fuel oil delivery "loop".

Emergency Power Loads. Emergency power shall be provided for the following functions:

- Emergency lighting as defined in 6.10
- Fire alarm system
- Generator auxiliaries
- Fire pump
- Visitor screening equipment
- Telephone switch
- Security systems
- Mechanical control systems
- Building Automation System (BAS)
- Elevators (one per bank)
- Sump pumps
- Sewage ejector pumps
- Smoke control systems
- High Rise Stairway Pressurization Fans
- Uninterruptible power systems serving technology/server rooms
- Air conditioning systems for technology/server and UPS rooms
- Exhaust fan in UPS battery rooms
- Power and lighting for Fire Control Center and Security Control Center
- Air conditioning systems for communications rooms
- FAA Aircraft Obstruction Lights.
- Other associated equipment designated by code

Generator Alarms. Generator alarms must be provided in the generator room. All malfunctions shall be transmitted to the BAS. In all buildings, with or without BAS, a generator alarm annunciator shall be located within the Fire Command Center.

Automatic Transfer Switches. Automatic transfer switches serving motor loads shall have in-phase monitor (transfer when normal and emergency voltages are in phase) to reduce possible motor damage caused by out-of-phase transfer. They shall also have pre-transfer contacts to signal time delay returns in the emergency motor control centers.

Automatic transfer switches shall include a bypass isolation switch that allows manual bypass of the normal or emergency source to insure continued power to emergency circuits in the event of a switch failure or required maintenance.

Fuel Distribution System. See Chapter 5: *Mechanical Engineering, Heating Systems, Boilers and Heat Exchangers*, for information on fuel oil piping and underground fuel oil tanks.

Location. Generators shall be located at least 30 m (100 feet) from communications frame equipment to avoid radio frequency interference. See Chapter 3: *Architectural and Interior Design, Space Planning, Building Support Spaces, Mechanical and Electrical Rooms, Emergency Generator Rooms* for additional generator room requirements. Generator and generator control panel shall be located in a separate room or enclosure.

6.13 Clean Power Systems

Uninterruptible Power Systems

In some facilities technology/server room back-up systems may be designed by the tenant agency. If this is the case, shell space and utility rough-ins shall be provided. In facilities where uninterruptible power supply (UPS) systems are to be provided as part of the building construction, they shall be designed as described in this section. All UPS systems are considered to be above standard for GSA space. Tenant agencies with UPS requirements are 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 back-up. When generator back-up is unnecessary, sufficient battery capacity shall be provided to allow for an orderly shut-down.

Critical Technical Loads. The nature, size, and locations of critical loads to be supplied by the UPS will be provided in the program. The UPS system shall serve critical loads only. Non-critical loads shall be served by separate distribution systems supplied from either the normal or electronic distribution system. A UPS system shall be sized with 25 percent spare capacity. The specification of a redundant module shall depend upon the criticality of the loads.

Emergency Electrical Power Source Requirements. When the UPS is running on emergency power, the current to recharge the UPS batteries shall be limited. This limited battery charging load shall be added when sizing the emergency generator.



If the UPS system is backed up by a generator to provide for continuous operation, the generator shall provide power to all necessary auxiliary equipment, i.e., the lighting, ventilation, and air conditioning supplying the UPS and the critical technical area.

System Status and Control Panel. The UPS shall include all instruments and controls for proper system operation. The system status panel shall have an appropriate audio/visual alarm to alert operators of potential problems. It shall include the following monitoring and alarm functions: system on, system bypassed, system fault, out of phase utility fault, closed generator circuit breaker. It shall 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 shall also be transmitted to the BAS.

UPS and Battery Room Requirements. Provide emergency lighting in both spaces. Provide a telephone in or adjacent to the UPS room. Battery room design must accommodate: proper ventilation, hydrogen detection, spill containment, and working clearances. See Chapter 3: *Architectural and Interior Design, Space Planning, Spaces for Uninterruptible Power Systems (UPS) and Batteries* for additional requirements for UPS and battery room. Also, see NEC and Chapter 7: *Fire Protection & Life Safety* for additional requirements.

Computer Center Power Distribution Unit

In some GSA buildings the power distribution system for computer centers will be designed by the tenant agency. In that case, utility rough-in shall be provided under the

construction contract. If distribution is to be provided under the building contract, it shall be designed according to the criteria in this section.

Power Distribution Units (PDU's). PDU's with internal or remote isolation transformers and output panelboards shall be provided in all computer centers to reduce/eliminate harmonic currents generated by non-linear loads and reflected back to the neutral service conductors. Neutral busses/conductors shall be sized at 200% of phase busses/conductors. PDU's with internal or remote isolation transformers shall be K-rated to serve non-linear loads. The transformer rating must take the increased neutral size into account.

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 shall be provided. The design of the technology/server room grounding system shall be discussed with the computer center staff.

Low Frequency Power System Grounding. The primary concern is to provide a safe, low-frequency, single point grounding system that complies with Article 250 of the *National Electrical Code*. The single point ground must be established to ground the isolation transformer or its associated main service distribution panel.

A grounding conductor shall be run from the PDU isolation transformer to the nearest effective earth grounding electrode as defined in the NEC. All circuits serving Automated Data Processing (ADP) equipment from a PDU shall have grounding conductors equal in size to the phase conductors.

High Frequency Power System Grounding. If requested by the User Agency, in addition to the low frequency power system grounding, a high frequency signal reference grounding system for radio frequency noise is required (with the two systems bonded together at one point). A grid made up of 600 mm (2-foot) squares will provide an effective signal reference grounding system. The raised floor grid may be used if it has mechanically bolted stringers. Alternatively, a grid can be constructed by laying a 600 mm mesh (2-foot squares) of braided copper strap or 1.3 mm (16 gauge, 0.051 inch) by 50 mm (2-inch) copper strap directly on the structural floor below the raised access floor. Data processing equipment shall 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., building automation systems, electronic security systems, card access control systems, and local area networks.

The following guidelines shall be considered to reduce common mode noise:

- Avoid running unshielded metallic signal or data lines parallel to power feeders.
- Where metallic signal or data lines must be routed in noise prone environments, use shielded 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 Transformers, Sizing of Neutrals

Harmonic frequencies are introduced into the branch circuit distribution system by the power supplies of the following items of equipment:

- Electronic ballasts
- Variable frequency drives
- PC's
- Laser printers
- File servers
- Fax machines
- Copiers

The third order harmonics (180 Hz) add in the neutral conductor and, in the case of 100 percent total harmonic distortion, would result in a neutral current of 1.73 times the phase current.

K-Rated Transformers: (K-13) with a 200 percent neutral shall feed branch circuit panelboards with 200 percent neutrals.

6.14 Grounding Systems

General. Grounding systems shall 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:



Metzenbaum Courthouse, Cleveland, OH

Separate equipment ground conductors. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

- 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

Busway Supply Circuits. Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

Separately Derived Grounds. Good practice dictates that, in order to minimize extraneous “noise” on certain systems, particularly those in which harmonics are generated, the specific system grounds shall be separated prior to grounding at the service grounding electrode or counterpoise.

Isolated Grounds. Isolated grounds are 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, shall be electrically isolated from the main grounding system. The isolated grounds shall terminate at a common ground or counterpoise.

In buildings where a 208/120V 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 shall be considered.

Raised floors. Access floors shall be grounded. A grounding conductor shall be bonded to every other floor pedestal and shall be extended to the technology/server room common ground bus.

Counterpoise. Where feasible, a grounding conductor (counterpoise) shall be provided in an isosceles triangle configuration with sides greater than or equal to 3 meters(10 feet). The conductor shall be tinned copper not less than No. 4/0 AWG and shall be electrically connected to the incoming domestic water services on either side of the building as well as the various clusters of three (3) ground rods spaced at intervals. Ground rods shall be 15mm (5/8") dia. by 2400mm (96") long and shall be tin coated copper. The counterpoise loop will involve direct burial in earth 1200mm (24") min. below grade. The following items shall be connected to the counterpoise loop:

- 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

6.15 Lightning Protection Systems

General. 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 and the architectural configuration of the building. The decision to recommend a lightning protection system shall be made at the earliest stages of design and shall be supported by a study as prescribed by NFPA 780.

Master Label. If a decision is made to provide a lightning protection system it shall be installed in compliance with UL 96 and NFPA 780. A UL Master Label shall be required.

Alternate Systems. The requirement of a “Master Label” imposes certain restrictions or limitations on the design of the system which may be in conflict with the architectural design, particularly if the façade includes large curved surfaces which preclude the installation of air terminals and where the spacing of down conductors are limited. In those instances the design engineer may appeal to the Contracting Officer to waive the “Master Label” requirement on the basis that the design generally follows the “Faraday Cage” principle of lightning protection.

Grounding. The down conductors shall follow direct paths from the air terminals to ground connections or to the counterpoise loop.

6.16 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 designed shall be determined by a security design professional and shall be commensurate to the threat evaluation of the facility. The system must be integrated into the design, if a new building, or provided for in a non-intrusive way, in the case of an existing building. The systems shall be provided with integral battery back-up and connected to the building emergency generator.

6.17 Short Circuit and Coordination Study

The design engineer shall submit a preliminary computer generated short circuit analysis on all projects. The final coordination and analysis shall be done by the contractor's testing agency or by the independent agency employed by the client, and a report shall be submitted.

Fire Protection & Life Safety

7

ATF National Laboratory Center and Fire Research Laboratory

Beltsville, Maryland

Architect: Kallmann McKinnell & Wood Architects, Inc.

GSA Project Manager: John L. Crowley

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7.1 General Approach

GSA's approach in the construction of new facilities and projects in existing facilities is to incorporate efficient, cost-effective fire protection and life safety systems that are effective in detecting, extinguishing or controlling a fire event that results in improving overall building safety. The primary goal is to protect human life from fire and products of combustion. The secondary goals are to reduce the potential loss from fire (i.e., Federal real and personal property, maintain client agency mission continuity, and control environmental impact) to the Federal Government and taxpayer.

Scope

This chapter provides the technical fire protection and life safety requirements and design criteria for GSA facilities to meet the goals identified above. The majority of the fire protection and life safety requirements are contained in numerous national codes and standards. Compliance with national codes and standards is explained, and areas where GSA's requirements differ from the referenced national codes and standards are delineated. The Authority Having Jurisdiction (AHJ), for all technical requirements in this chapter, for all fire protection and life safety code interpretations and code enforcement requirements is the GSA regional fire protection engineer.

Applicability

The technical fire protection and life safety requirements are primarily directed to the construction of new facilities and renovation projects. However, for renovation projects

where the work area consists of a portion or portions of a building, the requirements herein shall be limited to the work area(s) in which work is being performed, unless when specified by the GSA regional fire protection engineer that the requirements shall also apply throughout the floor on which the work area(s) are located or otherwise beyond the work area. Performance based designs are also encouraged.

A registered fire protection engineer is required to be a full participant of the architect/engineer (A/E) design team for each phase of the project from concepts through design, construction, final acceptance, and occupancy. The design team fire protection engineer must have at least 6 years experience from which at least 3 consecutive years are directly involved in the fire protection engineering field. This same or an equally competent professional must remain on the A/E's project staff for each phase of the project and shall perform the following:

- Analyses and provides criteria for the following:
 - 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 the following:
 - Egress
 - Water Supply
 - Smoke Control (Fire Dynamics)/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/Stair Pressurization Systems

See Appendix A for specific submission requirements.

For all projects involving fire protection and life safety issues, a dialog must be established between the design team fire protection engineer and the GSA regional fire protection engineer. The GSA regional fire protection engineer shall have the right to revise the specific requirements within this chapter based on a technical evaluation/analysis and the project's specific needs.

In addition, the Design Team's registered fire protection engineer may propose alternative designs, systems, methods, or devices not specifically prescribed within this Chapter or in lieu of the specific prescribed requirements within this Chapter. The GSA regional fire protection engineer shall review the technical documentation submitted by the Design Team's registered fire protection engineer to determine if the proposed alternative is deemed equivalent or superior to the intent of the prescribed requirements in this chapter. If the GSA regional fire protection engineer determines that the proposed alternative is deemed equivalent or superior to the intent of the prescribed requirements in this chapter, then the proposed alternative is considered approved by GSA for the purposes of this Chapter and for the application for which the proposed alternative will be used. Refer to Chapter 1 for additional information.

7.2 Certificate of Occupancy

No new construction or renovation project or portion thereof shall be occupied until the regional fire protection engineer has issued a certificate of occupancy to the GSA Project Manager. Issuance of a certificate of occupancy shall not be construed as an approval of any violation of a Code or GSA design standard or criteria.

Once the GSA regional fire protection engineer has ensured that to the best of their 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, a certificate of occupancy will be issued to the GSA Project Manager.

The GSA regional fire protection engineer is authorized to issue a temporary certificate of occupancy. This certificate shall allow partial occupancy of specific areas, prior to completion of the project. All life safety and fire protection systems serving the areas proposed for occupancy and all floors below shall be completed, inspected, successfully tested and approved by the GSA regional fire protection engineer. The temporary certificate of occupancy shall identify the specific area(s) of the project where occupancy is permitted. Following the issuance of a temporary certificate of occupancy, the GSA regional fire protection engineer shall set a time frame for the completion, inspection, testing and approval of all life safety and fire protection systems, and the correction of any outstanding life safety and fire protection deficiencies. Upon completion, inspection, successful testing and approval of all fire protection and life safety systems and correction of all outstanding fire and life safety deficiencies, the GSA regional fire protection engineer will issue a certificate of occupancy to the GSA Project Manager.

7.3 Fire Safety During Construction and Renovation Projects

General. Fire safety during construction and renovation projects shall comply with the requirements in the International Building Code (IBC), International Fire Code (IFC), and National Fire Protection Association (NFPA) 241.

Fire Protection Systems. Disruptions to fire alarm and sprinkler systems shall be kept to a minimum or avoided. 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 shall 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 shall make the final determination of the adequacy of proposed equivalent levels of fire protection prior to 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.

7.4 Commissioning

The commissioning process will ensure that the fire protection and life safety systems and equipment installed in a building are in compliance with the building design requirements.

The Design Team’s fire protection engineer shall prepare written commissioning plan documentation that outline the 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 construction, final acceptance, occupancy, and post occupancy. At a minimum, the commissioning plan documentation shall include a discussion on the building structure; applicable standards, federal laws and regulations; system and equipment performance assumptions, codes and standards strategies; testing and start-up requirements; inspection, testing and maintenance requirements; and safeguards to verify and confirm that systems, equipment and devices have undergone start-up testing prior to final acceptance testing, including the identification and notification of all parties needed to perform and witness all testing. The commissioning plan documentation shall also describe in detail the performance objectives of each fire protection and life safety system planned for the project. In addition, it shall also include all of the additions, deletions or modifications made to each of the fire protection and life safety systems during each phase of the project. All of this documentation will assist the Construction Manager, Project Manager, Commissioning Authority and the GSA regional fire protection engineer in the advocacy, review, inspection and final acceptance process.

In addition, the Design Team’s fire protection engineer shall prepare construction contract specifications to align the actions of the construction contractor with the commissioning plan, addressing all involved tests, special inspections, and certifications.

Examples of fire protection and life safety commissioning activities include, but are not limited to the following items:

Preliminary planning: Assure proposed space is accommodated by each involved system as it applies to that space, in accordance with the requirements within PBS-P100 and all referenced codes & standards. Review associated project budgets to assure that an adequate amount of space is shown to not only address each system itself, but validate that architectural, structural, and mechanical system costs associated with pathway, firestopping, concealment, and placement are included in the project’s budget. Integrate appropriate GSA guide specification requirements into systems planning in the review of the systems budgets to assure budget assumptions are in concert with the requirements for design.

Preliminary Concept Design: Review concept drawings to assure adequate egress from the conceptual facility, adequate utility connection/service for fire protection systems, adequate site access for fire department and other emergency responders, and assuring compliance with the requirements within PBS-P100 and all referenced codes and standards based on the limited information in this stage of design. Identify proposed hazard ratings and occupancy classifications of various building space types and confirm their impact to involved systems.

Final Concept Design: Confirm that proposed systems comply with the requirements within PBS-P100 and all referenced codes and standards. Assure that systems proposed for the facility will comply with the latest GSA guide specifications for each proposed system. Identify the designer’s intent to use acceptable materials/ equipment and that proposed capabilities (if any) are appropriate for the space occupancy classification and hazard ratings.

Design Development: Validate that concept approved fire protection and life safety systems are based on the requirements within PBS-P100, referenced codes and standards, and the latest edition of GSA guide specifications for the systems involved. Check fire protection & life safety engineering calculations to determine accuracy and proper application of design to the facility. Evaluate the project specifications and project drawings for correctness, coordination and agreement. Validate operational assumptions and level of details for each system to assure clarity and detail for project bids and construction direction. Coordinate work with the GSA review process so that the GSA regional fire protection engineer receives the project design package for review after completion of the aforementioned work.

Construction Documents: Review layouts for each fire protection and life safety system, validating that the construction documents are in compliance with the requirements within PBS-P100 and referenced codes and standards, that the construction documents conform to the design drawings, specifications, and supporting contract documents, and that equipment submittals are correctly annotated and the application of each piece of equipment is appropriate for the facility and this project. Review system/equipment locations to assure clearance when in proximity to ductwork and other building features. Validate appropriateness of control sequences, and their representation on drawings and/or specifications. Verify that specifications include appropriate spare parts.

Construction Inspection: During construction, inspect system installations to assure compliance with design intent, approved specifications & drawings, and approved submittals. Coordinate on site inspections with the GSA regional fire protection engineer for the project so that there is unified communication about each system and required changes or improvements. When all system components are in-place, coordinate preliminary and acceptance testing, checking functionality of all modes

of operation. Prepare test reports. Verify that training for building operating staff includes information on what to do for each mode of operation. Verify that an appropriate number of spare system parts are provided per terms of the construction contract. Assure that the GSA regional fire protection engineer is involved in the scheduling of all acceptance testing and has an opportunity to attend testing as required. Participate in the review of test results and needed corrections with the GSA regional fire protection engineer as a means to facilitate issuing a Certificate of Occupancy.

Post Construction Inspection/Operations: Coordinate with GSA project management staff to assure that appropriate service/maintenance agreements exist for the care/servicing of the commissioned systems.

These activities shall be done for the following systems:

- Fire Alarm Systems
 - Initiating Devices and Related Circuits
 - Notification Appliances and Related Circuits
 - Power Supplies and Protection of Same
 - Communication of Signals Exterior to the Building (Central Station & MegaCenter)
 - System Controls and Peripherals
 - Interface with Other Systems (e.g., HVAC, Security Systems, etc.)
- Water Based Fire Extinguishing Systems
 - Sprinkler Systems
 - Water Supply Information
- Fire Pumps
 - Fire Pump
 - Jockey Pump
 - Fire Pump Controller and Transfer Switch
 - Pressure Regulation at Fire Pump
 - Fire Pump Room
- Standpipe and Fire Department Hose Connection Systems
- Non-Water Based Fire Extinguishing Systems
 - Wet Chemical Systems
- Smoke Management Systems
 - Exit Stairway Pressurization
 - Atrium Smoke Removal
- Emergency Power Systems
- Fire Doors and Windows
- Emergency Lighting and Exit Lighting
- Exit signage
- Photoluminescent Material Stairway Marking.
- Egress Systems
 - Aisles
 - Exit Access
 - Exit Stairs
 - Exit Doors & Hardware
 - Exits
 - Exit Discharge
- Other Equipment and Systems
 - Spray Applied Fire Resistive Materials
 - Firestopping Materials
 - Interior Finish Materials
 - High Density Storage Systems
 - Essential Electronic Facility Protection
 - Lightning Protection
 - Portable Fire Extinguishers and Cabinets
 - Fire Command Center
 - Equivalent Technologies

7.5 Building Construction

Types of Construction. For each construction type, design fire resistive ratings of structural members in accordance with the requirements in the IBC.

Special Inspections. The GSA Project Manager shall ensure that special inspections for sprayed fire-resistant materials applied to structural elements and decks are in accordance with the requirements in the IBC. Special inspections shall be based on the fire-resistive design as designated in the approved construction documents.

7.6 Interior Finishes

General. The interior finish requirements for walls, ceilings, floors, draperies, curtains, and movable partitions shall 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 shall be limited to those having a flash point of 60 degrees C (140 degrees F) or higher.

All other materials composed of combustible substances, such as wood (e.g., plywood, 610 mm by 1219 mm (2 feet by 4 feet) wood boards, etc.) shall be treated with fire-retardant chemicals by a pressure impregnation process or other methods that treats the materials throughout (as opposed to surface treatment).

7.7 Occupancy Classifications

General. Occupancy classifications shall meet the requirements in the IBC.



Charles Evans Whittaker U.S. Courthouse, Kansas City, MO

7.8 Means of Egress

General. The means of egress design requirements for the building shall meet the requirements in NFPA 101. The technical egress design requirements in NFPA 101 shall be used in lieu of the technical egress design 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, 1-hour fire rated corridors shall not be required.
- Interlocking (scissor) stairs shall count as only one exit stair. A minimum of two exit stairs are required for any multi-story building.
- For common paths of travel and dead end corridors, GSA permits the NFPA 101 exceptions for sprinkler protection to apply to fully sprinklered individual floors, even if the other floors of the building are not sprinklered.
- Fire escapes, as defined in the NFPA 101, shall not be considered approved exits.

Stairway Pressurization. In new construction projects having occupied floors located more than 22860 mm (75 feet) above the level of exit discharge or more than 9144 mm (30 feet) below the level of exit discharge, exit stairways shall be pressurized in accordance with the requirements in the IBC.

Photoluminescent Materials

Exit Stair Identification Signs. The following requirements take precedence over the requirements in NFPA 101:

- Stair identification signs shall have a photoluminescent background complying with Standard Specification for Photoluminescent (Phosphorescent) Safety Markings ASTM E2072-04 as a minimum standard.
- The signs shall be a minimum size of 457 mm (18 inches) by 305 (12 inches).
- The letters designating the identification of the stair enclosure shall be a minimum of 38 mm (1 1/2 inches) in height.
- The number designating the floor level shall be a minimum of 127 mm (5 inches) in height and located in the center of the sign.
- All other lettering and numbers shall be a minimum of 25 mm (1 inch) in height.
- The directional arrow shall be a minimum of 76 mm (3 inches) in length.

For projects in historic structures, the Design Team fire protection engineer shall consult with the GSA Regional Historic Preservation Officer and the GSA regional fire protection engineer regarding these requirements.

Exit Stair Treads. The following requirements take precedence over the requirements in the NFPA 101:

- Stair treads shall incorporate a photoluminescent stripe that is either an applied coating, or a material integral with, the full width of the horizontal leading edge of each stair tread, including the horizontal leading edge of each landing nosing.

- The width of the photoluminescent stripe shall be between 25 mm (1 inch) and 51 mm (2 inches).
- The width of the photoluminescent stripe, measured horizontally from the leading edge of the nosing shall be consistent at all nosings.
- The photoluminescent materials used shall comply with ASTM E2072-04 as a minimum standard.

For projects in historic structures, the Design Team fire protection engineer shall consult with the GSA Regional Historic Preservation Officer and the GSA regional fire protection engineer regarding these requirements.

Exit Stair Handrails. The following requirements take precedence over the requirements in the NFPA 101:

- Stair handrails shall incorporate a photoluminescent marking that is either an applied coating, or a material integral with, the entire length of each handrail.
- The photoluminescent handrail marking, at a minimum, shall be located at the top surface of each handrail, having a minimum width of 13 mm (1/2 inch).
- The photoluminescent handrail marking shall stop at the end of each handrail. If the handrail turns a corner, the marking shall continue around the corner.
- The photoluminescent materials used shall comply with ASTM E2072-04 as a minimum standard.

For projects in historic structures, the Design Team fire protection engineer shall consult with the GSA Regional Historic Preservation Officer and the GSA regional fire protection engineer regarding these requirements.

7.9 Fire Alarm Systems

General. Fire alarm systems shall be installed in accordance with the requirements in NFPA 72, the IFC, and the applicable GSA fire alarm system specification.

Special Requirements. The following requirements take precedence over the requirements in NFPA 72 and the IFC:

- All fire alarm systems shall be addressable systems.
- All fire alarm systems installed in buildings shall be an emergency voice/alarm communication system when any one of the following conditions exist:
 - The building is 2 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 voice/alarm communication system shall provide an automatic response to the receipt of a signal indicative of a fire emergency. Manual control with the capability of making live voice announcements shall also be furnished to provide occupants notification either on a selective or all-call basis

- With the exception of mass notification, fire alarm systems shall not be integrated with other building systems such as building automation, energy management, security, etc. Fire alarm systems shall be self-contained, stand alone systems able to function independently of other building systems.
- All emergency voice/alarm communication systems shall be installed within a room separated from the remainder of the building by not less than a 1-hour fire resistance rated fire barrier.

- Each fire alarm system shall be provided with a power conditioner to protect the fire alarm system from electrical surges, spikes, sags, over-voltages, brownouts, and electrical noise. The power conditioner shall be U.L. listed and shall have built in overload protection.
- Wiring supervision for fire alarm systems shall be provided as defined in NFPA 72 as follows:
 - Interconnected riser loop or network (Style 7 – Class A)
 - Initiating device circuits (Style B – Class B)
 - Signaling line circuit for each floor (Style 4 – Class B)
 - Signaling line circuit for network (Style 7 – Class A)
 - Notification appliance circuits (Style Y – Class B)
- All fire alarm signals (i.e., alarm, supervisory, and trouble signals) shall be automatically transmitted via a digital alarm communicator over leased phone lines to a U.L. listed Central Station Service and the GSA Regional Emergency Management Control Center.
- All fire alarm system wiring shall be solid copper and installed in conduit. Stranded wiring shall not be used.
- Conduit shall be rigid metal or electrical metallic tubing, with a minimum inside diameter of 19 mm (3/4 inch) that utilizes compression type fittings and couplings.

Manual Fire Alarm Boxes

General. Manual fire alarm boxes shall be installed in accordance with the requirements in NFPA 72, the IFC, and manufacturer's instructions.

Special Requirements. The following requirements take precedence over the requirements in NFPA 72 and the IFC:

- Manual fire alarm boxes shall be installed in every new construction project in accordance with the spacing and location requirements in NFPA 72.
- Manual fire alarm boxes shall be double-action stations.
- Manual fire alarm boxes shall be of contrasting color to the background on which they are mounted.

Waterflow Switches

General. Waterflow switch(es) shall be installed in accordance with the requirements in NFPA 13, NFPA 72 and the IFC.

Special Requirements. The following requirements take precedence over the requirements in NFPA 13, NFPA 72 and the IFC:

- A waterflow switch(es) shall be provided for each floor or fire area protected by sprinkler systems.
- Each waterflow switch shall be separately annunciated at the main fire alarm control unit and all required annunciators.

Smoke Detectors

General. Smoke detectors shall be installed in accordance with the requirements in NFPA 72, the IFC, and the International Mechanical Code (IMC).

Special Requirements. The following requirements take precedence over the requirements in NFPA 72, the IFC and the IMC:

- Area smoke detectors shall not be installed in each of the following rooms: mechanical equipment, electrical closet, telephone closet, emergency generator room, uninterruptible power service and battery rooms, and other similar rooms.
- Smoke detection appropriate for the application shall be installed in each of the following rooms: electrical switch gear, transformer vaults and telephone exchanges (PABX).
- Duct smoke detectors shall meet the requirements in the IFC and IMC.

Audible Notification Appliances

General. Performance, location, and mounting of audible notification appliances shall be in accordance with the requirements in NFPA 72.

Special Requirements. The following requirements take precedence over the requirements in NFPA 72:

- To ensure audible signals are clearly heard, the sound level shall be at least 70 dBA throughout the office space, general building areas and corridors measured 1524 mm (5 feet) above the floor. The sound level in other areas shall be at least 15 dBA above the average sound level or 5 dBA above any noise source lasting 60 seconds or longer.
- The design for achieving the required minimum dBA levels shall 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. The *SFPE Handbook of Fire Protection Engineering*, Chapter on *Design of Detection Systems* or other audio design guides should be used to provide guidance and methodology to achieve the required dBA levels.
- Where emergency voice/alarm communication systems are provided, fire alarm speakers shall be installed in elevator cars and exit stairways; however they shall only be activated to broadcast live voice messages (e.g., manual announcements only). The automatic voice messages shall be broadcast through the fire alarm speakers on the appropriate floors, but not in stairs or elevator cars.

Visible Notification Appliances

General. Placement and spacing of visible notification appliances shall be in accordance with the requirements in NFPA 72.

Special Requirements. The following requirements take precedence over the requirements in NFPA 72:

- Visible notification appliances shall only be installed in projects that involve the installation of new fire alarm systems.
- Visible notification appliances shall only be required to be installed in public and common areas. For the purposes of this requirement, visible notification appliances shall not be 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, etc.
- Visual notification appliance circuits shall have a minimum of 25 percent spare capacity.
- Visible notification appliances shall not be installed in exit enclosures (i.e., exit stairs, etc.).

Fire Alarm Messages for High Rise Occupancies

Upon receipt of any fire alarm signal, the fire alarm system shall automatically activate a distinctive three-pulse temporal whoop pattern for three (3) cycles followed by the specified automatic voice messages which shall be repeated until the control panel is reset (i.e., three-pulse temporal whoop pattern - three-pulse temporal whoop pattern - three-pulse temporal whoop pattern - voice message; three-pulse temporal whoop pattern - three-pulse temporal whoop pattern - three-pulse temporal whoop pattern - voice message; etc.), or until overridden by manually activated live voice messages.

The automatic voice messages shall be broadcast through the fire alarm speakers on the specified floors, but not in exit stairs or elevator cars. However, the capability to transmit voice messages to elevator cars and exit stairs shall be included, but be manual only.

The “Fire Zone” message shall be broadcast through speakers on the floor of alarm origin, the floor immediately above the floor of origin, and the floor immediately below the floor of origin. In addition, the visible alarm notification appliance circuit(s) shall be activated on the floor of alarm origin, the floor immediately above the floor of origin, and one floor immediately below the floor of origin. A first floor alarm shall transmit a “Fire Zone” message to all below grade levels.

The “Safe Area Zone” message shall simultaneously be broadcast to all other building floors. However, the visible alarm notification appliance circuit(s) shall not be activated on these floors. The “Safe Area Zone” message shall activate for two complete rounds and silence automatically. After five minutes, if the system is still in an alarm condition, the “Safe Area Zone” message shall automatically start and activate for two complete rounds and silence again. This sequence shall be repeated until the fire alarm system is reset. In the event a subsequent fire alarm is received at the fire alarm control panel by a floor that was previously receiving a “Safe Area Zone” message, this floor shall automatically revert to perform the actions for a “Fire Zone” message.

A live voice message shall override the automatic output through use of a microphone input at the main fire command center. When using the microphone, live messages shall be broadcast through speakers in stairwells, in elevator cars, and throughout the selected floor or floors. Each stairwell shall have its own dedicated speaker zone and speaker zone activation switch. Each elevator bank shall have its own dedicated speaker zone and speaker zone activation switch. An “All Call” switch shall be provided which activates all speakers in the building simultaneously.

Messages shall be digitized voice and utilize a professional quality male voice and shall be as follows:

- **"Fire Zone" Message:** "May I have your attention, please. May I have your attention, please. A fire has been reported which may affect your floor. Please walk to the nearest exit and leave the building. Please do not use the elevators," or
- **"Fire Zone" Message:** "May I have your attention, please. May I have your attention, please. A fire has been reported which may affect your floor. Please walk to the nearest exit, walk down ____ floors, re-enter the building, walk onto the floor, and await further instructions. Please do not use the elevators."
- **"Safe Area Zone" Message:** "May I have your attention, please. May I have your attention, please. A fire has been reported in another area of the building. You are in a safe area. Please stay in your work area and await further instructions. Please do not use the elevators."

Annunciator. All fire alarm systems shall have at least one annunciator located within 7620 mm (25 feet) from the primary fire department entrance to the building. For projects in historic structures, the Design Team fire protection engineer shall consult with the GSA Regional Historic Preservation Officer and GSA regional fire protection engineer regarding this requirement.

Survivability

General. The fire alarm system shall meet the survivability requirements in NFPA 72.

Special Requirements. The following requirements take precedence over the requirements in NFPA 72:

- Two vertical risers (i.e., supply and return interconnected network circuits Style 7 - Class A) shall be installed as remote as practicable from each other so that a single fire will not involve both risers.
- The two vertical risers shall be protected by a minimum 2-hour rated enclosure or an approved 2-hour rated cable or system, not common to both vertical risers.
- The horizontal interconnection between the two vertical risers at the top and bottom shall be protected by a minimum 2-hour rated enclosure, or an approved 2-hour cable or system, or an approved construction material having a 2-hour fire resistance rating.
- A minimum of two (2) distinct fire alarm audible notification appliance circuits and a minimum of two (2) distinct visible notification appliance circuits shall be provided on each floor.
- Adjacent fire alarm audible and visible notification appliances shall be on separate circuits.

Fire Command Center

General. The fire command center shall meet the requirements in the IFC.

Special Requirements. The following requirements take precedence over the requirements in the IFC:

- A fire command center shall be constructed in all new construction projects and meet the construction requirements in the IFC.
- Each fire command center shall be provided in a location approved by the GSA regional fire protection engineer after consultation with the local fire department.
- Each fire command center shall be provided with appropriate lighting, ventilation, and emergency lighting.

7.10 Water Supply for Fire Protection

Adequacy of Water Supply. The designer shall assess adequacy of the existing water supply. The designer shall perform water supply flow testing of fire hydrants and/or fire pumps. If data less than one year old is available from the local jurisdiction, the designer shall verify the locations involved as well as the quality and accuracy of the data.

Capacity and Duration. The required fire flows and pressures for buildings shall comply with the requirements in NFPA 13 and the IBC.

Fire Pump Design. When a fire pump is necessary to supplement fire flow and pressure, size it to comply with the requirements in NFPA 13, 14, and 20. For emergency power requirements see PBS-P100, Chapter 6.

Special Requirements. The following requirements take precedence over the requirements in NFPA 13, 14, and 20:

- The fire pump shall be sized only 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.

- The fire pump shall be electric motor driven, horizontal split case centrifugal type, unless this is not feasible.

Fire Pump Installation. The fire pump shall be installed in accordance with the requirements in NFPA 20.

Fire Pump Operations. A fire pump shall start automatically at 69 kPa (10 psi) below pressure maintenance pump (jockey pump) start pressure.

Fire Pump Controller. The power transfer switch and the fire pump controller shall be factory assembled and packaged as a single unit. Separate transfer switches are not permitted. The fire pump controller shall be monitored by the fire alarm system.

Pressure Maintenance Pump (Jockey Pump). A pressure maintenance pump shall be utilized where it is desirable to maintain a uniform or relatively high pressure on the fire protection system. A jockey pump shall be sized to make up the allowable leakage rate within 10 minutes or 3.8 lpm (1 gpm), whichever is larger.

7.11 Water Based Fire Extinguishing Systems

General. Automatic sprinklers systems shall 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 shall be installed throughout all new construction 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 shall be installed throughout the designated work area for all major renovation 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/isolated areas having insufficient or nonexistent water supplies in close proximity, designing the fire sprinkler system in accordance with NFPA 13 can be both impractical and economically very onerous. See Section “Automatic Sprinkler Systems for Remote/Isolated Facilities” for additional information regarding automatic sprinkler system requirements.
- All sprinkler systems shall be wet-pipe sprinkler systems, unless installed in areas subject to freezing.
- In areas subject to freezing, install dry-pipe sprinkler systems, dry pendent sprinklers, or provide heat in the space, and/or reroute the sprinkler piping. Heat tape shall not be used on sprinkler piping.

- Antifreeze sprinkler systems shall not be installed in any new construction or renovation projects.
- Pre-action type sprinkler systems shall not be installed in any new construction or renovation projects.

Sprinkler System Design

General. Sprinkler systems shall be hydraulically calculated in accordance with the requirements in NFPA 13.

Special Requirements. The following requirements take precedence over the requirements in NFPA 13:

- Sprinkler systems shall be designed using a minimum system design area of 1,500 sq. ft. and shall not be decreased below this value.
- Where floor openings are not classified as atriums, the sprinklers at the ceiling shall be zoned with the lower level if it is enclosed on the upper level (the enclosure is effectively creating a high ceiling). Otherwise, sprinklers shall be zoned with the upper level.
- Sprinkler system control valves shall be located in accessible spaces. Sprinkler system control valves shall not be located in above ceiling spaces.

Seismic Protection. Seismic protection shall be installed where required in the IBC.

Types of Sprinklers

General. Quick response sprinklers (QRS) shall be installed in all new construction and renovation projects in accordance with the requirements in NFPA 13.

Special Requirements. The following requirements take precedence over the requirements in NFPA 13:

- Sprinklers equipped with “O-ring” water seals shall not be utilized in any new construction or renovation projects.

- QRS sprinklers shall not be installed in high temperature areas (e.g., high temperature areas defined in NFPA 13 or elevator machine rooms, etc.) in a building. Standard response sprinklers shall be installed of the appropriate temperature rating.
- All automatic sprinklers installed less than 2134 mm (7 feet) above the floor shall be equipped with sprinkler guards to provide protection against accidental damage.

Sprinkler Piping System

General. Sprinkler piping, fittings, control valves, check valves, and drain assemblies shall meet the requirements in NFPA 13.

Special Requirements. The following requirements take precedence over the requirements in NFPA 13:

- Black steel piping and/or copper tubing shall be used for all wet-pipe sprinkler piping. Chlorinated polyvinyl chloride (CPVC) sprinkler piping shall not be installed in any new construction or renovation project, unless specifically approved for installation by the GSA regional fire protection engineer.
- Galvanized (internal and external) sprinkler piping shall be used for all dry-pipe sprinkler systems.
- Steel pipe sizes 51 mm (2 inches) and smaller shall be Schedule 40 and shall be threaded.
- Steel pipe sizes larger than 51 mm (2 inches) shall be minimum Schedule 10. Piping less than Schedule 40 shall be roll grooved.
- Threadable lightwall pipe shall not be used.
- Steel piping having a corrosion resistant ratio less than 1 shall not be used.
- Plain-end fittings shall not be used.

Fire Department Connections. Underwriters Laboratories Inc (UL) listed locking fire department connection caps shall be installed on all fire department

connections where the local fire department has a program and the hardware to accommodate locking fire department caps.

Automatic Sprinkler Systems for Remote/Isolated Facilities

General. The requirements below apply to facilities located in remote/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 the 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.

1. The cost associated with the installation of the interior NFPA 13 fire sprinkler system (includes all costs such as labor, materials, the adequate water supply source, pumps, etc.) has a cost exceeding \$10.00 per square foot; and
2. The costs associated with connecting the interior NFPA 13 fire sprinkler system to the adequate water supply source (includes all costs such as labor, materials, the adequate water supply source, pumps, etc.) is greater than 50 percent of the cost for the installation of the interior NFPA 13 fire sprinkler system.

If the preceding conditions exist, the sprinkler system shall be designed in accordance with the requirements in NFPA 13D.

Special Requirements. The following requirements take precedence over the requirements in NFPA 13D:

- The water supply source for the sprinkler system shall be a minimum of 1,000 gallons and shall be capable of meeting system demands for at least 30 minutes.
- Antifreeze sprinkler systems shall not be permitted.

7.12 Non-Water Based Fire Extinguishing Systems

Wet Chemical Extinguishing Systems. Wet chemical extinguishing systems shall be installed to protect commercial food heat-processing appliances required to have a Type 1 hood in accordance with the requirements in NFPA 17A and the manufacturers recommendations.

Dry Chemical Extinguishing Systems. Dry chemical extinguishing systems shall not be installed to protect any commercial cooking equipment installations.

Clean Agent Extinguishing Systems. Clean agent extinguishing systems shall not be installed in any new construction or renovation project, unless specifically approved for installation by the GSA regional fire protection engineer. However, an approved clean agent extinguishing system shall not be installed in lieu of a wet-pipe sprinkler system.

7.13 Standpipes and Fire Department Hose Outlets

Standpipes

General. Standpipes shall be installed in buildings where required in the IFC.

Special Requirements. The following requirements take precedence over the requirements in the IFC:

- All standpipes shall be connected to the fire protection water supply, be permanently pressurized, and be installed in accordance with the requirements in NFPA 14.
- Dry standpipes shall only be permitted in spaces subject to freezing.
- Where standpipe and sprinkler systems are required, a combination sprinkler/standpipe system design shall be provided.

Fire Department Hose Outlets. Each fire main riser shall be provided with 63 mm (2 1/2 inch) fire department hose outlets. Each outlet shall be located in the stair shaft and have a removable 38 mm (1 1/2 inch) adapter and cap. Threads and valves shall be compatible with the local fire department requirements.

7.14 Portable Fire Extinguishers and Cabinets

General. Portable fire extinguishers and cabinets shall be installed in accordance with the requirements in the IFC.

Special Requirements. The following requirements take precedence over the requirements in the IFC:

- Portable fire extinguishers and cabinets shall not be installed in common areas, general office or court space when the building is protected throughout with quick response sprinklers.
- In office buildings protected throughout with quick response sprinklers, fire extinguishers shall only be installed in areas such as mechanical and elevator equipment areas, computer rooms, UPS rooms, generators rooms, kitchen areas, special hazard areas, etc.

7.15 Fire Protection for Storage Facilities

General Storage. The storage arrangements and protection of a general storage facility shall meet the requirements in NFPA 13 and NFPA 231.

Rack Storage. The storage arrangements and protection of a rack storage facility shall meet the requirements in NFPA 13 and, NFPA 230.

Record Storage. The storage arrangements and protection of a record storage facility shall meet the requirements in NFPA 13 and NFPA 232.

Archive and Record Center

General. The storage arrangements and protection of an archive and record center shall meet the requirements in NFPA 13, NFPA 232 and the information provided in NFPA 232A and the National Archives and Records Administration guidelines as published in the Federal Register, GSA sponsored large scale fire testing.

Special Requirements. The following requirements take precedence over the requirements in NFPA 232:

- Smoke detectors shall be installed throughout archival storage areas in accordance with the requirements in NFPA 72.

Flammable and Combustible Liquid Storage. The storage arrangements and protection of a flammable and combustible liquid storage area shall meet the requirements in NFPA 30 and the applicable Factory Mutual Data Sheets.

7.16 Special Fire Protection Requirements

Elevator Systems

General. Elevator systems shall be designed and installed in accordance with the requirements in ANSI/ASME Standard A17.1 and the IBC.

Special Requirements. The following requirements take precedence over the requirements in ANSI/ASME Standard A17.1 and the IBC:

- Venting of hoistways shall meet the requirements in the IBC.
- Each elevator machine room shall be provided with a wet-pipe sprinkler system using standard response sprinklers. The sprinkler system for the elevator machine room shall be provided with separate manual isolation valves and a separate water flow switch located outside the room in an accessible location. Tamper switches shall be provided on all such valves.
- Sprinkler protected elevator machine rooms containing elevator control equipment shall be provided with a means to disconnect automatically the main line power supply to the affected elevator prior to 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.

Electrical Equipment Rooms and Electrical Closets

General. All electrical equipment rooms (e.g., switch gear rooms, transformer vaults, etc.) and electrical closets shall be protected by an automatic sprinkler system in accordance with the requirements in NFPA 13.

Special Requirements. The following requirements take precedence over the requirements in NFPA 13:

- All electrical switchgear rooms and transformer vaults shall be provided with separate manual isolation valves and a separate water flow switch located outside the room in an accessible location. Tamper switches shall be provided on all such valves.
- Sprinklers installed in electrical equipment rooms and electrical closets shall be equipped with sprinkler guards to provide protection against accidental damage.

Essential Electronic Facilities

General. Essential electronic facilities consist of spaces that have high value or mission essential electrical equipment such as mainframe computers or telephone switches with the potential for high dollar loss and/or business interruption. Essential electronic facilities shall 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 shall be provided throughout the facility including data storage areas.
- Quick response sprinklers shall be used throughout the facility including data storage areas.
- The sprinkler system shall have a separate isolation valve and a separate water flow switch located outside of each protected area in an accessible location. Each valve shall be provided with a tamper switch that is connected to the building's fire alarm system.
- Activation of the sprinkler water flow switch shall disconnect power to the computers and to the HVAC systems with no time delay.
- The activation of two cross-zoned conventional photoelectric smoke detectors or 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 essential electronic facilities, etc.) within a single protected area shall disconnect power to the computer equipment and to the HVAC system after a pre-set time delay.

- Water based and/or non-water based fire extinguishing systems shall not be installed below raised floors that are less than or equal to 457 mm (18 inches) in height.

Places of Confinement

General. Places of confinement are considered places where persons are held under lock during daytime hours, but not overnight.

Special Requirements. Places of confinement shall meet the following requirements:

- Places of confinement shall be separated from other parts of the building by fire partitions having a minimum 1-hour fire resistance rating. The fire-resistive enclosure shall also include all areas within the secure prisoner movement system.
- Sprinklers shall be installed within all places of confinement, including, but not limited to, prisoner holding cells, the main prisoner detention cell block, prisoner attorney interview rooms, etc.
- The sprinklers installed shall be institutional quick response flush pendent sprinklers designed for standard and extended coverage applications.
- The institutional sprinklers shall 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

General. Atriums shall 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 shall be designed as a separate sprinkler zone. In addition, a separate manual isolation valve and a separate water flow switch shall be located in an accessible location. A tamper switch shall be provided on all such valves.
- Atrium smoke removal systems shall be designed and installed in accordance with the requirements in the IBC.

Track Files

General. 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 shall meet the following requirements:

- The track file system shall be constructed entirely of steel. At least 1.4 mm (18-gauge) sheet metal shall be used for all parts of the shelving unit.
- The system shall be no more than 2438 mm (8 feet) high, and a minimum clearance of 457 mm (18 inches) shall be maintained between the top of the shelving and the ceiling.
- The sprinkler density shall be 12.2 (L/min)/m² (0.3 gpm/sq. ft.) over 139 m² (1500 sq. ft.). Sprinkler spacing shall be 9.3 m² (100 sq. ft.) maximum.
- The back cover of stationary end files shall be solid sheet metal.
- For floor loading requirements see PBS-P100, Chapter 4.

Cooling Towers

General. Cooling towers shall meet the requirements in NFPA 214.

Special Requirements. The following requirements take precedence over the requirements in NFPA 214:

- Cooling towers over 57 cubic meters (2000 cubic feet) in size, having combustible fill shall be provided with an automatic deluge sprinkler system.
- Automatic sprinkler protection shall not be required in cooling towers over 57 cubic meters (2000 cubic feet) in size, constructed of non-combustible materials, having non-combustible components (including piping) and non-combustible decks.
- Automatic sprinkler protection is required for cooling towers which are constructed of combustible materials, have combustible components (such as PVC fill, louvers, drift eliminators, etc.), or a combustible deck.

Residential Housing Units

General. Residential housing units shall 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 shall have a maximum riser height of 178 mm (7 inches) and a minimum tread depth of 279 mm (11 inches).
- Residential housing units are required to be protected by an automatic fire sprinkler system. The design of the automatic fire sprinkler system for the residential housing shall be based on the design and installation requirements in NFPA 13D. Each residential housing unit shall be provided with a local waterflow switch that will initiate

a local alarm. The sprinkler waterflow alarm shall be arranged so that the operation of the waterflow switch shall produce an alarm signal that is audible throughout all inhabited areas of the individual housing unit. The sprinkler system waterflow switch and control valve shall be monitored for alarm, supervisory, and trouble conditions.

- Residential housing units shall be provided with approved multiple-station smoke alarms in the following locations: (a) in all sleeping rooms, (b) outside of each separate sleeping area, in the immediate vicinity of the sleeping rooms, and (c) on each level of the dwelling unit, including basements. All smoke alarms shall be designed and installed in accordance with the requirements in the NFPA 72. All smoke alarms within the residential housing unit shall 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 shall not be installed in the residential housing unit.

Chemical Laboratories

General. Laboratories shall 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 shall not be expanded in existing office buildings.
- All chemical laboratories shall be sprinklered, regardless of size. Sprinkler protection shall be calculated to provide a density of 0.15 gpm per sq. ft. over a 3,000 sq. ft. area.

U.S. Court Facilities

For special fire protection and life safety requirements for U.S. Courts facilities, refer to PBS-P100 Chapter 9 and the *U.S. Courts Design Guide*.

U.S. Marshal Service

For special fire protection and life safety requirements for U.S Marshal 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*.

Child Care Centers

For special fire protection and life safety requirements for Child Care Centers, refer to the GSA *Child Care Center Design Guide* (PBS-P140).



Child Care Center

7.17 Emergency Power, Lighting and Exit Signage

Emergency and Standby Power Systems. Emergency and standby power shall meet the performance requirements in NFPA 70, NFPA 110, and NFPA 111.

Emergency Lighting. Emergency lighting shall meet the performance requirements in NFPA 101.

Exit Signage. Exit signage shall be installed and meet the performance requirements in NFPA 101.

7.18 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 shall explore alternative approaches outlined in state rehabilitation codes, International Existing Building Code (IEBC), and performance based codes to resolve conflicts between prescriptive code requirements and preservation goals. In addition, the requirements and recommendations of NFPA 914 shall be considered for rehabilitation projects in historic structures. The Design Team shall also evaluate the HUD Guideline Fire Ratings of Archaic Materials and Assemblies that provides test data on the fire resistance of a variety of historic materials and GSA publication titled *Fire Safety Retrofitting in Historic Buildings*.

GSA's regional fire protection engineer serves as the AHJ, 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 imperative to timely resolution of conflicts between fire safety and preservation goals.

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:

- 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 must be kept closed to maintain a rated enclosure. Non-prescriptive compliance solutions, such as modification of historic door assemblies, must 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 beam, 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 must be coordinated with, and approved in writing by, the manufacturer to ensure that UL labels and detector performance are not compromised. Smoke detector housings must be removed prior to application of special finishes.



Security Design

8

Richard Bolling Federal Building First Impressions Project

Architect: BNIM Architects

Kansas City, Missouri

GSA Project Manager: George Gourse

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8.1 Planning and Cost

Planning

Designing and constructing safe and secure cost effective buildings has always been one of GSA's primary goals. To design and construct a safe and secure building, a collaborative approach to the design process is required, starting at the conceptual phase of the project and continuing throughout the process. It is necessary for all persons responsible for the safety and security of the building components to interact closely throughout the entire design and construction process. This means that all interested parties involved in issues pertaining to safety and security understand the issues and concerns of both parties. This also involves inviting the client, local building and fire officials, the appropriate designers and consultants to participate in such discussions. This process is particularly helpful in complex situations where many people represent different interests and a common goal needs to be achieved (i.e., a safe and secure building).

A multidisciplinary team will determine the appropriate design criteria for each project, based on a building-specific risk assessment and an analysis of all available information on security considerations, constraints, and tenant needs. However, a delicate balance must be achieved between safety and the security measures proposed. Therefore, the GSA fire protection engineer shall be a full participant on the subject multidisciplinary team to ensure that the safety of the building occupants exiting the building and the emergency responders entering the building are not impacted unknowingly by any proposed security measure. In the event Raised Floor/Underfloor Air Distribution systems are considered for the project, refer to *GSA RF/UFAD Guidelines*.

In historic buildings, to minimize loss of character, design criteria should be based on facility-specific risk

assessment and strategic programming. Strategic programming includes focusing security modifications on vulnerability points and locating less vulnerable activities in the historic buildings.

Zones of Protection

A zoned protection system is used, with intensifying areas of security beginning at the site perimeter and moving to the interior of the building.

Crime Prevention Through Environmental Design

(CPTED). CPTED techniques should be used to help prevent and mitigate crime. Good strategic thinking on CPTED issues such as site planning, perimeter definition, sight lines, lighting, etc., can reduce the need for some engineering solutions.

For further information on CPTED, see:

- Publications by the National Institute of Law Enforcement and Criminal Justice (NILECJ).
- Crowe, Timothy D., *Crime Prevention Through Environmental Design*. National Crime Prevention Institute (1991).

Capability to Increase or Decrease Security. Designs should include the ability to increase security in response to a heightened threat, as well as to reduce security if changes in risk warrant it.

Multidisciplinary Approach. Improving security is the business of everyone involved with Federal facilities including designers, builders, operations and protection personnel, employees, clients, and visitors. Professionals who can contribute to implementing the criteria in this document include architects and structural, mechanical, fire protection, security, cost, and electrical engineers. Blast engineers and glazing specialists may also be

required as well as building operations personnel and security professionals experienced in physical security design, operations, and risk assessment.

Each building system and element should support risk mitigation and reduce casualties, property damage, and the loss of critical functions. Security should be considered in all decisions, from selecting architectural materials to placing trash receptacles to designing redundant electrical systems.

Site Security Requirements. Site security requirements, including perimeter buffer zones, should be developed before a site is acquired and the construction funding request is finalized. This requirement may be used to prevent the purchase of a site that lacks necessary features, especially sufficient setback, and to help reduce the need for more costly countermeasures such as blast hardening.

Adjacent Sites. When warranted by a risk assessment, consideration should be given to acquiring adjacent sites or negotiating for control of rights-of-way. Adjacent sites can affect the security of Federal facilities.

Access Control and Electronic Security. Electronic security, including surveillance, intrusion detection, and screening, is a key element of facility protection; many aspects of electronic security and the posting of security personnel are adequately dealt with in other criteria and guideline documents. These criteria primarily address access control planning—including aspects of stair and

lobby design—because access control must be considered when design concepts for a building are first conceived. While fewer options are available for modernization projects, some designs can be altered to consider future access control objectives.

Cost

Initial Costs. When cost is not considered, one risk can consume a disproportionate amount of the budget while other risks may go unmitigated or not addressed at all. Budgets should match the requirements of the risk assessment. It is important that decision-makers know funding needs early so that they can request funding to fully implement the requirements of the risk assessment. Should projects be over budget, security, along with other building elements, may be reevaluated. However, if security is decreased, there should be compensating operational procedures and/or periodic reevaluation to see if technology or procedures can mitigate the risk.

The security budget shall be an output of a project-specific risk assessment. After the initial risk assessment has been conducted, a plan shall outline security requirements for specific building systems. To facilitate funding, cost control, and risk management, agencies shall consider a work breakdown structure which summarizes security expenditures in a specific account that can be clearly identified and monitored throughout design phases. This can facilitate the allocation of those funds to counter-

measures for project-specific risks. For example, funding crime prevention may be more important than funding terrorist prevention countermeasures for some projects.

Cost-Risk Analysis. Actual costs may be more or less than budgeted. This cost risk results from the need to predict bidding market costs years in advance, evolving technology, changing risks, different countermeasures, and varying project conditions. The “Standard Practice for Measuring Cost Risk of Buildings and Building Systems,” ASTM E 1946, may be used to manage cost risk.

Site Planning and Landscape Design

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

Effective site planning and landscape design can enhance the security of a facility and eliminate the need for some engineering solutions. Security considerations should be an integral part of all site planning, perimeter definition, lighting, and landscape decisions.



Thomas Eagleton Courthouse, St. Louis, MO

Vehicular Control

Distance. The preferred distance from a building to unscreened vehicles or parking is ____ (project-specific information to be provided). Ways to achieve this distance include creating a buffer zone using design features such as street furniture and bollards that can function as barriers; restricting vehicle access (see sections on *Perimeter Protection Zone and Landscaping* below, and Chapter 9). See Chapter 2: *Site Circulation Design*, for fire department/fire apparatus access requirements for which design must also be in compliance.

Perimeter Protection Zone. Site perimeter barriers are one element of the perimeter protection zone. Perimeter barriers capable of stopping vehicles of _____ lbs., up to a speed of _____, shall be installed (project-specific information to be provided). A vehicle velocity shall be used considering the angle of incidence in conjunction with the distance between the perimeter and the point at which a vehicle would likely be able to start a run at the perimeter. A barrier shall be selected that will stop the threat vehicle. Army TM 5-853-1 and TM 5-853-2/AFMAN 32-1071, Volume 2 contain design procedures. See Chapter 2: *Site Circulation Design*, for fire department/fire apparatus access requirements for which design must also be in compliance. In designing the barrier system, consider the following options:

- Using various types and designs of buffers and barriers such as walls, fences, trenches, ponds and water basins, plantings, trees, static barriers, sculpture, and street furniture;
- Designing site circulation to prevent high speed approaches by vehicles; and

- Offsetting vehicle entrances as necessary from the direction of a vehicle's approach to force a reduction in speed.

Perimeter Vehicle Inspection

- Provide space for inspection at a location to be specified.
- Provide design features for the vehicular inspection point that stop vehicles, prevent them from leaving the vehicular inspection area, and prevent tailgating.

Site Lighting

Effective site lighting levels: At vehicular and pedestrian entrances, ____ (project-specific information to be provided) horizontal maintained foot candles; and for perimeter and vehicular and pedestrian circulation areas, ____ horizontal maintained foot candles. In most circumstances, perimeter lighting should be continuous and on both sides of the perimeter barriers, with minimal hot and cold spots and sufficient to support CCTV and other surveillance. However, for safety reasons and/or for issues related to camera technology, lower levels may be desirable. Other codes or standards may restrict site lighting levels. Designers shall consult IESNA recommended practices for security lighting.

Site Signage

Confusion over site circulation, parking, and entrance locations can contribute to a loss of site security. Signs should be provided off site and at entrances; there should be on-site directional, parking, and cautionary signs for visitors, employees, service vehicles, and pedestrians. Unless required by other standards, signs should generally not be provided that identify sensitive areas.

Landscaping

Landscaping design elements that are attractive and welcoming can enhance security. For example, plants can deter unwanted entry; ponds and fountains can block vehicle access; and site grading can also limit access. Avoid landscaping that permits concealment of criminals or obstructs the view of security personnel and CCTV, in accordance with accepted CPTED principles.



Oakland Federal Building

8.2 Architecture and Interior Design

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

Planning

Office Locations. Offices of vulnerable officials should be placed or glazed so that the occupant cannot be seen from an uncontrolled public area such as a street. Whenever possible, these offices should face courtyards, internal sites, or controlled areas. If this is not possible, suitable obscuring glazing or window treatment shall be provided, including blast and ballistic resistant glass (see section on *New Construction, Exterior Windows, Additional Glazing Requirements*), blast curtains, or other interior protection systems.

Mixed Occupancies. When possible, high-risk tenants should not be housed with low-risk tenants. If they are housed together, publicly accessible areas should be separated from high-risk tenants.

Public Toilets and Service Areas. Public toilets, service spaces, or access to vertical circulation systems should not be located in any non-secure areas, including the queuing area before screening at the public entrance.

Lobbies. See the GS0A PBS document, *Design Notebook for Federal Lobby Security*.

Loading Docks and Shipping and Receiving Areas.

Loading Docks and Shipping and Receiving Areas should be separated by a specified distance in any direction from critical utilities and services. The recommended distance is 50 feet.

Retail in the Lobby. Retail and other mixed uses, which are encouraged by the Public Buildings Cooperative Use Act of 1976, create public buildings that are open and inviting. While important to the public nature of the buildings, the presence of retail and other mixed uses may present a risk to the building and its occupants and should be carefully considered on a project specific basis during the risk assessment process. Retail and mixed uses may be accommodated through such means as separating entryways, controlling access, and hardening shared partitions, as well as through special security operational countermeasures.

Stairwells. Stairwells required for emergency egress should be located as remotely as possible from areas where blast events might occur. Wherever possible, stairs should not discharge into lobbies, parking, or loading areas.

Mailroom. The mailroom should be located away from facility main entrances, areas containing critical services, utilities, distribution systems, and important assets. In addition, the mailroom should be located at the perimeter of the building with an outside wall or window designed for pressure relief. It should have adequate space for explosive disposal containers. An area near the loading dock may be a preferred mailroom location.

Interior Construction

Lobby Doors and Partitions. Doors and walls along the line of security screening should meet requirements of UL752 Level___(project-specific information to be provided).

Critical Building Components. The following critical building components should be located no closer than ___ feet in any direction to any main entrance, vehicle circulation, parking, or maintenance area (project-specific information to be provided). If this is not possible, harden as appropriate:

- Emergency generator including fuel systems, day tank, fire sprinkler, and water supply;
- Normal fuel storage;
- Main switchgear;
- Telephone distribution and main switchgear;
- Fire pumps;
- Building control centers;
- UPS systems controlling critical functions;
- Main refrigeration systems if critical to building operation;
- Elevator machinery and controls;
- Shafts for stairs, elevators, and utilities;
- Critical distribution feeders for emergency power.

Exterior Entrances. The entrance design must balance aesthetic, security, risk, and operational considerations. One strategy is to consider co-locating public and employee entrances. Entrances should be designed to avoid significant queuing. If queuing will occur within the building footprint, the area should be enclosed in blast-resistant construction. If queuing is expected outside the building, a rain cover should be provided. Historic buildings generally require alternative design schemes that will not alter the exterior or lobby configuration. Consult the Regional Historic Preservation Officer regarding appropriate solutions.

Forced Entry. See section on *Exterior Walls* for swinging door, horizontal sliding door, and wall criteria. See section on *Structural Engineering, New Construction, Exterior Windows* for window criteria.

Equipment Space. Public and employee entrances should include space for possible future installation of access control and screening equipment. In historic buildings place security equipment in ancillary spaces where possible.

Entrance Co-location. Combine public and employee entrances.

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 shall be protected by devices capable of arresting a vehicle of the designated threat size at the designated speed. This criterion may be lowered if the access circumstances prohibit a vehicle from reaching this speed (see section on *Site Planning and Landscape Design, Vehicular Control, Perimeter Protection Zone*).

Additional Features

Areas of Potential Concealment. To reduce the potential for concealment of devices before screening points, avoid installing features such as trash receptacles and mail boxes that can be used to hide devices. If mail or express boxes are used, the size of the openings should be restricted to prohibit insertion of packages.

Roof Access. Design locking systems to meet the requirements of the International Building Code and limit roof access to authorized personnel.



Warren B. Rudman Courthouse, Concord, NH



Sam Gibbons U.S. Courthouse, Tampa, FL

8.3 Commissioning

The design team's security consultant/engineer shall identify and coordinate commissioning practices with the Construction Manager, Project Manager, and (if contracted separately) the Commissioning Authority, for the project's programmed performance goals. As appropriate, coordinate with other disciplines to fully enable required testing and certifications. Incorporate into construction specifications those testing and certification requirements that involve construction contractors. Examples of possible programmed performance goals, include:

- Glazing/Framing Blast Resistance.
- HVAC Emergency Modes of Operation (for Chemical-Biological Attack).
- Effectiveness of Entrance Card-Key System(s).
- Speech Privacy.
- Effectiveness of Electronic Security.
- Functionality of Assistance/Alarm Systems.
- Effectiveness of Building Automation System Interface.
- Functionality of Applied Innovative Technologies.

8.4 New Construction

Progressive Collapse. Designs that facilitate or are vulnerable to progressive collapse must be avoided. At a minimum, all new facilities shall be designed for the loss of a column for one floor above grade at the building perimeter without progressive collapse. This design and analysis requirement for progressive collapse is not part of a blast analysis. It is intended to ensure adequate redundant load paths in the structure should damage occur for whatever reason. 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 shall 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 of the damage.

In the event of an internal explosion in an uncontrolled public ground floor area, the design shall prevent progressive collapse due to the loss of one primary column, or the designer shall show that the proposed design precludes such a loss. That is, if columns are sized, reinforced, or protected so that the threat charge will not cause the column to be critically damaged, then progressive collapse calculations are not required for the internal event. GSA encourages the use of highly confined reinforced concrete or stiffened steel columns and discourages the use of steel column splices within these spaces. For design purposes, assume there is no additional standoff from the column beyond what is permitted by the design.

Discussion: As an example, if an explosive event causes the local failure of one column and major collapse within one structural bay, a design mitigating progressive collapse

would preclude the additional loss of primary structural members beyond this localized damage zone (i.e., the loss of additional columns, main girders, etc.). This does not preclude the additional loss of secondary structural or non-structural elements outside the initial zone of localized damage, provided the loss of such members is acceptable for that performance level and the loss does not precipitate the onset of progressive collapse.

Building Materials. All building materials and types acceptable under the model International Building Code are allowed. However, special consideration should be given to materials which have inherent ductility and which 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 pre-stressed concrete, pre-cast 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.

Exterior Walls

Design for limited load:

- Design exterior walls for the actual pressures and impulses up to a maximum of ____ psi and ____ psi-msec (project-specific information to be provided).
- The designer should also ensure that the walls are capable of withstanding the dynamic reactions from the windows.
- Shear walls that are essential to the lateral and vertical load bearing system, and that also function as exterior walls, shall be considered primary structures. Design exterior shear walls to resist the actual blast loads predicted from the threats specified.

- Where exterior walls are not designed for the full design loads, special consideration shall be given to construction types that reduce the potential for injury (see *Building Materials* in this section).

Design for full load:

- Design the exterior walls to resist the actual pressures and impulses acting on the exterior wall surfaces from the threats defined for the facility (see also discussions in Design for limited load above).

Forced Entry:

- Security of Swinging Door Assemblies ASTM F 476 Grade ____ (project-specific information to be provided).
- Measurement of Forced Entry Resistance of Horizontal Sliding Door Assemblies ASTM F 842 Grade ____ (project-specific information to be provided).
- A medium protection level (per TM 5-853) for walls would be the equivalent of 4" concrete with #5 reinforcing steel at 6" interval each way or 8" CMU with #4 reinforcing steel at 8 in. interval. TM 5-853 provides other alternatives for low, medium, and high protection.

Exterior Windows

The multidisciplinary team shall evaluate the performance requirements for all security-glazing materials proposed for the project. The multidisciplinary team shall ensure that normal tools carried by firefighters, such as a pick head axe, halligan tool, or similar device, can readily overcome the subject 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 that a blast may not blow out the windows, alternative methods or systems must be designed to ensure smoke from the incident is not trapped inside the building. (See section on *New Construction, Fire Protection Engineering, Smoke Removal Systems*).

The following terms are to be applied and identified for each project-specific risk assessment:

No restriction. No restrictions on the type of glazing.

Limited protection. These windows do not require design for specific blast pressure loads. Rather, the designer is encouraged to use glazing materials and designs that minimize the potential risks.

- Preferred systems include: thermally tempered heat strengthened or annealed glass with a security film installed on the interior surface and attached to the frame; laminated thermally tempered, laminated heat strengthened, or laminated annealed glass; and blast curtains.
- Acceptable systems include thermally tempered glass; and thermally tempered, heat strengthened or annealed glass with film installed on the interior surface (edge to edge, wet glazed, or daylight installations are acceptable).
- Unacceptable systems include untreated monolithic annealed or heat strengthened glass; and wire glass.

The minimum thickness of film that should be considered is 4 mil. In a blast environment, glazing can induce loads three or more times that of conventional loads onto the frames. This must be considered with the application of anti-shatter security film.

The designer should design the window frames so that they do not fail prior to the glazing under lateral load. Likewise, the anchorage should be stronger than the window frame, and the supporting wall should be stronger than the anchorage.

The design strength of a window frame and associated anchorage is related to the breaking strength of the glazing. Thermally tempered glass is roughly four times as strong as annealed, and heat strengthened glass is roughly twice as strong as annealed.

Table 8-1

Glazing Protection Levels Based on Fragment Impact Locations

Performance Condition	Protection Level	Hazard Level	Description of Window Glazing Response
1	Safe	None	Glazing does not break. No visible damage to glazing or frame.
2	Very High	None	Glazing cracks but is retained by the frame. Dusting or very small fragments near sill or on floor acceptable.
3a	High	Very Low	Glazing cracks. Fragments enter space and land on floor no further than 3.3 ft. from the window.
3b	High	Low	Glazing cracks. Fragments enter space and land on floor no further than 10 ft. from the window.
4	Medium	Medium	Glazing cracks. Fragments enter space and land on floor and impact a vertical witness panel at a distance of no more than 10 ft. from the window at a height no greater than 2 ft. above the floor.
5	Low	High	Glazing cracks and window system fails catastrophically. Fragments enter space impacting a vertical witness panel at a distance of no more than 10 ft. from the window at a height greater than 2 ft. above the floor.

* In conditions 2, 3a, 3b, 4 and 5, glazing fragments may be thrown to the outside of the protected space toward the detonation location.

Design up to specified load. Window systems for the exterior façade should be designed to be in balance with the framing, anchorage and supporting walls in order to mitigate hazard of flying glass in an explosive event. The walls, anchorage of the window to the walls or floors, and the window framing itself should be designed for the maximum capacity of the glass type selected. This is to ensure that the glass fails before the window frame or wall can fail.

The designer of the window systems may use the outputs from government produced and sponsored computer programs (e.g., WINGARD, WINLAC, SAFEVUE) coupled with test data and recognized structural dynamic analysis procedures to show that the glazing either survives the specified threats or the post damage performance of the glazing protects the occupants in accordance with the conditions specified here (Table 8-1). When using such methods, the designer may consider a breakage

probability no higher than 750 breaks per 1000 when calculating loads to frames and anchorage.

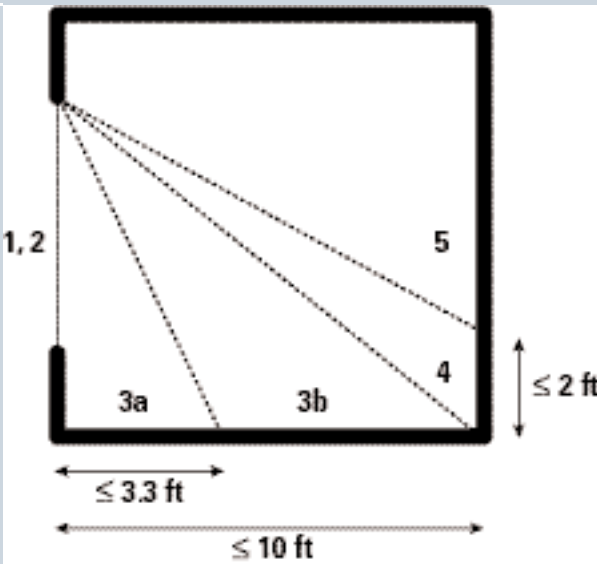
While most test data use glazing framed with a deep bite, this may not be amenable to effective glazing performance or installation. It has been demonstrated that new glazing systems with a 3/4-inch minimum bite can be engineered to meet the performance standards of Table 8-2 with the application of structural silicone. However, not much information is available on the long-term performance of

glazing attached by structural silicone or with anchored security films.

All glazing hazard reduction products for these protection levels require product-specific test results and engineering analyses performed by qualified independent agents demonstrating the performance of the product under the specified blast loads, and stating that it meets or exceeds the minimum performance required. Performance levels are based on the protection conditions presented in Table 8-2. A Government-provided database indicating the performance of a wide variety of products will be made available to the designer.

Table 8-2
Test Structure

Side view of test structure illustrating performance conditions of Table 8-1



Test window should be in the design position or centered on the wall.

- **Window Fenestration:** The total fenestration openings are not limited; however, a maximum of 40 percent per structural bay is a preferred design goal.
- **Window Frames:** The frame system should develop the full capacity of the chosen glazing up to 750 breaks per 1000, and provide the required level of protection without failure. This can be shown through design calculations or approved testing methods.
- **Anchorage:** The anchorage should remain attached to the walls of the facility during an explosive event without failure. Capacity of the anchorage system can be shown through design calculations or approved tests that demonstrate that failure of the proposed anchorage will not occur and that the required performance level is provided.

Glazing alternatives. Glazing alternatives are as follows:

- **Preferred systems include:** thermally tempered glass with a security film installed on the interior surface and attached to the frame; laminated thermally tempered, laminated heat strengthened, or laminated annealed glass; and blast curtains.
- Acceptable systems include monolithic thermally tempered glass with or without film if the pane is designed to withstand the full design threat (see Condition 1 on Table 8-2).

- Unacceptable systems include untreated monolithic annealed or heat-strengthened glass; and wire glass.

In general, thicker anti-shatter security films provide higher levels of hazard mitigation than thinner films. Testing has shown that a minimum of a 7 mil thick film, or specially manufactured 4 mil thick film, is the minimum to provide hazard mitigation from blast. The minimum film thickness that should be considered is 4 mil.

Not all windows in a public facility can reasonably be designed to resist the full forces expected from the design blast threats. As a minimum, design window systems (glazing, frames, and anchorage) to achieve the specified performance conditions (Table 8-2) for the actual blast pressure and impulse acting on the windows up to a maximum of ____ psi and ____ psi-msec. As a minimum goal, the window systems should be designed so that at least ____ percent of the total glazed areas of the facility meet the specified performance conditions when subjected to the defined threats (project-specific information to be provided).

In some cases, it may be beneficial and economically feasible to select a glazing system that demonstrates a higher, safer performance condition. Where tests indicate that one design will perform better at significantly higher loads, that design could be given greater preference.

Where peak pressures from the design explosive threats can be shown to be below 1 psi acting on the face of the building, the designer may use the reduced requirements of Exterior Walls, Limited Protection, in this section.

Additional Glazing Requirements:

- Ballistic windows, if required, shall meet the requirements of UL 752 Bullet-Resistant Glazing Level ____ (project-specific information to be provided). Glass-clad polycarbonate or laminated polycarbonate are two types of acceptable glazing material.



Robert C. Byrd Courthouse, Charleston, WV

- Security glazing, if required, shall meet the requirements of ASTM F1233 or UL 972, *Burglary Resistant Glazing Material*.

This glazing should meet the minimum performance specified in Table 8-2. However, special consideration should be given to frames and anchorages for ballistic-resistant windows and security glazing since their inherent resistance to blast may impart large reaction loads to the supporting walls.

- Resistance of Window Assemblies to Forced Entry (excluding glazing) ASTM F 588 Grade___ (project-specific information to be provided; see above for glazing).
- Design for eavesdropping and electronic emanations is beyond the scope of the criteria.

Non-Window Openings. Non-window openings such as mechanical vents and exposed plenums should be designed to the level of protection required for the exterior wall. Designs should account for potential in-filling of blast over-pressures through such openings. The design of structural members and all mechanical system mountings and attachments should resist these interior fill pressures.

Interior Windows. Interior glazing should be minimized where a threat exists. The designer should avoid locating critical functions next to high risk areas with glazing, such as lobbies, loading docks, etc.

Parking. The following criteria apply to parking inside a facility where the building superstructure is supported by the parking structure:

- The designer shall protect primary vertical load carrying members by implementing architectural or structural features that provide a minimum 6-inch standoff.
- All columns in the garage area shall be designed for an unbraced length equal to two floors, or three floors where there are two levels of parking.

Selected Design Areas. For lobbies and other areas with specified threats:

- The designer shall implement architectural or structural features that deny contact with exposed primary vertical load members in these areas. A minimum standoff of at least 6 inches from these members is required.
- Primary vertical load carrying members shall be designed to resist the effects of the specified threat (see *Progressive Collapse* in this section).

Loading Docks. The loading dock design should limit damage to adjacent areas and vent explosive force to the exterior of the building. Significant structural damage to the walls and ceiling of the loading dock is acceptable. However, the areas adjacent to the loading dock should not experience severe structural damage or collapse. The floor of the loading dock does not need to be designed for blast resistance if the area below is not occupied and contains no critical utilities.

Mailrooms and Unscreened Retail Spaces. Mailrooms where packages are received and opened for inspection, and unscreened retail spaces (see *Architecture and Interior Design, Planning, Retail in the Lobby and Mailroom*) shall be designed to mitigate the effects of a blast on primary vertical or lateral bracing members. Where these rooms are located in occupied areas or adjacent to critical utilities, walls, ceilings, and floors, they should be blast and fragment resistant. Significant structural damage to the walls, ceilings, and floors of the mailroom is acceptable. However, the areas adjacent to the mailroom should not experience severe damage or collapse.

Venting. The designer should consider methods to facilitate the venting of explosive forces and gases from the interior spaces to the outside of the structure. Examples of such methods include the use of blow-out panels and window system designs that provide protection from blast pressure applied to the outside but that readily fail and vent if exposed to blast pressure on the inside.

8.5 Existing Construction Modernization

Existing structures undergoing a modernization should be upgraded to new construction requirements when required by the risk assessment except where noted in *Progressive Collapse*, below. The requirements of new construction apply to all major additions and structural modifications.

Protection Levels. Risk assessments based on the new construction criteria shall be performed on existing structures to examine the feasibility of upgrading the facility. The results, including at a minimum recommendations and cost, shall be documented in a written report before submission for project funding.

Progressive Collapse. Progressive Collapse analysis must be performed if:

1. The building is to be upgraded for seismic forces
2. The building structural frame will be exposed as part of the current scope of work making any structural upgrade for preventing progressive collapse appropriate at this time.
3. The exterior façade of the building is to be removed making structural upgrade of the perimeter structural system appropriate at this time.

Prior to the submission for funding, all structures shall be analyzed according to requirements for new construction, and a written report shall clearly state the potential vulnerability of the building to progressive collapse. This report will be used as a planning tool to reduce risk. Findings of the design-analysis shall be incorporated into the project's risk assessment and include the methodology, the details of the progressive collapse analysis, retrofit recommendations, cost estimates, and supporting calculations.

8.6 Historic Buildings

Historic buildings are covered by these criteria in the same manner as other existing buildings (see *Existing Construction Modernization* in this section).



Edward T. Gignoux U.S. Courthouse, Portland, ME

8.7 Structural Engineering

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The intent of these criteria is to reduce the potential for widespread catastrophic structural damage and the resulting injury to people. The designer should 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.

There are three basic approaches to blast resistant design: blast loads can be reduced, primarily by increasing standoff; a facility can be strengthened; or higher levels of risk can be accepted. The best answer is often a blend of the three.

The field of protective design is the subject of intense research and testing. These criteria will be updated and revised as new information about material and structural response is made available.

Refer to Chapter 4: *Structural Engineering*, for additional related information.

General Requirements

Designer Qualifications. For buildings designed to meet Medium or Higher Protection Levels, a blast engineer must be included as a member of the design team. He/she should have formal training in structural dynamics, and demonstrated experience with accepted design practices for blast resistant design and with referenced technical manuals.

Design Narratives. A design narrative and copies of design calculations shall be submitted at each phase identifying the building-specific implementation of the criteria. Security requirements should be integrated into the overall building design starting with the planning phase.

Compliance. Full compliance with the risk assessment and this chapter is expected. Specific requirements should be in accordance with the findings of the facility risk assessment.

New Techniques. Alternative analysis and mitigation methods are permitted, provided that the performance level is attained. A peer group should evaluate new and untested methods.

Methods and References. All building components requiring blast resistance shall be designed using established methods and approaches for determining dynamic loads, structural detailing, and dynamic structural response. Design and analysis approaches should be consistent with those in the technical manuals (TMs) below.

The following are primary TMs (see *Good Engineering Practice Guidelines*, Item 18, in this section for additional references):

- Air Force Engineering and Services Center. *Protective Construction Design Manual*, ESL-TR-87-57. Prepared for Engineering and Services Laboratory, Tyndall Air Force Base, FL. (1989)
- U.S. Department of the Army. *Fundamentals of Protective Design for Conventional Weapons*, TM 5- 855-1. Washington, DC, Headquarters, U.S. Department of the Army. (1986)
- U.S. Department of the Army. *Security Engineering*, TM 5-853 and Air Force AFMAN 32-1071, Volumes 1, 2, 3, and 4. Washington, DC, Departments of the Army and Air Force. (1994)
- U.S. Department of the Army. *Structures to Resist the Effects of Accidental Explosions*, Army TM 5-1300, Navy NAVFAC P-397, AFR 88-2. Washington, DC, Departments of the Army, Navy and Air Force. (1990)
- U.S. Department of Energy. *A Manual for the Prediction of Blast and Fragment Loading on Structures*, DOE/TIC 11268. Washington, DC, Headquarters, U.S. Department of Energy. (1992)

Structural and Non-Structural Elements. To address blast, the priority for upgrades should be based on the relative importance of a structural or non-structural element, in the order defined below:

- **Primary Structural Elements** - the essential parts of the building's resistance to catastrophic blast loads and progressive collapse, including columns, girders, roof beams, and the main lateral resistance system;

- **Secondary Structural Elements** - all other load bearing members, such as floor beams, slabs, etc.;
- **Primary Non-Structural Elements** - elements (including their attachments) which are essential for life safety systems or elements which can cause substantial injury if failure occurs, including ceilings or heavy suspended mechanical units; and
- **Secondary Non-Structural Elements** - all elements not covered in primary non-structural elements, such as partitions, furniture, and light fixtures.

Priority should be given to the critical elements that are essential to mitigating the extent of collapse. Designs for secondary structural elements should minimize injury and damage. Consideration should also be given to reducing damage and injury from primary as well as secondary non-structural elements.

Loads and Stresses. Where required, structures shall be designed to resist blast loads. The demands on the structure will be equal to the combined effects of dead, live , and blast loads. Blast loads or dynamic rebound may occur in directions opposed to typical gravity loads.

For purposes of designing against progressive collapse, loads shall be defined as dead load plus a realistic estimate of actual live load. The value of the live load may be as low as 25 percent of the code-prescribed live load.

The design should use ultimate strengths with dynamic enhancements based on strain rates. Allowable responses are generally post elastic.

Protection Levels. The entire building structure or portions of the structure will be assigned a protection level according to the facility-specific risk assessment. Protection levels for ballistics and forced entry are described in *New Construction* in this section. The following are definitions of damage to the structure and exterior wall systems from the bomb threat for each protection level:

- **Low and Medium/Low Level Protection** - Major damage. The facility or protected space will sustain a high level of damage without progressive collapse. Casualties will occur and assets will be damaged. Building components, including structural members, will require replacement, or the building may be completely unrepairable, requiring demolition and replacement.
- **Medium Level Protection** - Moderate damage, repairable. The facility or protected space will sustain a significant degree of damage, but the structure should be reusable. Some casualties may occur and assets may be damaged. Building elements other than major structural members may require replacement.
- **Higher Level Protection** - Minor damage, repairable. The facility or protected space may globally sustain minor damage with some local significant damage possible. Occupants may incur some injury, and assets may receive minor damage.

Good Engineering Practice Guidelines

The following are rules of thumb commonly used to mitigate the effects of blast on structures. Details and more complete guidance are available in the Technical Manuals listed in the *New Techniques, Methods and References* section, and in the references below. The following guidelines are not meant to be complete, but are provided to assist the designer in the initial evaluation and selection of design approaches.

For higher levels of protection from blast, cast-in-place reinforced concrete is normally the construction type of choice. Other types of construction such as properly designed and detailed steel structures are also allowed. Several material and construction types, while not disallowed by these criteria, may be undesirable and uneconomical for protection from blast.

- To economically provide protection from blast, inelastic or post elastic design is standard. This allows the structure to absorb the energy of the explosion through plastic deformation while achieving the objective of saving lives. To design and analyze structures for blast loads, which are highly nonlinear both spatially and temporally, it is essential that proper dynamic analysis methods be used. Static analysis methods will generally result in unachievable or uneconomical designs.
- The designer should recognize that components might act in directions for which they are not designed. This is due to the engulfment of structural members by blast, the negative phase, the upward loading of elements, and dynamic rebound of members. Making steel reinforcement (positive and negative faces) symmetric in all floor slabs, roof slabs, walls, beams and girders will address this issue. Symmetric reinforcement also increases the ultimate load capacity of the members.
- Lap splices should fully develop the capacity of the reinforcement.
- Lap splices and other discontinuities should be staggered.
- Ductile detailing should be used for connections, especially primary structural member connections.
- There should be control of deflections around certain members, such as windows, to prevent premature failure. Additional reinforcement is generally required.
- Balanced design of all building structural components is desired. For example, for window systems, the frame and anchorage shall be designed to resist the full capacity of the weakest element of the system.

- Special shear reinforcement including ties and stirrups is generally required to allow large post-elastic behavior. The designer should carefully balance the selection of small but heavily reinforced (i.e., congested) sections with larger sections with lower levels of reinforcement.
- Connections for steel construction should be ductile and develop as much moment connection as practical. Connections for cladding and exterior walls to steel frames shall develop the capacity of the wall system under blast loads.
- In general, single point failures that can cascade, producing wide spread catastrophic collapse, are to be avoided. A prime example is the use of transfer beams and girders that, if lost, may cause progressive collapse and are therefore highly discouraged.
- Redundancy and alternative load paths are generally good in mitigating blast loads. One method of accomplishing this is to use two-way reinforcement schemes where possible.
- In general, column spacing should be minimized so that reasonably sized members can be designed to resist the design loads and increase the redundancy of the system. A practical upper level for column spacing is generally 30 ft. for the levels of blast loads described herein.
- In general, floor to floor heights should be minimized. Unless there is an overriding architectural requirement, a practical limit is generally less than or equal to 16 ft.
- It is recommended that the designer use fully grouted and reinforced CMU construction in cases where CMU is selected.
- It is essential that the designer actively coordinate structural requirements for blast with other disciplines including architectural and mechanical.
- The use of one-way wall elements spanning from floor-to-floor is generally a preferred method to minimize blast loads imparted to columns.



U.S. Census Bureau, Bowie, MD

- In many cases, the ductile detailing requirements for seismic design and the alternate load paths provided by progressive collapse design assist in the protection from blast. The designer must bear in mind, however, that the design approaches are at times in conflict. These conflicts must be worked out on a case by case basis.

The following additional references are recommended:

- Biggs, John M. *Introduction to Structural Dynamics*. McGraw-Hill. (1964).
- The Institute of Structural Engineers. *The Structural Engineer's Response to Explosive Damage*. SETO, Ltd., 11 Upper Belgrave Street, London SW1X8BH. (1995).
- Mays, G.S. and Smith, P.D. *Blast Effects on Buildings: Design of Buildings to Optimize Resistance to Blast Loading*. Thomas Telford Publications, 1 Heron Quay, London E14 4JD. (1995).
- National Research Council. *Protecting Buildings from Bomb Damage*. National Academy Press. (1995).

8.8 Mechanical Engineering

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

The mechanical system should continue the operation of key life safety components following an incident. The criteria focus on locating components in less vulnerable areas, limiting access to mechanical systems, and providing a reasonable amount of redundancy.

Air System

Air Intakes. On buildings of more than four stories, locate intakes on the fourth floor or higher. On buildings of three stories or less, locate intakes on the roof or as high as practical. Locating intakes high on a wall is preferred over a roof location.

Utility Protection

Utilities and Feeders. Utility systems should be located at least 50 feet from loading docks, front entrances, and parking areas.

Incoming Utilities. Within building and property lines, incoming utility systems should be concealed and given blast protection, including burial or proper encasement wherever possible (see section on *Electrical Engineering, Service and Distribution, Utilities and Feeders*).

8.9 Electrical Engineering

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

The major security functions of the electrical system are to maintain power to essential building services, especially those required for life safety and evacuation; provide lighting and surveillance to deter criminal activities; and provide emergency communication (see section on *Architecture and Interior Design, Interior Construction, Critical Building Components*, for location of critical building components).

Service and Distribution

Distributed Emergency Power. Emergency and normal electric panels, conduits, and switchgear should be installed separately, at different locations, and as far apart as possible. Electric distribution should also run at separate locations.

Normal Fuel Storage. The main fuel storage should be located away from loading docks, entrances, and parking. Access should be restricted and protected (e.g., locks on caps and seals).

Emergency Fuel Storage. The day tank should be mounted near the generator, given the same protection as the generator (see section on *Emergency Generator*,

below), and sized to store approximately _____ hours of fuel (project-specific information to be provided). A battery and/or UPS could serve a smaller building or leased facility.

Tertiary Power. Conduit and line can be installed outside to allow a trailer-mounted generator to connect to the building’s electrical system. If tertiary power is required, other methods include generators and feeders from alternative substations.

Emergency Generator. The emergency generator should be located away from loading docks, entrances, and parking. More secure locations include the roof, protected grade level, and protected interior areas. The generator should not be located in any areas that are prone to flooding.

Utilities and Feeders. Utility systems should be located away from loading docks, entrances, and parking. Underground service is preferred. Alternatively, they can be hardened.

Power and Lighting

Site Lighting. Site lighting should be coordinated with the CCTV system.

Restrooms. Emergency power should be provided for emergency lighting in restrooms.

Communications and Security Systems

Redundant Communications:

- The facility could have a second telephone service to maintain communications in case of an incident.
- A base radio communication system with antenna should be installed in the stairwell, and portable sets distributed on floors. This is the preferred alternative.

Radio Telemetry. Distributed antennas could be located throughout the facility if required for emergency communication through wireless transmission of data.

Alarm and Information Systems. Alarm and information systems should not be collected and mounted in a single conduit, or even co-located. Circuits to various parts of the building shall be installed in at least two directions and/or risers. Low voltage signal and control copper conductors should not share conduit with high voltage power conductors. Fiber-optic conductors are generally preferred over copper.

Spare Conduits. Empty conduits and power outlets shall be considered for possible future installation of security control equipment, SmartCard technologies and other technology advances. This would eliminate the need for major retrofits.

8.10 Fire Protection Engineering

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

The fire protection system inside the building should maintain life safety protection after an incident and allow for safe evacuation of the building when appropriate.

While fire protection systems are designed to perform well during fires, they are not traditionally designed to survive bomb blast. The three components of the fire protection system are:

1. active features, including sprinklers, fire alarms, smoke control, etc.;
2. passive features, including fire resistant barriers; and
3. operational features, including system maintenance and employee training.

Please note that this chapter focuses only on active features. See Chapter 7: *Fire Protection Engineering*, for additional information.

Security Enhancements

Water Supply. The fire protection water system should be protected from single point failure in case of a blast event. The incoming line should be encased, buried, or located 50 ft. away from high threat areas. The interior mains should be looped and sectionalized where provided. The interior standpipes should be cross connected on each floor.

Dual Fire Pumps: Electric and Diesel. To increase the reliability of the fire protection system in strategic locations, a dual pump arrangement could be considered, with one electric pump and one diesel pump.

Egress Door Locks. All security locking arrangements on doors used for egress must comply with requirements of the International Building Code.

Smoke Removal Systems

Smoke Removal. In the event of a blast, the available smoke removal system may be essential to smoke removal, particularly in large, open spaces. This equipment should be located away from high risk areas such as loading docks and garages. The system controls and power wiring to the equipment should be protected. The system should be connected to emergency power to provide smoke removal.

The multidiscipline team should consider having separate HVAC systems in lobbies, loading docks, and other locations where the significant risk of internal event exists.

Smoke removal equipment should be provided with stand-alone local control panels located in the fire command center that can continue to individually function in the event the control wiring is severed from the main control system.

During an interior bombing event, smoke removal and control is of paramount importance. The multidiscipline team should consider the fact that if window glazing is hardened, a blast may not blow out windows, and smoke may be trapped in the building.

The design team fire protection engineer must consult the GSA regional fire protection engineer and the local fire department about the above issues.

8.11 Electronic Security

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

The purpose of electronic security is to improve the reliability and effectiveness of life safety systems, security systems, and building functions. When possible, accommodations should be made for future developments in security systems.

This chapter is not a design guide for electronic security systems. The following criteria are only intended to stress those concepts and practices that warrant special attention to enhance public safety. Please consult design guides pertinent to your specific project for detailed information about electronic security (see section on *Architecture and Interior Design, Interior Construction, Critical Building Components* for location of critical building components).

Control Centers and Building Management Systems

Operational Control Center (OCC), Fire Command Center (FCC), and Security Control Center (SCC):

- The SCC and OCC may be co-located. If co-located, the chain of command should be carefully pre-planned to ensure the most qualified leadership is in control for specific types of events.
- Provide secure information links between the SCC, OCC, and FCC.

Backup Control Center (BCC):

- A backup control workstation should be provided in a different location, such as a manager's or engineer's office. If feasible, an off-site location should be considered.
- A fully redundant BCC should be installed (this is an alternative to the above).

Security for Utility Closets, Mechanical Rooms, and Telephone Closets

Key System. Anticipate use of a key system.

Intrusion Detection. Some or all of the following basic intrusion detection devices should be provided:

- Magnetic reed switches for interior doors and openings.
- Glass break sensors for windows up to scalable heights.
- Balanced magnetic contact switch sets for all exterior doors, including overhead/roll-up doors; review roof intrusion detection.

Monitoring

- Monitoring should be done at an off-site facility.
- Use an on-site monitoring center during normal business hours.
- Have a 24-hour on-site monitoring center.

Closed Circuit TV (CCTV)

A color CCTV surveillance system with recording capability shall be provided to view and record activity at

the perimeter of the building, particularly at primary entrances and exits. A mix of monochrome cameras should be considered for areas that lack adequate illumination for color cameras.

Duress Alarms or Assistance Stations

Call buttons should be provided at key public contact areas and as needed in the offices of managers and directors, in garages, and other areas that are identified as high risk locations by the project-specific risk assessment.



Martin Luther King Courthouse, Newark, NJ

8.12 Parking Security

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

Parking restrictions help keep threats away from a building. In urban settings, however, curbside or underground parking is often necessary and/or difficult to control. Mitigating the risks associated with parking requires creative design and planning measures, including parking restrictions, perimeter buffer zones, barriers, structural hardening, and other architectural and engineering solutions.

Parking

Parking on Adjacent Streets. Parking is often permitted in curb lanes, with a sidewalk between the curb lane and the building. Where distance from the building to the nearest curb provides insufficient setback, and compensating design measures do not sufficiently protect the building from the assessed threat, parking in the curb lane shall be restricted as follows:

- Allow unrestricted parking.
- Allow government-owned and key employee parking only.
- Use the lane for stand-off. Use structural features to prevent parking.

Parking on Adjacent Properties. The recommended minimum setback distance between the building and parked vehicles for this project is _____ (project-specific information to be provided). Adjacent public parking should be directed to more distant or better protected areas, segregated from employee parking and away from the facility.

Parking Inside the Building

- Public parking with ID check.
- Government vehicles and employees of the building only.
- Selected government employees only.
- Selected government employees with a need for security.

On-site Surface or Structured Parking. Adjacent surface parking shall maintain a minimum stand-off of _____ feet. Parking within _____ feet of the building shall be restricted to authorized vehicles (project-specific information to be provided).

Parking Facilities

Natural Surveillance. For all stand-alone, above ground parking facilities, maximizing visibility across as well as into and out of the parking facility shall be a key design principle.

The preferred parking facility design employs express or non-parking ramps, speeding the user to parking on flat surfaces.

Pedestrian paths should be planned to concentrate activity to the extent possible. For example, bringing all pedestrians through one portal rather than allowing them to disperse to numerous access points improves the ability to see and be seen by other users. Likewise,



limiting vehicular entry/exits to a minimum number of locations is beneficial. Long span construction and high ceilings create an effect of openness and aid in lighting the facility. Shear walls should be avoided, especially near turning bays and pedestrian travel paths. Where shear walls are required, large holes in shear walls can help to improve visibility. Openness to the exterior should be maximized.

It is also important to eliminate dead-end parking areas, as well as nooks and crannies.

Landscaping should be done judiciously so as not to provide hiding places. It is desirable to hold planting away from the facility to permit observation of intruders.

Stairways and Elevators:

- Stairways and elevator lobby design shall be as open as code permits. The ideal solution is a stair and/or elevator waiting area totally open to the exterior and/or the parking areas. Designs that ensure that people using these areas can be easily seen — and can see out— should be encouraged. If a stair must be enclosed for code or weather protection purposes, glass walls will deter both personal injury attacks and various types of vandalism. Potential hiding places below stairs should be closed off; nooks and crannies should be avoided.
- Elevator cabs should have glass backs whenever possible. Elevator lobbies should be well-lighted and visible to both patrons in the parking areas and the public out on the street.

Perimeter Access Control:

- Security screening or fencing may be provided at points of low activity to discourage anyone from entering the facility on foot, while still maintaining openness and natural surveillance.
- A system of fencing, grilles, doors, etc. should be designed to completely close down access to the entire facility in unattended hours, or in some cases, all hours. Any ground level pedestrian exits that open into non-secure areas should be emergency exits only and fitted with panic hardware for exiting movement only.
- Details of the parking access control system will be provided for the designer.

Surface Finishes and Signage. Interior walls should be painted a light color (i.e., white or light blue) to improve illumination. Signage should be clear to avoid confusion and direct users to their destination efficiently. If an escort service is available, signs should inform users.

Lighting. Lighting levels should comply with Table 6-3.

The lighting level standards recommended by the Illuminations Engineering Society of North America (IESNA) Subcommittee on Off-Roadway Facilities are the lowest acceptable lighting levels for any parking facility. The above table adjusts the lighting levels according to the protection level. A point by point analysis should be done in accordance with the IESNA standards.

Emergency Communications. Emergency intercom/duress buttons or assistance stations should be placed on structure columns, fences, other posts, and/or freestanding pedestals and brightly marked with stripping or paint visible in low light. If CCTV coverage is available, automatic activation of corresponding cameras should be

provided, as well as dedicated communications with security or law enforcement stations. It is helpful to include flashing lights that can rapidly pinpoint the location of the calling station for the response force, especially in very large parking structures. It should only be possible to re-set a station that has been activated at the station with a security key. It should not be possible to re-set the station from any monitoring site.

A station should be within 50 feet of reach.

CCTV:

- Color CCTV cameras with recording capability and pan-zoom-tilt drivers, if warranted, should be placed at entrance and exit vehicle ramps. Auto-scanning units are not recommended.
- Fixed-mount, fixed-lens color or monochrome cameras should be placed on at least one side of regular use and emergency exit doors connecting to the building or leading outside. In order for these cameras to capture scenes of violations, time-delayed electronic locking should be provided at doors, if permitted by governing code authorities. Without features such as time-delayed unlocking or video motion detection, these cameras may be ineffective.

8.13 Submission Requirements

Every project will have unique characteristics and requirements for submission and review. These shall be coordinated by the GSA Project Manager.

The general submission requirements for each phase of project development are described in Appendix A.



Design Standards for U.S. Court Facilities

9

United States Courthouse and Federal Building Modernization

Phoenix, Arizona

Architects: Thomas Phifer and Partners

GSA Project Manager: Keith L. Lew

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9.1 Summary

The following complementary documents provide comprehensive programming and design criteria for United States Courts facilities.

- *U.S. Courts Design Guide: (USCDG)*
Focuses on the functional program requirements; the departmental and interdepartmental adjacency relationships; finish materials; and the specific performance criteria for environmental systems including heating, cooling, and lighting. It also addresses acoustic, security, telecommunications and audio/visual design requirements.
- *Requirements and Specifications for Special Purpose and Support Space Manual including all volumes and addenda: (USMS-RSSPSSM)*
Provides the finish criteria for USMS functional program requirements; spatial relationships; electronic/physical security plus hardware standards and special HVAC requirements within the U.S. Courts and Court-related spaces.

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 and USMS-RSSPSSM speak directly to the functional requirements of the *user and tenant*. Chapter 9 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; life-safety and accessibility requirements.

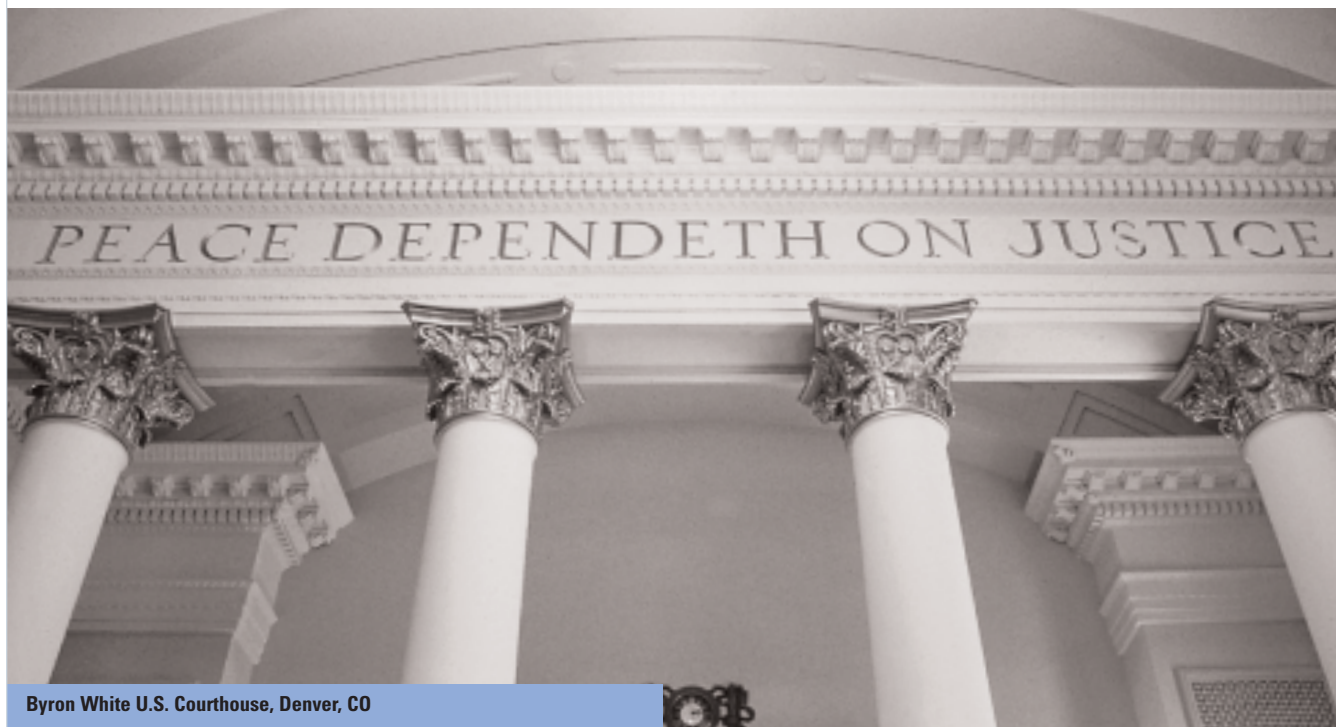
The USCDG makes reference to technical information related to performance criteria in order to help illustrate the rationale for the design requirements and to establish the standard for level of quality.

Chapter 9 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.

Chapter 9 does not cover issues related to selection of audio-visual, data, or telecommunications systems. (This criterion is developed in the *U.S. Courts Courtroom Technology Manual*.) Reference is made to these systems in Chapter 9 only with regard to the electrical service requirements in the areas where they are being installed.

Complementary documents to both the USCDG and Chapter 9 are the USMS-RSSPSSM standards. 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. (The building perimeter and site specific security issues are the responsibility of the GSA.) GSA is responsible for power to the electronic security devices, but it should be understood by the design consultants that the USMS security contractor provides detailing and environmental requirements related to security within the functional area dedicated to the courts. Chapter 9 will indicate general requirements, but the USMS-RSSPSSM is the standard to follow.

9.2 General Requirements



Byron White U.S. Courthouse, Denver, CO

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 provided 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, see Chapter 13 of the U.S. Courts Design Guide. Permanent 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 the physically disabled.

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 to be addressed at each respective component with regard to accessibility for physically challenged individuals.

Design for accessibility must comply with the requirements of the Architectural Barriers Act Accessibility Standard (ABAAS). Please refer to Chapter 1, Section 1.10 (*Accessibility Design Standards*) for information on general compliance issues.

It is GSA and judiciary policy that all Federal courtrooms have the lectern, counsel tables, the witness stand, and jury box accessible in the original design; and the judge's bench, clerk's station, and other court personnel workstations adaptable, 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 & location
- Quantity of accessible seating
- Ramps or lift access to all raised seating

Access to all raised areas in courtrooms require lifts or permanent ramps. If lifts are provided, lifts must be an integral part of the architecture of the courtroom. Bench areas will 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. These include 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 physically challenged visitors including individuals with sight and hearing difficulties. (All areas of the Courtrooms must accommodate listening systems for the hearing impaired; and translators, notetakers, interpreters for the visually disabled.)

Table 9-1 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 has been included in the original design to incorporate accessible elements at a later time. Wherever ramps or 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 disabilities shall 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

The Project Design Team will include an acoustic consultant who shall develop the appropriate information at each stage of the design process to assure the Courts and GSA that sound/vibration issues have been properly addressed.

The following is a list of NIC and STC ratings for privacy levels required in a courthouse:

Privacy Level	NIC*	STC
Inaudible	65	55
Confidential	50	50
Normal	40	45
Minimal	27	40

*Per USCDG Standards

The STC ratings related to the Court’s environment fall into three categories. These categories are listed below along with some typical examples of interior partition construction that will provide the appropriate acoustic isolation:

- STC of 40-45:** One layer of 12.7mm (1/2”) gypsum wallboard on each side of steel studs to the underside of structure with acoustic sealant at top and bottom.
- STC of 50:** One layer of 15.9mm (5/8”) gypsum wallboard on each side of steel studs, plus an additional layer on one side, to the underside of structure with acoustic sealant at top and bottom. (Install 69.8mm (2-3/4”) glass fiber insulation in the wall cavity.)
- STC of 55:** One layer of 6.3mm (1/4”) and 15.9 (5/8”) gypsum wallboard on each side of steel studs to the underside of structure with acoustic sealant at top and bottom. (Install 69.8mm (2-3/4”) glass fiber insulation in the wall cavity.)

Refer to discussions on the acoustic criteria for each courthouse facility space described in the USCDG. (The finished space performance will be tested against these specific requirements.)

Table 9-1

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	Wheelchair turning radius clearance. Permanent ramp or 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 lift. (Electrical service, space and floor depression must be included in the initial design for future lift.)
Courtroom Clerk, Deputy Clerk, Bailiff and Court Reporter Stations	Comply with clear floor space and maneuvering requirements of ABAAS. Adaptable for future inclusion of ramp or lift. (Electrical service, space and floor depression must be included in the initial design for a future lift.)
Lectern	Include an adjustable platform with a height variation between 710mm and 760mm (28" & 30") above the floor. Knee space at least 685mm (27") high. The lectern must be at least 760mm (30") wide and 480mm (19") deep.
JURY & ANCILLARY FACILITIES	
Jury Assembly Room	Located on accessible route. Refer to ABAAS for number of wheelchair spaces. ABAAS also determines requirements for listening devices, kitchen-type service units and associated refreshment areas.
Jury Deliberation Rooms	One space at tables. Clearance provided at coat storage and dedicated toilet rooms. Portable assistive listening system may be used if there is more than one deliberation room. (Provided by Judiciary)
Witness Rooms Attorney Rooms Conference Rooms	Provide proper clearance for circulation and height at tables for wheelchairs.
USMS FACILITIES	
Court Holding Areas	Each classification of holding shall have one cell accommodating wheelchair clearances and an appropriate toilet plus lavatory.
Visitor Booths & Attorney/Prisoner Areas	One but not less than 5% of booths/areas must provide turning radius and counter height dimensions for a wheelchair on both sides.



White Plains Courthouse

9.3 Architectural and Interior Design

This section addresses technical requirements for architectural materials and systems which should be provided in buildings designed to serve the U.S. Courts. Specific requirements are presented for all special or unique Courts spaces and Court-related agencies, including those to accommodate the U.S. Marshals Service. See Chapter 13 of USCDG and Chapter 3 of this document for additional information.

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 plenums 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 which are efficient regarding construction, operation and maintenance costs.

Building Enclosure Systems

The baseline standard for quality 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 4 classification of the DOJ Vulnerability Assessment and the Medium level protection of the Interagency Security Criteria.

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 plenum below for the horizontal distribution of power, data, telecommunication, and low-voltage system cabling; plus the related flexibility in position of connections above the floor. Accessible flooring systems can be defined as a suspended floor plane above the structural slab with relocatable modular components. Chapter 3 outlines appropriate dimensional characteristics of access floor systems for Federal facilities, describing the use of a 600 mm by 600 mm (2-foot by 2-foot) grid, having a clear raised depth, below floor supporting construction able to accommodate building system distribution below the floor. Access flooring shall be used in appropriate areas in courthouses, which include courtrooms, chambers, offices, conference rooms, etc. See *GSA RF/UFAD Guidelines* for details.

It is extremely important to take in to account the height of the accessible floor system in the determination of floor-to-floor dimensions.

Standard floor finishes within each function of the Courts facility need to be selected primarily on the basis of acoustic enhancement and general durability.

The USCDG contains detailed information on specific requirements for the use of carpet and other floor finish materials under each category of functional space. The USMS-RSSPSSM contains the very stringent requirements for the USMS in all detention-related areas of their facilities.

Interior Wall Systems

Interior Partition 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.) Refer to the USCDG for further information related to recommended interior partition construction.

Ceiling Systems

Chapter 3 outlines the general parameters for selection of a ceiling system in typical office spaces and recommends the use of a standard 600 mm by 600 mm (2-foot by 2-foot) suspension system with a commercial quality, acoustic ceiling tile. 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.

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, satisfy acoustical requirements using removable finishes and features so that original ornamental surfaces may be maintained.

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 0.5 to 0.6 seconds). This will involve the use of reflective and absorptive materials in the space.

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; smoke detectors; communication devices; lights; and life safety devices. 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.

Office and Conference Spaces: Flexibility and durability are also the main considerations in the selection of a ceiling system which must accommodate change and accessibility above the ceiling plane. The ceiling material should absorb sound to provide speech privacy and control transfer of noise from machines, computers, light ballasts, and other sources within adjacent office areas.

Detainee Areas: Security and durability are the main considerations in the selection of a ceiling system. Refer to USMS-RSSPSSM for suggested ceiling materials in these spaces.

The USCDG outlines all of the appropriate interior finishes for U.S. Court related 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, hearing room, jury assembly room, and public transaction counters. In general, built-in furniture needs to be designed with integral cable raceways plus conduits sized for future expansion and change. Built-in furnishings will also include access panels to permit easy cable and wiring changes. Provisions for power, data and telecommunication outlets and inputs; sound and other systems shall 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 should be carefully coordinated to achieve a consistent image, proper function, and required clearances.

Movable furniture to be provided by GSA in the U.S. Court facilities will consist of miscellaneous items, primarily lecterns and counsel tables for courtrooms.

Typical provisions for moveable 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 the GSA within the baseline rent charges are assumed to be included within the anticipated construction budget.

Refer to the USMS-RSSPSSM for a detailed description of USMS fixed and movable furniture requirements in U.S. Court Facilities.

Table 9-2

Typical Interior Fixed Furniture Elements

SPACE	TYPE OF FURNITURE ELEMENT
Courtroom	Judge's Bench (Refer to USCDG for specific configuration.) Deputy Clerk Desk (Adaptable for computer and printer.) Witness Box Fixed base chairs for jury and one not fixed Spectator Rail Jury Box Spectator Benches
Grand Jury Room	Bench Witness Stand Jury Rails
Judge's Chambers Suite	Kitchen-type serving unit with sink (Cabinets above and below) Book shelves
Judge's Robing Room	Lockers for robes
Judge's Toilet	Vanity, mirror, and medicine cabinet
Jury Assembly	Check-In counter Coat closet with rods Kitchenette-type serving unit (Cabinets above and below)
Jury Areas	Toilets with vanity and mirror Kitchenette-type serving unit Coat closet with rods
Library Spaces	Stand-up counter
All Public Areas	Stand-up counters
USMS Detention Cells	Benches Modesty screen
USMS Prisoner/Attorney Interview	Counter Stool (Prisoner side)
USMS Reception/Cashier	Service counter
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
USMS & CSOS Work/Mail Room	Base cabinets Work surface Shelving

Note: Refer to USMS-RSPSSM for related furniture.

Fixed Components

Table 9-2 outlines the basic fixed furniture elements that are provided for all Courts related functions.

Signage and Graphics

Many Federal Courthouses are large, complex structures requiring clear and coordinated systems of signage and wayfinding which allows first time users to locate their place of involvement in the judicial process as quickly and directly as possible.

A standardized system of signage, with interchangeable components, is required throughout the courthouse. ADA Accessibility Guidelines are specific about parameters of design including location, size, color, and tactile qualities of signage and use of graphic symbols to assist non-readers.

In addition to providing all general building identification and way-finding signage; GSA will supply all Courts related signs in public corridors of the building. Signage requirements within the Courts dedicated space, related to their function, will be provided by the Courts. Signs for life safety and public convenience (restrooms) within the functional areas of the Courts are supplied by GSA.

For installation of signage in historic buildings, the design team shall consult with the RHPO regarding the following requirements.

The following signage shall be furnished by GSA, and any remaining requirements will be determined and provided by the Courts:

Identification/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 Handicapped
- 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 ADA accessible path to building services.
- *Signage for Controlled Access Areas* – Judicial and staff areas and if admission to controlled areas is based upon recognizance, 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 stated)
- *Signage for Special Locking Arrangements*

9.4 Structural Systems



Byron White Courthouse, Denver, CO

General Requirements

The selection of the primary structural system for the new U.S. Court facility will be based on a variety of functional, technical, and load criteria. Whatever system is selected, the building should be planned with the longest logical clear spans (spacing between columns) 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/telecommunication 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. Increasingly, the requirements of electrical and data/telecommunication systems require frequent access, and change to accommodate use of new technology.

Other design considerations include:

- **Floor-to-floor** heights providing adequate space for raised access floor systems.
- **Floor-to-floor** heights designed to support horizontal utility runs above the ceiling.
- **Floor-loading** capacities planned to accommodate initial and planned future loads, particularly in areas near building cores – which can serve as special “high” service zones.
- **Floor-loading** to accommodate the secure, solid filled, reinforced security walls wherever they may occur in the dedicated USMS space.
- **Roof loads** must consider general personnel and equipment loads, and should be planned to accommodate additional loads for antennas, satellite dishes, and window washing equipment.

Special structural capacity should also be provided in the following areas of U.S. Court facilities:

- **Judge’s chambers** should be designed to provide 7.2 kPa (150 lb/sf) live load capacity.
- **Court library areas** (central and satellite) designed to provide 7.2 kPa (150 lb/sf) live load capacity.
- **Moveable shelving live loads** should be determined by reference to International Building Code requirements in the location where construction is taking place.
- **USMS space** per RSSPSSM.
- **Clerk of the Court file storage area** designed to accommodate high density file storage as identified by the court.



Martin Luther King Courthouse, Newark, NJ

9.5 Mechanical Systems

This section focuses on technical requirements for the mechanical engineering systems which 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. Marshal Service.

Federal Court facilities should 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 need to be evaluated throughout the design process.

U.S. Courts facilities require a variety of space types, each with it's own set of specific requirements. In addition, Court functions require flexibility in the time of operation and control of dedicated HVAC systems.

System Selection and Design

HVAC Specific Design Criteria Requirements

- Outdoor winter temperature equal to ASHRAE 1% design dry bulb and coincident wet bulb.
- Outdoor summer temperatures equal to ASHRAE 99% design dry bulb/97.5% wet bulb.
- Indoor air: Courtrooms – 22°C (74°F)/50% RH (at summer conditions and occupancy) – 22°C (74°F)/20-35% RH (at winter conditions and occupancy).
- If provided, the smoke purge system in the courtroom should be activated manually.

- All openings carrying piping through the slab or through partitions must be sealed with appropriate fire resistive/ smoke resistive material. All air ducts leading to and from sensitive spaces must be acoustically treated with 2 inches (50 mm) of duct lining for a distance of at least 12 feet (3700 mm) from the diffuser or return air intake.
- HVAC systems shall 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 will be in accordance with the guidelines and procedures established in Chapter 5. Life Cycle Cost (LCC) analyses will be conducted to ensure selection of the most cost-effective alternative environmental considerations. The HVAC system should also be designed to provide 23.4°C (74°F) in judge's chambers, courtrooms and trial jury suites on average. The courtroom HVAC system will be designed so that courtroom thermostats can be reset from the building automation system to pre-cool the courtrooms to 21.1°C (70°F) prior to scheduled occupancy. Jury deliberation rooms, judges' chamber suites, and courtrooms are to be placed on the same system with separate zones having related thermostats and the design should account for variation in occupancy load. Humidification must be provided as specified in Chapter 5. 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 shall 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 "after hours activity", and to satisfy specific requirements in a U.S. Court facility, the central plant equipment (chillers,

boilers, cooling towers, pumps, AHUs, etc.) will 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 each air handling unit.) Piping systems should consider arrangements to permit changing courtroom HVAC systems from primary to secondary chilled water for off hours. The design shall allow sub-metering of utilities and equipment to permit the facility manager to allocate cost of operation beyond standard-hours of operation.

Courtrooms/Chambers

Temperature and Systems Control. The HVAC system serving judge's chambers, courtrooms, and trial jury suites should provide an average temperature of 23.4° (74°F). The courtroom system zone will be designed to allow thermostats to be reset from the building automation system to pre-cool to 21.1°C (70°F) prior to scheduled occupancy.

Air Distribution. The diffusers serving the spectator areas must be sized to serve the allowable seating capacity plus 25%, to accommodate for extra seating. The diffusers need to be selected to meet minimum ventilation requirements at no loads, with no appreciable increase in system noise during load changes.

Provide six (6) air changes per hour for rooms with ceiling height up to 4.6 meters (15 feet); and eight (8) air changes per hour for rooms with a ceiling height greater than 4.6 meters (15 feet). Systems should be designed to meet these requirements when spaces are fully occupied, unless otherwise noted.

The maximum percentage of recirculated air should not exceed 85%.

If the courtroom is served by a fan system dedicated to more than one courtroom, then the return air from each courtroom and its associated areas must be ducted directly to the unit.

Return air from the chamber suites will be ducted directly toward the return air shaft for a minimum distance of fifteen (15) feet. (Treat ductwork to meet the acoustical 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. Return air from the rooms must be ducted directly back to the exhaust air riser. Ductwork will be treated to meet the acoustical deliberation room design criteria.

Air Changes. In the Assembly Room, Deliberation Room, and toilet rooms, the system must provide 10 air changes per hour (ACH) with 80-85% return.

Refer to USMS-RSSPSSM for all detention requirements.



Harold D. Donohue Federal Building and U.S. Courthouse, Worcester, MA

Since U.S. Court facilities should be expected to have a long useful life, new construction and renovation projects need to 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. HVAC designers shall locate equipment adjacent to the building perimeter wall that will abut future expansion for orderly tie into new system components.

The HVAC system design for the Courtroom, Judge's Chamber Suite, and the Jury Deliberation Room, which comprise a single "court set", shall be designed to allow the HVAC system to operate after hours.

The design shall include winter humidification for "special" designated areas in the building. Special controls for winter dehumidification will not be included since modern HVAC systems are designed to keep relative humidity within acceptable ranges.

Acoustic Performance

Acoustic performance should be a major consideration regarding the selection of HVAC equipment. Systems serving the courtrooms and auxiliary spaces should be designed with sound attenuation to provide consistent and acceptable sound levels. This is particularly critical in design of court facilities that require extensive use of sound and A/V equipment for recording and presentations.



Edward T. Gignoux U.S. Courthouse, Portland, ME

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 and acoustic lining in the duct work;
- Low-velocity, low static-pressure fan systems;
- Special low-noise diffusers; and
- Sound traps.

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 air-handling units (AHUs) and variable air volume (VAV) boxes will not be located in close proximity to courtrooms, jury rooms, and chambers. The minimum distance should be 7.6 meters (25 feet) between AHU and courtrooms. (Refer to Chapter 5, *Theaters and Auditoriums*, for criteria regarding maximum duct velocity.) General system design needs to provide appropriate treatment of mechanical supply/ return ducts to minimize sound and voice transfer from courtroom, chambers, jury deliberation spaces, witness rooms to surrounding areas.

Noise criterion (NC), defines the limits that the octave band spectrum of noise source must not exceed, should range from 25-30 in U.S. Court facilities. For sound level maintenance, the courtroom needs to 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 12 feet from the diffuser or return air intake.

Mechanical System Diffusers, Vents

Mechanical system diffusers and grills in public and staff areas will need to be secure from tampering, particularly in areas which provide some degree of seclusion and privacy (restrooms, attorney-client visitation rooms, etc.). Maximum-security detention-type grilles, secured with tamper proof fasteners, shall be provided at all areas accessible to prisoners. (Refer to USMS-RSSPSSM for more information.)

Changes in Building Envelope to Meet Energy Guidelines

Due to the energy load requirements of court facilities, designers should 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 should be used to compensate for higher than average load requirements resulting from court functions. Total building energy usage should be established according to calculations using mandatory design standards contained in Chapter 5. To demonstrate the same total energy usage, a new calculation will 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 particular areas. Information technology systems will be the most uncertain source of heat flows during design phases, therefore the HVAC system should 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 should have redundancy and also be connected to the emergency power system.)

9.6 Fire Protection

Refer to Chapter 7: *Fire Protection & Life Safety* for sprinkler and fire alarm requirements.

All security systems, including those that control egress at the USMS detention area, will be connected to emergency power and meet the requirements of the International Building Code.



Robert C. Byrd Courthouse, Charleston, WV

9.7 Electrical Systems

GSA will provide emergency and secondary power distributed as a basic requirement.

Normal building distribution systems should be designed to comply with Chapter 6. They will include a special electrical distribution system, consisting of an isolation transformer with associated branch circuit distribution equipment, and should be designed to serve the data network system and associated equipment supporting non-linear loads.

Uninterruptible power will be provided to serve localized security, emergency smoke evacuation, and any other critical systems. This system should also be connected to the emergency power distribution system. (Other UPS for equipment is to be provided by tenants with their equipment.)

Spare Capacity. General design requirements for office and courtroom areas should be based on anticipated loads and requirements outlined in Chapter 6. The capacity of the feeders serving all areas of the building needs to 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 should be in accordance with: Table 9-3, Electrical Power Requirement/Outlets, electrical codes and good practice.

Grounding. The GSA will provide grounding as indicated in Chapter 6.

Clean Power. It is not economical, or convenient, to provide electrical supply from back-up generators and/or a central UPS to a small proportion of outlets in office areas. However, every desk in the courthouse is likely to support PC's or other data/telecommunication equipment, and "clean" (dedicated service with no harmonics or spikes) desk circuits should be protected by excluding "dirty" loads (such as large photocopiers and vacuum cleaners).

On-Floor Electrical Distribution

Most areas of the courthouse may incorporate underfloor horizontal distribution systems. Final horizontal distribution plans will be designed considering potential EMI/RFI sources. (Access floor areas will comply with Chapter 6.)

Emergency and UPS Power Systems

Service and Distribution. Emergency and normal electrical panels, conduit, and switchgear will be installed separately, at different locations, and as far apart as possible. Electrical distribution should also run at separate locations.

Conduit and lines need to 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 will be regarded as a tertiary source of power for systems in the building where operational continuity is critical. (An operational plan should be in place to provide this service quickly when needed.)

Emergency power will be derived from generators sized to carry the required loads. Generators should be synchronized to serve a common distribution board

which, in turn, serves appropriate automatic transfer switches (ATS) and the fire pump. Separate ATS should 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.)

Discussions should be held early in the design process on a U.S. Court facility project to determine whether UPS is required for any function at the facility.

If a building-wide UPS system is provided, the system should serve the building distribution system at 208Y/120V. This system will have an output at 208Y/120V distributed through the building by a UPS power riser in each on-floor electric room. Taps from the riser will provide power to on-floor transformers and branch panels in each electric room to serve on-floor loads requiring UPS power. (Connected loads on the UPS power system may include PABX, computer and local equipment rooms.)

Coordination with Telecommunication System Design

Electrical power distribution for the various areas of U.S. Court facilities should be coordinated with the design of the telecommunication powering/grounding systems to improve the overall integrity of the telecommunications utility. 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 telecom utility (creating errors in transmission, etc.).

Table 9-3

Electrical Power Requirement/Outlets

Note: 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 described in Chapter 6.

LOCATION	EQUIPMENT/OUTLET(S)	NOTES
COURTROOMS		
Judge's Bench	Quadriplex receptacle for general purpose use; Duplex receptacle for computer, monitor; additional duplex receptacle for video arraignment.	
Courtroom	Duplex outlet with dedicated circuit for portable magnetometer. Branch circuits will be provided for additional loads dictated by the Courts.	
Court Clerk Workstation	One quadriplex receptacle (general use) and one duplex receptacle for PC and monitor per clerk position.	Printers as a group.
Court Reporter'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.	
Jury Box	One quadriplex receptacle for general purpose use.	Mounted on inside of jury box enclosure.
Attorney Tables	One quadriplex receptacle (general use) per attorney table position.	Recessed floor box.
Spectator Seating	One 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, ALS, data, telecommunication and video recording and presentation equipment.	
Other	Duplex outlets at 20' intervals along the walls of courtroom. Duplex outlets at two locations (min.) in front of bench millwork. Additional outlets at appropriate locations for ceiling-mounted screen, fixed and/or movable positions for slide projector, video monitor, video recorder, interactive white-board and image copier, and x-ray viewer equipment. Locate floor boxes for multiple possible locations of a lectern and/or 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.

LOCATION	EQUIPMENT/OUTLET(S)	NOTES
COURT SUPPORT		
Witness Waiting Rooms	Distributed convenience outlets, including provisions for cleaning/housekeeping.	
Attorney/Client Conference	Distributed convenience outlets, including provisions for cleaning/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 Area(s)	Distributed convenience outlets, including provisions for cleaning equipment and motor loads. Provide separately metered power outlets for news agencies telecast equipment.	
Law Clerk Office	One 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.
Court Reporter Office	One 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.
Judicial Conference Room(s)	Distributed convenience outlets. Provide outlets as required for video conferencing/arraignment equipment, video monitors/VCR 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 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 outlet(s), two minimum, for PC, monitor, printer, FAX.	
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.

Table 9-3
Electrical Power Requirement/Outlets (continued)

LOCATION	EQUIPMENT/OUTLET(S)	NOTES
JUDICIAL CHAMBERS (continued)		
Reference/Conference General	Provide outlets for video conferencing, TV monitor, projectors. Distributed convenience outlets in reception/waiting and general office areas. Provide 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, FAX, copier, etc.) not in FF&E budget.
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). Outlets for film/slide projection equipment, TV monitor and VCR, 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 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.

LOCATION	EQUIPMENT/OUTLET(S)	NOTES
GRAND JURY (continued)		
Other areas	Distributed convenience outlets, including provisions for cleaning/housekeeping.	GFI in toilet areas, per codes.
JURY ASSEMBLY		
Jury Assembly Room	Distributed convenience outlets. Provide outlets as required for video conferencing equipment, video monitors/VCR 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 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	Outlets for PC, other equipment. Distributed convenience outlets.	
Public Waiting Areas	Distributed convenience outlets, including provisions for cleaning/housekeeping.	
Entry Control	Security equipment. Distributed convenience outlets, including provisions for cleaning/housekeeping.	Recessed floor box, if/as required.
Staff Offices	One quadriplex receptacle (general use). Duplex 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 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.	

Table 9-3 Electrical Power Requirement/Outlets (continued)

LOCATION	EQUIPMENT/OUTLET(S)	NOTES
CLERK OF COURT AREAS		
Counter Work positions	One quadriplex receptacle (general use); duplex 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.
Public Waiting/ Document Viewing 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 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 Areas	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.
Other Area(s)	Distributed convenience outlets, including provisions for cleaning equipment and motor loads.	
COURT-RELATED AGENCIES/ SPACES		
Similar to Court Clerk/Court Administrative areas above.		
NOTE: (1) For all electrical power and outlet requirements in USMS dedicated spaces, refer to USMS-RSSPSSM. (2) The power outlet requirements for each project should be verified.		

A secure, air-conditioned data/telecommunications closet should be located near the judges’ chambers, courtroom, and court offices to contain network equipment. (The use of cable trays rather than conduits needs to be considered.)

Lighting Systems

Illumination levels, lighting types, and lighting controls in specific court functional areas are provided in the USCDG. In all other spaces, illumination levels and lighting controls will be provided as specified in Chapter 6. Task lighting must be variable to 100 FTC (1100 lx).

Color accuracy is of the highest priority in the courtroom. GSA will 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 of courtroom finishes.

An override switch will be located at the judge's bench and at the courtroom deputy clerk station to allow instantaneous over-ride of all dimming controls in an emergency.

The following lighting controls can be specified, depending upon 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 (SCR) dimmers; or
- Remote electronic dimmers with pre-set 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 should be operated with a key. Light switches will not be accessible from the spectator seating area or witness box. Provision of integrated electronic controls should be considered with pre-set lighting schemes having integrated controls for: shading devices at windows and skylights; plus controls for presentation screens (if provided by the Courts). The controls should allow varying levels of light to suit the needs and desires of the courtroom participants.

Electronic ballasts for fluorescent lamps should 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, will have built-in batteries plus emergency generator service.

Areas that require battery back up in the event of power failure to maintain camera and direct visual surveillance include:

- Vehicular Sallyport;
- Prisoner Sallyport and Movement Corridors;
- Detention Cell Block areas;
- Communications Center;
- Prisoner Processing areas;
- Squad Room;
- Public Reception Rooms;
- Prisoner-Attorney Interview room;
- Court Holding Cell Areas;
- Judge's Chambers;
- Interconnecting door from Public Corridors to Controlled Corridors;
- Command and Control Center; and
- Courtrooms

Audio/Visual Requirements in U.S. Court Facilities

All audio/visual design and technical infrastructure requirements are indicated in the Administrative Office of the United States Courts (AOUSC) Publication: *Courtroom Technology Manual*. Other than limited infrastructure and a basic sound system, requirements are funded by the Judiciary.

9.8 Security Design

Agency Responsibilities

Courthouse security is the joint responsibility of the judiciary, DHS Federal Protective Service (FPS), 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 multi-tenant buildings, the Building Security Committee (BSC).

The CSC is responsible for identifying the 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 Security Design Criteria* (Class Medium level protection buildings); the Department of Justice's (DOJ) *Vulnerability Assessment of Federal Facilities* (Level IV buildings); and the United States Courts Design Guide (USCDG); and *Requirements and Specifications for Special Purpose and Support Space Manual Volumes 1-3*, USMS publication number 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 (JSST) 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 the GSA.

Refer to the USCDG 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-RSSPSSM, is implemented into the conceptual design for the new or renovated courts facility, it is intended to help in the development of the technical drawings, specifications, and other information to incorporate the security components into the project.

Appendix

Submission Requirements



A

United States Port of Entry

Architect: Charles Rose Architects Inc.

Del Rio, Texas

GSA Project Manager: Charles N. Lawrence

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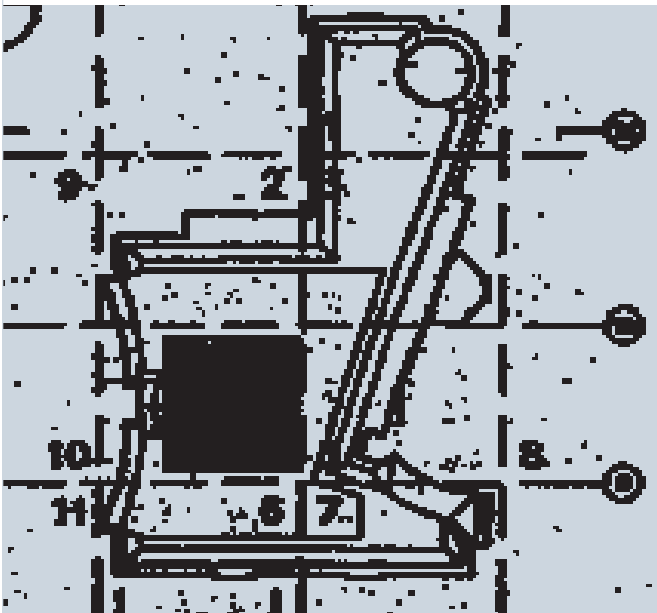
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A.1 General Requirements



Ronald Reagan Building, Washington, D.C.

These design submission requirements have been developed to ensure a rational, well-documented design process and to facilitate reviews by GSA staff and tenant agencies as the design develops. The submission requirements listed here apply to all projects, whether design services are performed by architects and engineers under contract to GSA or by in-house staff.

These requirements are the minimum standards and the specific A/E Scope of Work will take precedence on each project.

All submissions in each phase of work are required to be given to the GSA in drawing or written form and on computer disk 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 size 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

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).

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 Regional CAD Coordinator and are considered supplements to the national standards. (Refer to the base scale examples in the previous paragraph.)

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 shall 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, such as BOCA. 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 shall be primary, with English units secondary and in parenthesis.

Seals. Each sheet of the construction documents must bear the seal and signature of the responsible design professional. (Specification and calculations cover page only.)

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.

Security Requirements. All sensitive but unclassified (SBU) building information, including all building drawings and specifications either in electronic or paper formats, shall have imprinted on *each* page of the information:

**PROPERTY OF UNITED STATES GOVERNMENT
FOR OFFICIAL USE ONLY**

Do not remove this notice

Properly destroy documents when no longer needed

The following paragraph will be included on the *cover* page of the information (such as the cover page on the set of construction drawings and on the cover page of the specifications) and on the label of all magnetic media:

**PROPERTY OF THE UNITED STATES GOVERNMENT
COPYING, DISSEMINATION, OR DISTRIBUTION OF
THESE DRAWINGS, PLANS, OR SPECIFICATIONS TO
UNAUTHORIZED PERSONS IS PROHIBITED**

Do not remove this notice

Properly destroy documents when no longer needed

The previous two statements shall be *prominently* labeled in bold type in a size appropriate for the document. On a set of construction drawings, for example, the statements shall be in a minimum of 14 point bold type.

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 has set a goal to require interoperable Building Information Models (BIM) on FY06 projects in support of improving design quality and construction delivery. The Office of the Chief Architect is developing scope guidelines and offering regional pilot opportunities to help the regions in meeting this requirement. During the initial phase, and in support of design reviews during the concept design stage for new construction and modernization projects, interoperable BIM delivery shall

be a supplement to all existing submission requirements, including *PBS CAD Standards*. For additional information, see the online *PBS Guide to Building Information Models* at <http://rw-qpnet-oca.gsa.gov/bim-guide>. For questions or feedback, send a message to ifc.bim@gsa.gov.

Specifications

Format. Specifications should be produced according to the CSI division format. Each page should be numbered. Specifications should be bound and include a Table of Contents. The specifications shall include instructions to bidders and Division 1, edited to GSA requirements.

Project Specifications. The *General Guide for Editing Specifications* published by GSA can be obtained and used as a resource.

Editing of Specifications. It is the designer’s responsibility to edit all specifications to reflect the project design intent, GSA policy requirements and Federal law. 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 shall be deleted.

Dimensioning in Specifications. Domestically produced hard metric products shall 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 non-metric sized product may be specified, and its data will be soft converted to a metric equivalent.

Only in special cases can dual dimensions be used on GSA projects, subject to the approval of the GSA Contracting Officer.

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. As examples, the following should be provided with the following:

- Contractor “Redline” as-built drawings to include 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 be inclusive to record final changes to design and contractor noted as-built conditions as noted above.
- 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 the facility.

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 shall 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, TAB reports, and Commissioning 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
- Calculations (including energy, structural, lighting, fire, etc)

All electronic media shall 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, 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 shall be a check of building performance criteria as noted in A.2.

Design Quality Reviews

Design Quality Reviews (new in 2004) will be performed by an independent third-party review team at three stages of project design: Final Concepts (FC), Design Development (DD), and Construction Drawings (CD). These reviews are sponsored by the Office of the Chief Architect 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.

Cost Estimating Requirements

Cost estimates must be provided at various stages of the design process in compliance with GSA document Project Estimating Requirements (PER) and the following 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

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 shall provide all necessary documentation for these estimates and avail themselves to support this activity.

Cost Estimate Reporting

Cost estimates must be reported in an electronic spreadsheet format. Each of the cost estimate submissions shall contain the following:

1. Executive Summary
2. Basis of Estimate, Rationale, Assumptions and Market Analysis as required in PBS 3440.5.
3. GSA Report 3474
4. GSA Report 3473
5. Summary Reports (GSA Uniformat and CSI Masterformat formats as applicable)
6. Detail Line Item Cost Reports

Warm Lit Shell and Tenant Improvements (TI) Cost Estimates

The organization of the cost elements shall be in accordance with the GSA Pricing Policy, which calls for a separate tenant improvement breakdown of all tenant space fit-out identified by agency.

The estimate shall be broken down into 1) Warm-Lit Shell, and 2) Tenant Agency Fit-Out, as defined by agency in the housing plan and the supporting floor plans.

Estimating Format Requirements

The Format and Minimum Level of Detail for Estimating are as follows:

Project Phase	Estimate WBS	Detail Level	Summary Level	Estimate Basis	TI/Shell
Concept	GSA Uniformat	IV	III	Parameter and Quantification	Yes
Design Development	GSA Uniformat	V, Note 5	IV	Quantification and Parameter	Yes
	CSI Masterformat	Note 1, Note 5	Note 1		
75% CD	GSA Uniformat	N/A	III	Quantification	Yes
	CSI Masterformat	Note 2, Note 5	Note 3		
90% CD	GSA Uniformat	N/A	III	Quantification	Yes
	CSI Masterformat	Note 4, Note 5	Note 3		
100% CD	GSA Uniformat	N/A	III	Quantification	Yes
	CSI Masterformat	Note 4, Note 5	Note 3		

Note 1. 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 2. The level of detail of the cost estimate in CSI Masterformat shall correspond with Uniformat Level V as defined in PBS 3440.5. See Sample Forms.

Note 3. The summary of the cost estimate in CSI Masterformat shall correspond with Uniformat Level III as defined in PBS 3440.5. See Sample Forms.

Note 4. The level of detail of the cost estimate in CSI Masterformat shall correspond with Uniformat Level VI as defined in PBS 3440.5. See Sample Forms.

Note 5. Unit prices shall be broken down into labor, materials, and equipment.

Sample Form: Project Cost Summary

PROJECT TITLE:

PROJECT LOCATION:

AREA (GSF) =

CSI MASTERFORMAT

DIRECT

ECC COST

ECC COST/GSF

01 General Requirements

\$

\$

02 Sitework/Demo

\$

\$

03 Concrete

\$

\$

04 Masonry

\$

\$

05 Metals

\$

\$

06 Woods and Plastics

\$

\$

07 Thermal and Moisture Protection

\$

\$

08 Doors and Windows

\$

\$

09 Finishes

\$

\$

10 Specialties

\$

\$

11-13 Equipment, Furnishings and Special Construction

\$

\$

14 Conveyance

\$

\$

15 Mechanical

\$

\$

16 Electrical

\$

\$

Direct Cost Summary

\$

\$

Design Contingency

\$

\$

Subtotal

\$

\$

Overhead and Profit

\$

\$

Subtotal

\$

\$

Bond/Insurance 0.0%

\$

\$

Subtotal

\$

\$

Escalation from Estimate Date Mid-Point 0.0%

\$

\$

Subtotal

\$

\$

Construction Contingency 0.0%

\$

\$

Reservation– Art in Architecture 0.0%

\$

\$

Subtotal

\$

\$

ECC (ESTIMATED CONSTRUCTION COST)

\$

\$

SUBMISSION REQUIREMENTS

299

Sample Form: CSI Masterformat Detail Report

PROJECT NAME							DATE			
PROJECT PHASE							ESTIMATOR			
Description	Quantity		Material		Labor		Equipment/Other		Total	Unit Cost
	Quantity	UOM	Unit	Subtotal	Unit	Subtotal	Unit	Subtotal		
02 Site Work										
1 Excavate trench; mdm soil, expose pipe, 1/2 CY excavator	16.8	EA		\$	0.96	16.13	0.37	\$6	\$22	0.37
2 Backfill by hand, no compaction light soil	16.8	EA		\$	17.57	295.14	0.37	\$6	\$301	0.37
3 Fill, spread borrow w/dozer	16.8	EA		\$	0.41	6.96	0.37	\$6	\$13	0.37
4 Backfill, by hand, compaction in 6" layers, ari tamp	16.8	EA		\$	6.53	109.69	0.37	\$6	\$116	0.37
Site Work Subtotal				\$			\$7	\$25	\$453	

A.2 Performance Expectations Matrices

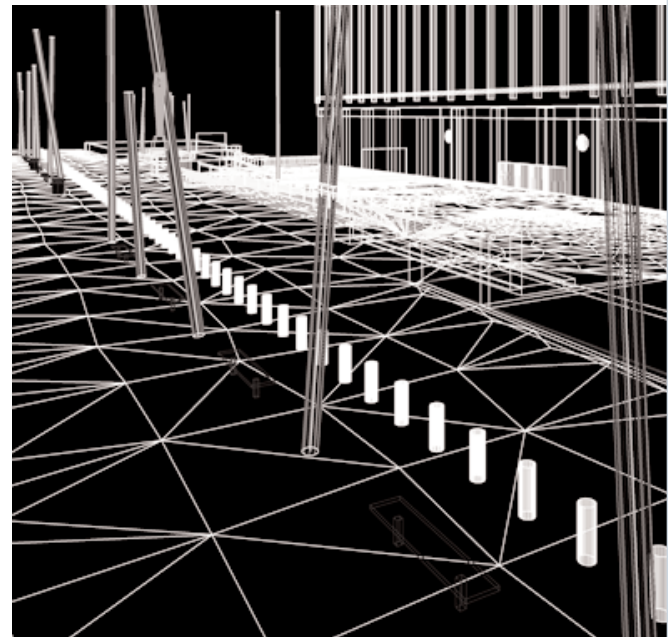
At the beginning of each project, the GSA Project Manager, tenants and design A/E need to define the functional objectives of a project. A functional objectives matrix, similar to the one shown in Figure A-1, while not required, may be an effective tool to define these objectives. (Such a matrix may 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 shall take the form of either a pre-concept design charrette and/or through a series of design team technical meetings during the concept phase. The technical discussion agenda can 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 shall identify the attainment of building functional objectives as represented by the matrix. This shall 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 the Chief Architect.



3D Wireframe Model, Pedestrian View, 26 Federal Plaza, New York

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
Superstructure		1	1	3	3	2	2	2	1
Enclosure	Walls	2	3	3	3	2	1	3	2
	Windows/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		2	2	3	2	3	3	3	2
Interior Finishes	Access Floors	3	1	1	2	2	1	1	1
	Walls	3	2	1	1	2	1	1	2
	Floors	3	3	1	1	2	1	1	3
		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
	Hazard Mat.	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
		1	1	1	3	2	1	1	2
Trans. Sitework		2	3	1	2	1	3	1	2

Figure A-2 Sustainability Matrix

		PRINCIPLES / OBJECTIVES					
		Energy	Water	Materials	In. Env. Qual.	Site & Trans.	O & M
SYSTEMS							
Foundations		1	1	2	1	1	1
On/Below Grade		1	1	2	1	1	2
Superstructure		1	1	2	1	1	2
Enclosure	Walls	3	1	2	2	1	3
	Windows/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	3	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
	Hazard Mat.	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
Trans. Sitework		2	1	1	1	3	1

A.3 New Construction and Modernizations

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 and related definitions describe this process.

Peer review, arranged through the Office of the Chief Architect, is required for all new construction projects as well as any modernization project with significant alterations to either the building aesthetic or systems. All new construction projects, as well as modernization projects which significantly alter an existing structure shall be presented to the Commissioner and Chief Architect for approval in Washington D.C.

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 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.

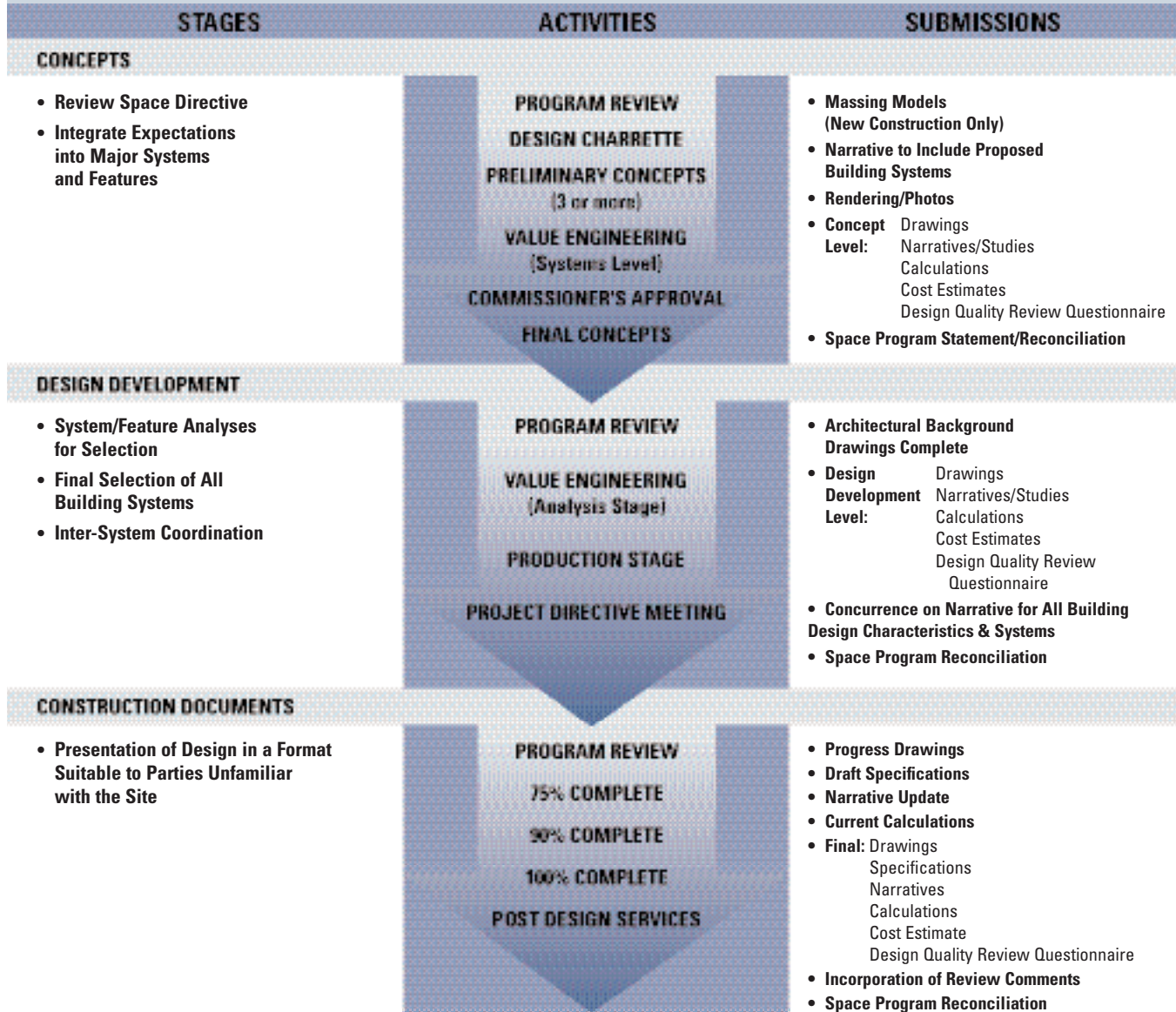
Concepts

A submission that will demonstrate compliance with the Building Program (space tabulation of building program) including all adjacency and functional requirements. This submission will also show 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 should 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.

Figure A-3

Design Process and Related Submission Requirements for New Construction and Modernization



During preliminary concepts, three concepts must be presented; these preliminary concepts are intended to be working level and not presentation documents. They should 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 will be further refined and presented as the final concept.

For major projects, presentation is made to the Commissioner of the Public Buildings Service for final approval.

Design Development

A set of submissions and meetings that will finalize 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, etc.

The design submission will consist of a combination of drawings, narrative and calculations. 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.

This submission is not a preliminary construction document stage. 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 shall be made, leading to system/feature selections.

Production Stage. Development of the most favored of each system with supporting calculations and narrative. Plans, sections, elevations and details showing systems should be included.

Value Engineering (Analysis Stage). 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). Initially it should focus on building systems and materials in a general sense during concepts. 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 should 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 design development phase. A meeting among GSA 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

A set of detailed and coordinated submissions that become the basis of a construction contract. The notes on these should result in a single interpretation of a specific set of data or facts and, therefore, become the basis of a competitive price proposal. Construction documents should avoid using terms that the design specialist may know, but which have nothing to do with the purchase and installation of a product. Individual GSA regions may request a single or multiple submissions (i.e. 75 percent, 100 percent) as appropriate. Reviews may be both formal and informal (“onboard”). Language between specifications and notes on the drawings must be consistent and complementary.

Design Awards

Every two years GSA recognizes outstanding projects through its biennial Design Awards program. Designers are required to submit each new construction project for consideration.

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 A.5 for requirements.
- **Sketches.** It may be recognized that the information requested in subparagraphs 1 and 2 may be in progress and not yet complete.
 1. Site location plan [at least 2 kilometers (1.25 miles) around site], showing:
 - Site relative to location of city center, major landmarks, major parking facilities, major roads and airport.
 - Location of subway stations and other mass transit links.
 2. Existing site plan (at least one block around site), describing:
 - Site boundaries, approximate topography, existing buildings, setbacks and easements.
 - Climatic conditions including path of sun.
 - Location of on-site and off-site utilities.
 - Natural landscape.
 - Pedestrian and vehicular circulation. (Include direction of traffic on adjoining streets.)
 3. Site plans for each design scheme, showing:
 - Building location and massing.
 - Building expansion potential.
 - Parking and service areas.

4. Floor plans, showing as a minimum:
 - 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:
 - Floor-to-floor heights and other critical dimensions.
 - Labeling of most important spaces.
 - Labeling of floor and roof elevations.

Slides.

1. Minimum of six 35 mm slides showing the site and elevations of existing buildings (or landscape, as applicable) surrounding the site.

Models.

1. Massing models of each architectural design scheme on a common base. (No fenestration should be provided at this stage of design development.)

Narrative (in “Executive Summary” format).

1. Site statement, describing:
 - Existing site features.
 - Climatic conditions.
 - Topography and drainage patterns.
 - Any existing erosion conditions.
 - Wetlands and locations of flood plains.
 - Surrounding buildings (style, scale).
 - Circulation patterns around site.
 - Site access.
 - Noise/visual considerations.
 - Local zoning restrictions.
 - Federal Aviation Agency requirements.
 - Hazardous waste.
 - Pollution.
 - Potential archeological artifacts.
 - Historic preservation considerations, if applicable.

2. Site photographs, showing contiguous areas and effected preservation zones.
3. Existing major site utilities.
4. Description of each architectural design scheme, explaining:
 - Organizational concept.
 - Expansion potential.
 - Building efficiency.
 - Energy considerations.
 - Advantages and disadvantages.
 - Historic preservation considerations, if applicable.
 - Sustainable design considerations.
 - Baseline mechanical system and strategy to comply with the assigned energy goal.
 - Fire protection design considerations.
5. 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.
6. Construction cost of alternative schemes.
 - Verify that each design scheme presented can be constructed within the project budget.
7. Space Program Statement/Reconciliation
8. Preliminary Energy Analysis for compliance with the assigned Energy Goals for each architectural concept.
9. Art in Architecture Statement.
 - Provide statement defining the integration of Art in Architecture. At a minimum identify the location for the proposed art concept.
10. 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.)

Drawings.

1. Site plan (at least one block around site), describing:
 - Site boundaries, approximate topography, existing buildings, setbacks and easements.
 - Building orientation with respect to path of sun.
 - Building massing and relationship to massing of surrounding buildings.
 - Future building expansion potential.
 - Location of on-site and off-site utilities.
 - Grading and drainage.
 - General landscape design, showing location of major features.
 - Pedestrian and vehicular circulation. (Include direction of traffic on adjoining streets.)
 - Parking and service areas.
 - Fire protection, water supplies, fire hydrants, and fire apparatus access roads.

Narrative.

1. Description of site and landscape design final concept.
 - Circulation.
 - Parking.
 - Paving.
 - Landscape design.
 - Irrigation, if any.
 - Utility distribution and collection systems.

- Method for storm water detention or retention.
- Landscape maintenance concept.
- Fire protection, water supplies, fire hydrants, and fire apparatus access roads.
- Accessibility path for the physically disabled.

Architectural

Drawings.

1. Floor plans, showing as a minimum:
 - 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.
 - 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.
 - Proposed interior layouts showing:
 - open office plan
 - enclosed office plan.
 - Indicate how major mechanical and electrical equipment can be removed/replaced.
2. Elevations of major building façades, showing:
 - Fenestration.
 - Exterior materials.
 - Cast shadows.
3. Elevations of major interior spaces, showing:
 - Lobby/Atrium.
 - Typical public elevator lobby.
 - Typical courtroom elevations.

4. Building sections (as necessary), showing:
 - Adequate space for structural, mechanical and electrical, telecommunications and fire protection systems.
 - Mechanical penthouses.
 - Floor-to-floor and other critical dimensions.
 - Labeling of most important spaces.
 - Labeling of floor and roof elevations.
5. Color rendering. [Minimum size must be 600 mm by 900 mm (24 inches by 36 inches).]

Photographs.

1. Four 200 mm by 250 mm (8-inch by 10-inch) color photographs, mounted, identified and framed, and two color slides, of the rendering or model image (showing at least 2 vantage points). In addition, provide for all building elevations (at least 1 vantage point per each elevation).
 - Two of the photographs and the two slides are to be sent to the GSA project manager.
 - Provide two additional 600 mm by 900 mm (24-inch by 36-inch) photographs of the rendering for the GSA project manager. (For courthouse projects only.)

Model.

1. Provide a model of the final concept with sufficient detail to convey the architectural intent of the design.

Narrative.

1. Architectural program requirements.
 - Show in tabular form how the final concept meets the program requirements for each critical function.
 - A revised description of any deviation from PBS-P100

2. Description of final concept, explaining:
 - Expansion potential.
 - Building floor efficiency.
 - Conveying systems design (elevators, escalators).
 - Design strategy to attain the assigned energy goal.
 - Treatment of historic zones, if applicable.
 - Operations and maintenance goals (exterior and interior window washing, relamping, etc.).
 - Sustainable design concepts (LEED strategy).
3. Vertical transportation analysis (elevators and escalators).

4. Code analysis.

The Code criteria shall 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.

- A Code/Criteria analysis shall 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.

5. Construction cost.

- Verify that the final concept can be constructed within the project budget.

6. Identify architectural systems alternatives which will be analyzed during design development for life cycle cost analysis.

Historic Preservation

8.5" x 11" report, signed by qualified preservation architect, including

Narrative.

1. General: Project purpose, scope, groups and individuals involved
2. Existing conditions, describing:
 - Overall building size, configuration, character
 - Project location
 - Existing original materials and design, relevant alterations
3. Preservation design issues and prospective solutions, including:
 - Location of new work/installation: visibility, impact on historic finishes
 - Compare options for preserving/restoring historic materials and design
 - Identify further study required to avoid adverse effects as applicable

Photographs.

- General and detail views showing existing conditions at affected preservation zones, keyed to plan showing location and orientation of each view
- Captions identifying location, subject, condition shown

Drawings.

Reduced to 8.5" x 11, 11" x 17" foldout or placed in cover pocket:

- Site and floor plans, as applicable
- Sketches or schematic CAD drawings (elevations, plans) showing preservation design concepts

Structural

Drawings.

1. Plans, showing:
 - Framing plans of the proposed structural system showing column locations; bay sizes; and location of expansion and seismic joints.

Narrative.

1. Identification of any unusual local code requirements.
2. Code compliance statement.
 - Name of model building code followed.
 - Building classification.
 - Identification of Region of Seismicity, wind speed, etc.
 - Identification of special requirements, such as highrise.
3. For new buildings:
 - Statement certifying that the structural engineer has reviewed the building configuration for seismic adequacy, and the criteria outlined in Chapter 4, Structural Engineering, have been met. This statement must be signed by the structural engineer and the architect.

Mechanical

For the system approved and selected from the three concepts, provide the following:

Drawings.

1. Floor Plan(s):
 - Identification of equipment spaces for major equipment.
 - Location of major equipment, including size, weight, and clearance requirements.

2. Flow Diagram(s):

- Air flow diagrams representing final concept of systems for each major space.
- Air flow diagrams representing final concept of building system.
- Water flow diagrams of the main mechanical system in the mechanical room(s) and throughout the building.

Narrative.

A written narrative describing the selected mechanical system and equipment, including:

- Design conditions.
- Ventilation rates, dehumidification and pressurization criteria.
- Equipment capacities, weights, sizes and power requirements.
- Description of heating, cooling, ventilating, and dehumidification systems for each major functional space.
- Fuel and utility requirements.
- A code compliance statement.

Calculations and Energy Analysis.

- Building load calculations.
- Psychometric calculations for full load and partial load utilization in summer, winter, spring, and fall. (Partial loads at 50% and 25%, and unoccupied hours.)
- Energy and life cycle cost analysis using DOE-2, or approved equal.
- Fuel consumption estimates.

Specifications.

- Table of Contents identifying specifications to be used on the project.

Cost Estimates.

- Cost of total HVAC system.
- Cost of major equipment.
- Cost of air distribution and piping system materials.

Fire Protection

Fire protection and life safety submission requirements shall be identified as a separate Fire Protection section as outlined in this document.

Drawings.

1. Plans showing:
 - Equipment spaces for fire protection systems (e.g., fire pump, fire alarm, etc.).
 - Fire protection water supplies, fire hydrant locations, fire apparatus access roads, and fire lanes.

Narrative.

1. Description of the building's proposed fire protection systems including the egress system.
2. Code compliance analysis
 - The design team fire protection engineer shall 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

Drawings.

1. Plans showing equipment spaces for all electrical equipment to include: panels; switchboards; transformers; UPS; and generators.

Narrative.

1. Description of at least two potential electrical systems and a baseline system.
 - General characteristics of a baseline system are described in Chapter 1, *General Requirements* of this document.
2. Proposed special features of electrical system.
3. Code compliance statement.

Certification Requirements

1. The architect/engineer (lead designer) must certify that the project has been conceptualized to comply with ASHRAE 90.1 and will meet GSA’s energy goal requirement.
2. Green building (sustainable) design concepts—LEED strategy.
3. Life cycle cost analysis.
 - VE decisions and commitments that were made during this phase by the Project Team.
4. 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 in Appendix A.2.

Final Concept Cost Estimate

A cost estimate must be provided. It should comply with the requirements for concept stage estimate stated in the *Cost Estimating Requirements* of the Appendix’s Section A.1 of this *Facilities Standard*.

Cost estimates must separate costs for interior tenant buildout from core/shell cost items as described in the *GSA New Pricing Guide*. The interior buildout cost must be divided by each building tenant.

Design Development

Site Planning and Landscape Design

Calculations.

1. Site storm drainage combined with building storm drainage, and sanitary sewer calculations.
2. Storm water detention calculations, if applicable.
3. Parking calculations, if applicable.
4. Dewatering calculations
 - Calculations modeling dewatering rates during dry and wet season excavation. Calculations must take into account effect of dewatering on adjacent structures and improvements.
 - Calculations must assume a specific shoring system as part of a comprehensive excavation system.

Narrative.

1. Site circulation concept, explaining:
 - Reasons for site circulation design and number of site entrances.
 - Reasons and/or calculations for number of parking spaces provided.
 - Reasoning for design of service area(s), including description of number and sizes of trucks that can be accommodated.
 - Proposed scheme for waste removal.
 - Proposed scheme for fire apparatus access and fire lanes.
2. Site utilities distribution concept.
 - Brief description of fire protection water supplies.
 - Brief description of fire hydrant locations.
3. Drainage design concept.
4. Landscape design concept, explaining:
 - Reasoning for landscape design, paving, site furnishings, and any water features.

- Reasoning for choice of plant materials.
 - Proposed landscape maintenance plan and water conservation plan.
 - Brief operating description of irrigation system.
5. Site construction description.
- Brief description of materials proposed for pavements and utilities.

Code analysis.

1. The Code criteria shall 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.
 - Identify local zoning and all building code requirements and provide a complete analysis as they pertain to the project.

Drawings.

1. Site layout plan, showing:
 - All buildings, roads, walks, parking and other paved areas (including type of pavement).
 - Accessible route from parking areas and from public street to main facility entrance.
 - Fire apparatus and fire lanes.
2. Grading and drainage plan, showing:
 - Site grading and storm drainage inlets, including storm water detention features.
3. Site utilities plan, showing:
 - 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.
4. Landscape design plan, showing:
 - General areas of planting, paving, site furniture, water features, etc.
5. Irrigation plan, if applicable.

Architectural

Calculations.

1. Acoustical calculations.
2. Dew point location.
3. Toilet fixture count.

Narrative.

1. Building concept, explaining:
 - Reasons for building massing, entrance locations and service locations.
 - Building circulation and arrangement of major spaces.
 - Interior design.
 - Adherence to the Building Preservation Plan, if applicable.
 - Energy conservation design elements.
 - Water conservation considerations.
 - Explain how all these design considerations are combined to provide a well integrated cohesive design concept.
2. Analysis of refuse removal, recycled materials storage and removal, and maintenance requirements.
3. Building construction description, explaining:
 - Structural bay size.
 - Exterior materials, waterproofing, air barriers/vapor retarders, and insulation elements.
 - Roofing system(s).
 - Exterior glazing system.
 - Interior finishes, with detailed explanation for public spaces.
 - Potential locations for artwork commissioned under the “Art in Architecture “ program, if applicable.
 - Use of recycled materials.
 - Sustainable design concepts and LEED strategy

4. Review of project for code compliance.
 - 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.
5. For major alterations, provide a determination whether an accessible floor is needed.
6. Building maintenance, explaining:
 - 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.
 - How courtrooms, dining facilities and other assembly spaces with fixed seating, multi-level spaces or with sloped floors will have their ceilings, lights and other ceiling elements maintained and repaired.
 - Proposed scheme for window washing equipment.
 - Consideration and prevention of bird nesting on exterior surfaces.
 - How major mechanical and electrical equipment can be serviced and/or replaced in future years.
7. Review of building for compliance with project specific criteria as noted in Chapter 8, *Security Design*.
8. Description of process for servicing and replacement of equipment given the necessary dimension clearances.
9. Program Status and Reconciliation Report.
 - Report verifying the current design's compliance with the approved space program. Any deviations must be clearly reported.
10. Curtainwall Report.
 - In projects with complex curtainwall systems, describe size and locations of major movement joints to accommodate structural drift due to seismic and/or wind loading. Describe proposed curtainwall attachment methods to accommodate these lateral movements.
 - Describe water migration, and fire safety systems.
 - Describe typical interfaces between exterior wall system and interior finishes.
 - Describe interfaces between major enclosure assemblies such as glass curtain wall to precast or stone panels.
 - Identification of at least three suppliers that can provide proposed exterior wall system.
 - Address any requirement for blast resistance in the context of “Windgard” simulations and/or blast testing results, as provided by the Office of the Chief Architect.
11. Building Keying and Signage Report.
 - 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.
 - Signage system and room numbering system must be integrated with keying system.
12. 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.

Drawings.

1. Building floor plans, showing:
 - Spaces individually delineated and labeled.
 - Enlarged layouts of special spaces.
 - Dimensions.
 - Planning module.
2. Building reflected ceiling plans, showing:
 - Enlarged layouts of special spaces.
 - Spaces individually delineated.
 - Materials labeled.
 - Ceiling heights labeled.
 - Lighting fixture types indicated and scheduled.

3. Building roof plan, showing:
 - Drainage design, including minimum roof slope.
 - Dimensions.
 - Membrane and insulation configuration of the roofing system.
3. Elevations, showing:
 - Entrances, window arrangements, doors.
 - Exterior materials with major vertical and horizontal joints.
 - Roof levels.
 - Raised flooring and suspended ceiling space.
 - Dimensions.
4. Interior Elevations, showing:
 - Lobby, atrium.
 - Public corridors.
 - Jury Assembly room.
 - Grand Jury.
 - Restrooms.
 - Chambers.
 - Typical public elevator lobby.
 - Typical courtroom elevations.
 - Typical tenant corridors.
 - Typical conference rooms.
5. One longitudinal and one transverse section, showing:
 - Floor-to-floor dimensions.
 - Stairs and elevators.
 - Typical ceiling heights.
 - General roof construction.
6. Exterior wall sections, showing:
 - Materials of exterior wall construction, including flashing, connections, method of anchoring, insulation, vapor retarders, and glazing treatments.
 - Vertical arrangement of interior space, including accommodation of mechanical and electrical services in the floor and ceiling zones.

7. Proposed room finish schedule, showing:
 - Floors, bases, walls and ceilings.
 - (Finish schedule may be bound into narrative.)
8. Perspective sketches, renderings and/or presentation model, if included in the project scope.
9. Proposed site furniture, showing:
 - Site furniture cut sheets or photos
 - Proposed locations.
10. Diagrams illustrating the ability to access, service and replace mechanical/electrical equipment showing the pathway with necessary clearance.
11. Location of accessible pathways and services for the physically disabled.
12. Placement of Art-in-Architecture elements.
13. Design of typical building signage including wayfinding and room identification, building directory, exterior building signage and major interior building identification.

Photographs.

1. Two sets each of 35 mm slides and 200 mm by 250 mm (8 inch by 10 inch) photographs for: rendering or model image (if changed from concept submission); and elevation views for all exposures (if changed from concept submission).

Historic Preservation

8.5" x 11" report, signed by qualified preservation architect, including

Narrative.

1. General: Project purpose, scope, groups and individuals involved, substantive changes to approach described in concept submission
2. Existing conditions, describing:
 - Overall building size, configuration, character
 - Project location

- Existing original materials and design, alterations.
- New findings from testing or analysis in concept phase

3. Preservation solutions explored, how resolved and why, including:

- Location of new work: visual impact, protection of ornamental finishes
- Design of new work/installation: visual and physical compatibility with existing original materials and design; materials/finishes chosen
- Methods of supporting new work/installation
- Preservation and protection of historic materials during construction through tenant move in

4. Effects, describing:

- How project will affect the building's architecturally significant qualities
- Measures proposed to mitigate any adverse effects on historic materials or design

Photographs.

- General and detail views showing existing conditions at affected preservation zones, keyed to plan showing location and orientation of each photo view
- Captions identifying location, subject, condition shown

Drawings.

Reduced to 8.5" x 11, 11" x 17" foldout or placed in cover pocket:

- Site and floor plans, as applicable
- Elevations, plans, and section details showing preservation design solutions for each issue identified, as approved by Regional Preservation Officer

Cover.

Building name, Address, Project title, Project Control Number, Author (Preservation Architect), Preservation Architect's Signature, Date of Submission.

Structural

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.

1. Gravity load and lateral load calculations, with tabulated results showing framing schedules.
2. Foundation calculations.
3. Calculations showing that the system is not vulnerable to progressive collapse.
4. Vibration calculations.
5. Blast calculations.

Narrative.

1. 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.
2. Comparative cost analysis of at least three potential framing systems.
 - 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.
 - 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.

3. Description of recommended structural concept, including:
 - Choice of framing system, including lateral load-resisting elements, and proposed foundation design.
 - Verification of adequacy of all assumed dead and live loads.
4. Identify all code requirements and provide a complete analysis as it pertains to this project including but not limited to:
 - Required fire-resistance rating of structural elements.
 - Summary of special requirements resulting from applicable local codes.
5. Proposed methods of corrosion protection, if applicable.
6. Geotechnical Engineering Report, including boring logs (if part of scope of work).
 - See Appendix A.5 for specific requirements.
7. Geologic Hazard Report.
 - See Appendix A.5 for specific requirements.
8. Blast consultant's report and analysis (if part of scope of work).

Drawings.

1. Framing plans and key details.

Mechanical

Drawings.

HVAC

1. Floor plan(s):
 - Single line piping and ductwork schematic layout.
 - Show terminal air devices.
 - Perimeter terminal units.

- Quarter-inch scale drawings of mechanical equipment room(s) showing all mechanical equipment serving the project, including equipment access and service requirements.
 - Roof plan showing all roof mounted equipment.
 - Show adequate access from mechanical equipment room(s) to freight elevators.
 - Show adequate access to roof-mounted equipment.
2. Single line schematic flow and riser diagram(s):
 - Airflow quantities and balancing devices for all heating/cooling equipment.
 - Water flow quantities and balancing devices for all heating/cooling equipment.
 - Flow/energy measuring devices for water and air systems for all cooling, heating and terminal equipment.
 3. Automatic Temperature Control Diagram(s):
 - Control flow diagrams showing all sensors, valves, and controllers (analog and digital).
 - Sequence of operations of all the systems and its operation (occupied and unoccupied).
 - BACnet or LON Work Building Automation System and their descriptions.

4. Schedules

- Provide schedules of major equipment that includes chillers, boilers, pumps, air handling units, and terminal units.
- Air Terminal Devices
- Air Balance Relationships between Spaces

Plumbing

1. Floor plan(s)
 - Proposed building zoning and major piping runs.
 - Locations of proposed plumbing fixtures and equipment.
2. Systems schematics and flow diagrams.

Narrative.

HVAC

1. A written narrative describing the final mechanical system and equipment selection including:
 - Design conditions.
 - Ventilation rates, dehumidification and pressurization criteria.
 - Equipment capacities, weights, sizes and power requirements.
 - 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.
 - Description of occupied and unoccupied and related sequence of operations.
 - Fuel and utility requirements.
 - An ASHRAE 90.1 compliance statement.
 - A PBS-P100 compliance statement.
 - A revised description of any deviation from the baseline system and PBS-P100

Plumbing

1. Proposed plumbing system.
 - Include lists of typical fixtures.
2. Evaluation of alternate sources for preheating of domestic water (solar or heat recovery).

Calculations and Energy Analysis.

HVAC

- Building load calculations.
- Heat and air balance calculations.
- Psychometric calculations for full load and partial load utilization in summer, winter, spring, and fall. (Partial loads at 50% and 25%, and unoccupied hours.)
- Detailed energy analysis using DOE-2, or approved equal. Output shall indicate energy consumption of the system and total building energy summary.

- Fuel consumption estimates.
- Comparative analyses to recommended system defined in concept submissions.
- Additional life cycle cost analyses as required to optimize equipment selections, heat recovery/storage, and control/zoning options.
- Selection cut sheets of equipment and control systems.
- Calculations for duct losses.
- Calculations for piping losses.

Plumbing

1. Proposed plumbing system.
 - Include lists of typical fixtures.
2. Evaluation of alternate sources for preheating of domestic water (solar or heat recovery).

Specifications.

- Redlined (strike through) version of each specification section to be used on the project

Cost Estimates.

- Cost of total HVAC system.
- Cost of major equipment.
- Cost of air distribution and piping system materials.

Fire Protection

Fire protection and life safety submission requirements shall be identified as a separate Fire Protection section as outlined in this document.

Calculations.

1. Occupant load and egress calculations.
2. Fire protection water supply calculations.
 - Includes water supply flow testing data.
3. Fire pump calculations where applicable.
4. Smoke control calculations where applicable (e.g., atrium, etc.).

5. Stairway pressurization calculations where applicable.
6. 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.

Narrative.

1. Building egress system.
 - Includes egress calculations and stairway exit capacities, remoteness, exit discharge, etc.
2. All building fire alarm and suppression systems.
3. Smoke control system(s), where applicable.
4. Special fire protection systems (e.g., kitchen extinguishing system), where applicable.
5. Fire resistance rating of building structural elements.
 - Coordinate with structural engineer.
6. Fire alarm system.
7. Interface of fire alarm system with Building Automation system and Security Systems.
8. Review of building for compliance with life safety requirements and building security requirements.
9. Interior finish requirements as they pertain to the life safety requirements.

Drawings.

1. Floor Plans showing:
 - Equipment spaces for fire protection systems (e.g., fire pump, fire alarm, etc.)
 - Fire protection water supply lines, fire hydrant locations, fire apparatus access roads, and fire lanes.
 - Standpipes and sprinkler risers.
 - Riser diagrams for sprinkler system.
 - Riser diagram for fire alarm system.
 - Remoteness of exit stairways.
 - Location of firewalls and smoke partitions.

- Identification of occupancy type of every space and room in building.
- Calculated occupant loads for every space and room in the building.
- Location of special fire protection requirements (e.g., kitchens, computer rooms, storage, etc.)

Electrical

Calculations.

1. Lighting calculations for a typical 186 m² (2,000 sf) open office plan with system furniture.
2. Lighting calculations for a typical one person private office.
3. Power calculations from building entry to branch circuit panel.
4. Load calculations.
5. Life cycle cost analysis of luminaire/lamp system and associated controls.

Narrative.

1. Description of alternative power distribution schemes.
 - Compare the advantages and disadvantages of each approach. Include the source of power, potential for on-site generation, most economical voltage and primary versus secondary metering.
2. Proposed power distribution scheme.
 - Provide a detailed description and justification for the selected scheme. Address special power and reliability requirements, including emergency power and UPS systems.
3. Proposed lighting systems.
 - Discuss typical lighting system features, including fixture type, layout, and type of controls.
 - Discuss special spaces such as lobbies, auditoria, dining rooms and conference rooms.
 - Discuss exterior lighting scheme.

4. Interface with Building Automation System.
 - Methods proposed for energy conservation and integration with Building Automation System.
 5. Engineering analysis for demand limit controls.
 6. Description of each proposed signal system.
 7. Description of proposed security systems' features and intended mode of operation.
 - Proposed zone schedule.
 - Proposed card access controls, CCTV assessment and intrusion protection system, if applicable.
 8. Proposed Telecommunications Infrastructure.
 - 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.
 9. 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.
5. Single line diagram of the building power distribution system.
 6. Plan of typical office lighting layout.
 7. Single line diagram of other signal system including: telephones; security; public address; and others.
 8. Security system site plan.
 - 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.
 9. Security system floor plans.
 - Proposed locations for access controls, intrusion detection devices, CCTV and local panels.

Drawings.

1. Site plan.
 - Proposed site distribution for power and communications, proposed service entrance and location of transformers, generators, and vaults, etc.
2. Floor plans.
 - Proposed major electrical distribution scheme and locations of electrical closets.
3. Floor plans.
 - Proposed major routing of communications system, communications equipment rooms and closets.
4. Floor plans.
 - Plan layouts of electrical rooms, showing locations of major equipment, including size variations by different manufacturers.

Design Development Cost Estimate

A cost estimate must be provided. It should comply with the requirements for design development phase estimate stated in the *Cost Estimating Requirements* of the Appendix's Section A.1 of this *Facilities Standard*.

Cost estimate must separate costs for interior tenant buildout from core/shell cost items as described in the *GSA New Pricing Guide*. The interior buildout costs must be divided by each building tenant.

Address what value engineering items were incorporated from the Concept Value Engineering 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

1. The architect/engineer (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.
2. Assemble material for LEED rating submission, indicating features and points that assure desired LEED rating.
3. VE decisions and commitments that were made during the Design Development phase by the Project Team.
4. In bullet form, identify how selected design features will support the project's performance expectations. All building systems involved with the project shall be discussed, each addressing all performance expectations as covered in the design program and Appendix 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.

One of the guidelines to insure inter-discipline and intra-discipline coordination is included under each category of work and is referred to as the Review Checklist. The A/E consultant should make sure that all of these items, and others that pertain to good project coordination, are reviewed and addressed before submission of the documents to GSA.

Update of Code Analysis. The Code criteria shall be reviewed by each design team discipline member to the degree of detail necessary to assure that tasks accomplished meet all the Code requirements.

Site Planning and Landscape Design

Drawings. General: The plans listed below, except the demolition plans, may be combined on small projects.

1. Demolition plans, if required.
2. Site layout plan.
 - Location of all buildings, roads, walks, accessible routes from parking and public street to building entrance, parking and other paved areas, and planted areas.
 - Limits of construction.
 - Locations and sizes of fire protection water supply lines, fire hydrants, fire apparatus access roads, and fire lanes.
 - Location of floodplains and wetlands.

3. Grading and drainage plan, showing:
 - Existing and new contours [use 500 mm (2 foot) interval minimum in area around buildings].
 - Spot elevations at all entrances and elsewhere as necessary.
 - Elevations for walls, ramps, terraces, plazas and parking lots.
 - All surface drainage structures.
 - Water retainage and conservation.
4. Site utilities plan, showing:
 - All utilities, including inlets, manholes, clean-outs and invert elevations.
5. Planting plan, showing:
 - Building outline, circulation, parking and major utility runs.
 - Size and location of existing vegetation to be preserved (include protection measures during construction).
 - Location of all new plant material (identify function, such as windbreak or visual screen where appropriate).
 - Erosion control.
6. Planting schedule, showing:
 - Quantity of plants, botanical names, planted size and final size.
7. Irrigation plan, if applicable.
 - Include schematic of irrigation control system.
8. Planting and construction details, profiles, sections, and notes as necessary to fully describe design intent.
9. Construction phasing, if part of project.
10. Survey of surrounding buildings, structures and improvements in both wet and dry season to document pre-construction elevations.
11. Potential archeological artifacts.

Calculations.

1. Final drainage calculations, including stormwater detention.
2. Final parking calculations, if applicable.
3. Pipe sizing calculations for water and sewer pipes.
4. Pavement design calculations.

Architectural

Drawings.

1. Project title sheet, drawing index.
2. Demolition plans.
 - Show for modernizations, if required.
3. Floor plans.
 - Show planning grids and raised access floor grid, if applicable.
4. Reflected ceiling plans.
 - Show ceiling grid and location of all elements to be placed in the ceiling.
5. Building sections.
 - Vertical zoning for electrical and mechanical utilities must be indicated on sections.
6. Roof plans.
 - Roof plans must show slopes, low points, drains and scuppers, equipment, equipment supports, roof accessories and specialty items, if applicable.
7. Exterior elevations.
8. Wall sections.
9. Interior elevations.
10. Details.

Schedules.Diagrams illustrating proper clearance for servicing and replacement of equipment.

Specifications.

1. Room finish, ceiling types, floor finish, color and door schedules can be incorporated into either the specifications or drawings.
2. Call for thermographic scans of building envelope to identify sources of heat transfer.
3. Call for assembly of mock-ups for spaces such as courtrooms and sample office space fitouts.
4. 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.

Technical specifications for repair and restoration of historic materials, including:

- Specialized materials and procedures for repair and restoration of historic materials.
- Procedures for protecting historic materials in areas being altered.
- Sample review requirements of repair and restoration procedures.
- Sample submittal requirements for replacement materials and new installations in preservation zones.

Structural

Drawings.

1. Demolition plans (when applicable).
2. Full set of structural construction drawings.
 - Drawings must be fully dimensioned, noted and detailed for accurate bidding and construction.
 - 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, shall be indicated.
 - 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.
 - 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.

- Soil bearing pressure and lateral earth pressure must be indicated.
- Properties of basic materials must be indicated.
- Blast-resistant requirements if applicable.
- Indicate the codes and standards used to develop the project.

3. Schedules.

- Schedules for foundations, columns, walls, beams, slabs, and decks, as applicable.

4. Structural details. (All typical details must be shown on the drawings.)

- Include details for steel connections.
- Include details for all fire-rated assemblies, indicating Underwriters Laboratories Inc. or other nationally recognized testing laboratory fire resistance directory design numbers.
- 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).
- Include details for anchorage of building system equipment and nonstructural building elements (maybe shown on mechanical, electrical, or architectural drawings, as applicable).

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.

1. Final structural calculations, including:

- Gravity loads.
- Lateral loads.
- Foundations.
- Thermal loads where significant.
- Vibration propagation.

- Progressive collapse.
- Supports for nonstructural elements, including mechanical and electrical equipment.
- Steel connections
- Blast analysis.

Whenever a figure is obtained from some other page of the calculations, refer to that page number in parenthesis 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.

Mechanical

Drawings.

HVAC

1. The construction documents must be complete, coordinated between disciplines, biddable, readable and buildable, with no room for unreasonable additional interpretation.
2. 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.
3. One of the guidelines to insure inter-discipline and intra-discipline coordination is included under each category of work and is referred to as the Review Checklist.
4. The A/E consultant should make sure that all of these items, and others that pertain to good project coordination, are reviewed and addressed before submission of the documents to GSA.

5. Systems must be fully drawn and sized to permit accurate bidding and construction.
6. Demolition plans:
 - Show for modernizations, if required.
 - Show all existing conditions relative to the project.
 - Show all work to be removed and differentiate this work from all existing conditions to remain.
7. New work HVAC piping and equipment plans:
 - 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.
 - Mechanical room piping layout shall be double line.
8. New work HVAC duct and equipment plans:
 - Single line piping and double line ductwork layout.
 - Show terminal air devices.
 - Perimeter terminal units.
 - Quarter-inch scale drawings of mechanical equipment room(s) showing all mechanical equipment serving the project including equipment access and service requirements. (The layout shall indicate the spaces allocated for maintenance and removal.)
 - Air balancing of systems.
 - Roof plan showing all roof-mounted equipment.
 - Show adequate access from mechanical equipment room(s) to freight elevators.
 - Show adequate access to roof-mounted equipment.
 - Mechanical details.
 - All dampers—both fire dampers and volume control dampers—must be shown. Ductwork ahead of the distribution terminal must be indicated in true size (double line).
9. New work single line schematic flow and riser diagram(s):
 - Airflow quantities and balancing devices for all heating/cooling equipment.
 - Water flow quantities and balancing devices for all heating/cooling equipment.
 - Flow/energy measuring devices for water and air systems for all cooling, heating and terminal equipment.
10. New work automatic temperature control diagram(s):
 - Control flow diagrams showing all sensors, valves, and controllers (analog and digital inputs for controllers, front end equipment and system architecture).
 - Sequence of operations of all the systems and its operation (occupied and unoccupied).
 - BACnet or LON Work Building Automation System and their descriptions.
 - Energy flow/metering devices for major equipment such as chillers, boilers, pumps, and other terminal equipment.
 - Diagram to show control signal interface, complete with sequence of operation; BACnet/LON Works.
 - Software requirements.
 - Show location of energy metering devices and their connection to central processor.
11. New work schedules:
 - Provide schedules of major equipment that includes chillers, boilers, pumps, air handling units, and terminal units.
 - Air Terminal Devices
 - Air Balance Relationships between Spaces

Plumbing

1. Demolition plans
 - Show for modernization, if required.

2. Piping riser diagrams.
 - Plumbing
3. Floor plans.
 - Plumbing layout and fixtures; large-scale plans should be used where required for clarity.
4. Riser diagrams for waste and vent lines.
5. Riser diagrams for domestic cold and hot water lines.
6. Plumbing fixture schedule.

Narrative.

A written narrative describing the final mechanical system and equipment selection including:

- Updated narrative submitted during design development.
- Updated ductwork and piping loss calculations.
- Updated equipment selections with capacities, weights, sizes and power requirements
- Updated psychometrics.
- Updated design conditions.
- Updated Ventilation rates, updated dehumidification and pressurization conditions.
- Updated description of the airside and waterside systems and the associated components, including operating characteristics, ranges, and capacities, spaces served and special features.
- Updated description of occupied, partial occupancy, and unoccupied related sequence of operations.
- Updated fuel and utility requirements.
- An ASHRAE 90.1 compliance statement.
- A code compliance statement.
- An updated description of any deviation from PBS-P100.

Calculations and Energy Analysis.

HVAC

- System load and supply air calculations (for VAV systems).

- System pressure static analysis at peak and minimum block loads (for VAV systems).
- Acoustical calculations (for VAV systems, use peak air flow).
- Calculations for duct losses.
- Calculations for piping losses.
- Flow and head calculations for pumping systems.
- Selection of equipment, cut sheets of selected equipment.
- Psychometric calculations for full load and partial load utilization in summer, winter, spring, and fall. (Partial loads at 50% and 25%, and unoccupied hours.)
- Detailed energy analysis using DOE-2, or approved equal. Output shall indicate energy consumption of the system and total building energy summary.
- Fuel consumption estimates.
- Comparative analyses to recommended system defined in concept submissions.
- Additional analyses as required to optimize equipment selections, heat recovery/storage, and control/zoning options.
- Sizing of fuel storage and distribution and vibration isolation.

Plumbing

1. Plumbing calculations.
 - Include entire building, including roof drainage calculations and hot water heating calculations.
 - Water supply calculations, including pressure.
 - Roof drainage calculations.
 - Sanitary waste sizing calculations.

Specifications.

- Completely edited version of each specification section to be used on the project.

Fire Protection

Fire protection and life safety submission requirements shall be identified as a separate Fire Protection section as outlined in this document.

Drawings.

1. Demolition plans.
 - Show for modernizations, if required.
2. Full set of fire protection construction drawings.
 - Drawings must be carefully dimensioned, noted and detailed for accurate bidding and construction.
3. Fire Protection details. (All typical details must be shown on the drawings.)

Building Construction

- Building's construction type (e.g., 443, 222, etc.).
- Firewalls and smoke partitions.
- Panel and curtain walls.
- 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.

Life Safety

- Each stair.
- Horizontal exits.
- Each required fire door.
- Stairway pressurization fans.
- Security door hardware, including operation procedures.

Water Supply

- Fire pump configuration.
- Anchorage of underground fire protection water supply lines.
- Standpipe riser.

Water Based Fire Extinguishing Systems

- Installation of waterflow switches and tamper switches.
- Sprinkler floor control valves, sectional valves, and inspector text assembly.

Non-Water Based Fire Extinguisher Systems

- Special fire extinguishing systems (e.g., wet chemical, etc.).

Fire Alarm System

- Fire alarm riser.
- Typical firefighter telephone station.
- Typical firefighter telephone jack.
- Electrical closets for fire alarm system panels.
- Fire alarm telephone panel (includes voice paging microphone and firefighter telephone system).
- Visual indicating device control and power detail, typical for floors (state location).
- Amplifier rack (state location).
- Typical location of duct smoke detectors.
- Outdoor fire alarm speaker.
- Wall mounted cone fire alarm speaker.
- Typical terminal cabinet.
- Lay in ceiling mounted fire alarm speaker.
- Lay in ceiling mounted fire alarm combination speaker/strobe.
- Wall mounted strobe device.
- Typical manual fire alarm box installation.
- Fire alarm system input/output matrix.
- Graphic annunciator panel.
- Installation of the graphic annunciator.
- Fire command center showing the locations of each panel to be installed.

Specifications.

1. Final Specifications.
 - Specifications shall be based on GSA M/E Supplements to Masterspec.

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 shall be part of the calculations.

1. Final occupant load and egress calculations.
2. Final fire protection water supply calculations.
 - Includes water supply flow testing data.
3. Final fire pump calculations where applicable.
4. Final smoke control calculations where applicable (e.g., atrium, etc.).
5. Final stairway pressurization calculations.
6. Fire modeling.
7. 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

Drawings. General: Systems must be fully drawn and sized to permit accurate bidding and construction.

1. Demolition plans.
 - Show for modernizations, if required.
2. Floor plans.
 - Show lighting, power distribution and communications raceway distribution and locations of fire alarm and annunciator panels.
3. Single-line diagram of primary and secondary power distribution.
 - Include normal power, emergency power and UPS.
4. Single-line diagram of fire alarm system.
5. Single-line diagram of telecommunications system.

6. Circuit layout of lighting control system.
7. Details of underfloor distribution system.
8. Site plan.
 - Indicate service locations, manholes, ductbanks and site lighting.
9. Layout of electrical equipment spaces.
 - Show all electrical equipment. Include elevations of substation transformers and disconnect switches.
10. Schedules for switchgear, switchboards, motor control centers, panelboards and unit substations.
11. Grounding diagram.
12. Complete phasing plan (if required) for additions and alterations.
13. Security systems site plan.
 - Final locations of all security devices and conduit runs.
14. Security system floor plans.
 - Layout of all security systems.
15. Storage areas for electrical equipment/spare parts.

Specifications.

1. Final specification.
 - Zone schedules may be bound into the specifications or shown on drawings.

Calculations.

1. Illumination level calculations.
2. Short circuit calculations.
3. Voltage drop calculations.
4. Overcurrent coordination study.
5. Generator calculations.
 - Include starter loads.

Certification Requirements for Energy Conservation

The architect/engineer (lead designer) must provide certification that the project has been designed and is in compliance with ASHRAE 90.1 (latest approved version), 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.

The architect/engineer 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. It should comply with the requirements for construction documents phase estimate stated in the *Cost Estimating Requirements* of the Appendix's Section A.1 of this *Facilities Standard*.

Cost estimate must separate costs for interior tenant buildout from core/shell cost items as described in the *GSA New Pricing Guide*. The interior buildout costs must be divided by each building tenant.

Data and Operations Manual

An operations manual shall be prepared and training provided for the building Operations and Maintenance personnel describing the design objectives and how to operate the building. The manual shall 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.

GSA Design Awards Submission

All prospectus level projects shall be submitted to the GSA Design Awards Program for consideration.

The submission must clearly communicate, in visual and narrative form, the scope and outstanding features of the project and be organized to facilitate easy review by the jury.

Materials must be in transparent sleeves inside a standard 10 by 11-½ inch three-ring binder that is no more than 1-½ inches thick. The project name and category must appear on the front and the spine of the binder. No deviations from these requirements are permitted.

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. The following flow diagram and related definitions describe this process.

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.

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 that the aesthetics support the design philosophy of GSA shown in Chapter 3, *Architecture and Interior Design* of this document. A preliminary analysis of proposed building systems should be accomplished to determine the most cost-effective alternatives.

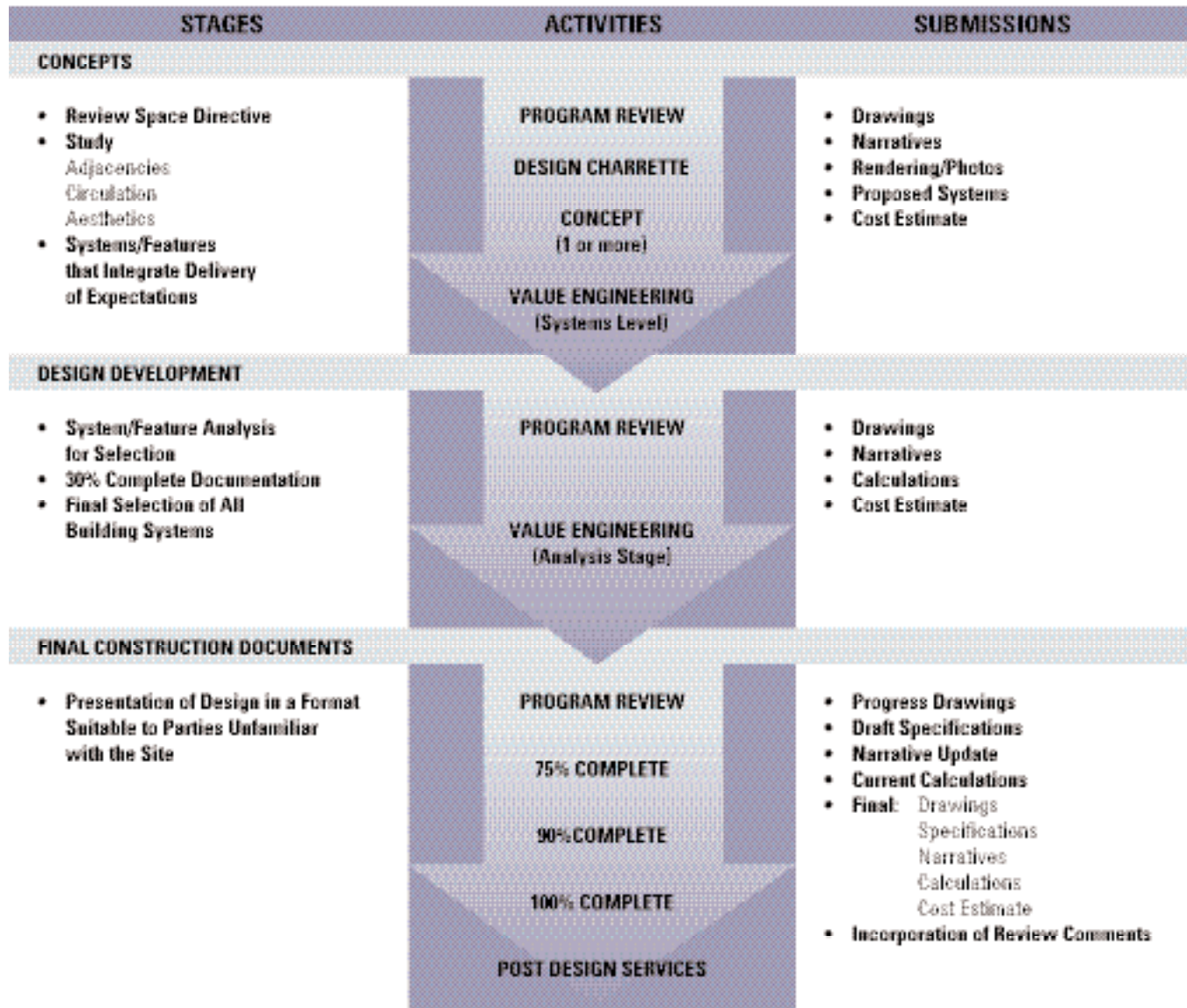
Design Development. A set of submissions and meetings that will finalize the selection of type, size and other material characteristics of all systems. Systems are not only structural, mechanical, fire protection and electrical, but all other building components such as envelope (wall, window and roof), interior (flooring, ceiling and partitions), toilet and service rooms, elevators, etc. 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 should be produced in a general fashion that any construction contractor nationwide can understand. Designs shall 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 should be consistent and complementary to notes on the drawings. The documents should 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 assure that tasks accomplished in each phase meet the code requirements.

Design Process and Related Submission Requirements for Renovation



Concept

Site Planning and Landscape Design

A sitework narrative only needs to be submitted if sitework is a substantial part of the scope of work for the alteration.

Narrative.

1. Site statement, describing:
 - Existing site features.
 - Topography and drainage patterns.
 - Any existing erosion conditions.
 - Wetlands and location of flood plains.
 - Circulation patterns around site.
 - Site access.
 - Noise/visual considerations.
 - Local zoning restrictions.
 - Potential archeological artifacts.
 - Historic preservation considerations, if applicable.
 - Fire protection considerations, if applicable.
2. Site analysis of utilities, if utilities are to be changed.
3. Description of site and landscape design concept.
 - Proposed changes to circulation design.
 - Proposed changes to parking.
 - Proposed method for stormwater detention or retention.
 - Proposed changes to paving.

Architectural

An architectural concept only needs to be submitted if architectural work is a substantial part of the scope of work for the alteration.

Drawings.

1. Demolition plans.
2. Floor plans, showing as a minimum:
 - Existing and new spaces, circulation, entrances, stairways, elevators, special spaces and service spaces including mechanical, fire protection, electrical and communication spaces. Dimensions for critical clearances, such as vehicle access and fire apparatus access should be indicated.

Narrative.

1. Architectural program requirements.
 - Describe how the design meets the project authorization.
2. Design concept, explaining:
 - General layout.
 - Treatment of historic zones, if applicable.
3. Calculations.
 - Where building renovation involves window or insulated wall systems, perform an LCC assessment to optimize selection.

Historic Preservation

8.5" x 11" report, signed by qualified preservation architect, including

Narrative.

1. General: Project purpose, scope, groups and individuals involved
2. Existing conditions, describing:
 - Overall building size, configuration, character
 - Project location
 - Existing original materials and design, relevant alterations
3. Preservation design issues and prospective solutions, including:
 - Location of new work/installation: visibility, impact on historic finishes
 - Compare options for preserving/restoring historic materials and design
 - Identify further study required to avoid adverse effects as applicable

Photographs.

- General and detail views showing existing conditions at affected preservation zones, keyed to plan showing location and orientation of each view
- Captions identifying location, subject, condition shown

Drawings.

Reduced to 8.5" x 11, 11" x 17" foldout or placed in cover pocket:

- Site and floor plans, as applicable
- Sketches or schematic CAD drawings (elevations, plans) showing preservation design concepts

Structural

A structural narrative only needs to be submitted if a structural upgrade is part of the scope of work.

Narrative.

1. 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.
 - This report may have been completed as part of the Prospectus Development Study.
2. Identification of governing codes.
3. Description of recommended changes to the structural system, addressing:
 - 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.
4. If a seismic safety study exists for the building, describe any variations taken in design, compared to the study's recommendations.

Mechanical

A mechanical narrative only needs to be submitted if the alteration scope of work involves changes to the major mechanical systems. Replacement in kind of all or part of an existing mechanical system does not need to be shown at this stage of design.

Narrative.

1. Description of requested changes to existing systems.
 - Describe HVAC and plumbing systems, including available capacity versus criteria in Chapter 5 of this document and operational characteristics.

- Identify how new systems will be tied into existing systems. (Any replacement should be well-integrated with other building systems that remain or are replaced.)
- Outline energy conservation opportunities that were researched. Highlight those that were incorporated. This report may have been completed as part of the Prospectus Development Study.

Fire Protection

Fire protection and life safety submission requirements shall be identified as a separate Fire Protection section as outlined in this document.

Drawings.

1. Demolition plans.
 - Identify existing fire protection systems (e.g., sprinklers, fire alarm notification appliances, etc.).
2. Floor plans, showing a minimum:
 - New fire protection systems (e.g., sprinklers, fire alarm notification appliances, etc.).

Narrative.

A fire protection narrative only needs to be submitted 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.

1. Fire Protection program requirements.
2. Description of the buildings proposed fire protection systems including modifications to the existing egress systems.
3. Code statement identifying changes in building occupancy classification, occupancy group(s), fire resistance requirements, egress requirements, etc.

Electrical

An electrical narrative only needs to be submitted if the alteration scope of work involves changes to the type or location of major electrical systems.

Narrative.

1. Description of requested changes to existing systems.
 - Describe lighting, power and signal systems, including available capacity versus criteria in Chapter 6, and operational characteristics.
 - Describe code deficiencies. Identify how new systems will be tied into existing systems.
 - This report may have been completed as part of the Prospectus Development Study.
2. Describe both existing and new distribution systems within the building.
 - Special power and reliability requirements should be addressed, including emergency power and UPS systems.

Concept Cost Estimate

A cost estimate must be provided. It should comply with the requirements for concept stage estimate stated in the *Cost Estimating Requirements* of the Appendix's Section A.1 of this *Facilities Standard*.

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

Calculations.

1. Storm drainage and sanitary sewer calculations.
2. Storm water detention facility calculations, if applicable.
3. Parking calculations, if applicable.

Narrative.

1. Site circulation concept, explaining:
 - Reasons for site circulation design and number of site entrances.
 - Reasons and/or calculation for number of parking spaces provided.
 - Reasoning for design of service area(s), including description of number and sizes of trucks that can be accommodated.
 - Proposed scheme for waste removal.
 - Proposed scheme for fire apparatus access (including aerial apparatus), roads and fire lanes.
2. Site utilities distribution concept.
3. Drainage design concept.
4. Landscape design concept, explaining:
 - Reasoning for landscape design, paving, site furnishings, and any water features.
 - Reasoning for choice of plant materials.
 - Proposed landscape maintenance plan.
 - Brief operating description of irrigation system.
 - Summarize water conservation opportunities that have been studied.
 - Brief description of fire protection water supplies.
 - Brief description of fire hydrant locations.

5. Site construction description.
 - Brief description of materials proposed for pavements and utilities.
6. Code Analysis.
 - Analysis of applicable local zoning and building code requirements.

Drawings.

1. Demolition plans (when applicable).
2. Preliminary site layout plan, showing:
 - 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.
 - Fire apparatus access (including aerial apparatus) and fire lanes.
3. Preliminary grading and drainage plan, showing:
 - Preliminary site grading, storm drainage inlets, including detention facilities.
4. Preliminary site utilities plan, showing:
 - 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.
5. Preliminary landscape design plan, showing:
 - Preliminary hardscape design, including site furniture, water features, etc.
 - Preliminary planting scheme.
 - Preliminary irrigation design.

Architectural

Narrative.

1. Building concept, explaining:
 - Entrance locations and service locations.
 - Building circulation and arrangement of major spaces.
 - Interior design.
 - Adherence to the Historic Building Preservation Plan, if applicable.
2. Building construction description, explaining, if applicable:
 - Exterior materials, waterproofing, air barriers/vapor retarders and insulation elements.
 - Roofing system(s).
 - Exterior glazing system.
 - Interior finishes, with detailed explanation for public spaces.
 - Potential locations for artwork commissioned under the “Art in Architecture” program, if applicable.

Drawings.

1. Demolition plans.
2. Building floor plans, showing:
 - Spaces individually delineated and labeled.
 - Enlarged layouts of special spaces.
 - Dimensions.
 - Accessible routes for the physically disabled as well as other compliance requirements regarding signage, toilets, etc.
3. Building roof plan, if applicable, showing:
 - Drainage design, including minimum roof slope.
 - Dimensions.
 - Membrane and insulation configuration of the roofing system.

4. Elevations of major building façades (if changes to the exterior are proposed), showing:
 - Existing and new fenestration.
 - Existing and new exterior materials.
 - Cast shadows.
5. Two building sections (of renovated areas only), showing:
 - Accommodation of structural systems.
 - Mechanical penthouses, if any.
 - Floor to floor and other critical dimensions.
 - Labeling of most important spaces.
6. Exterior wall sections, showing:
 - Materials of exterior wall construction, including flashing, connections and method of anchoring.
 - Vertical arrangement of interior space, including accommodation of mechanical, fire protection and electrical services in the floor and ceiling zones.
7. Proposed room finish schedule, showing:
 - Floors, base, walls and ceilings.
 - Finish schedule may be bound into narrative.

Historic Preservation

8.5 " x 11" report, signed by qualified preservation architect, including

Narrative.

1. General: Project purpose, scope, groups and individuals involved, substantive changes to approach described in concept submission
2. Existing conditions, describing:
 - Overall building size, configuration, character
 - Project location
 - Existing original materials and design, alterations
 - New findings from testing or analysis in concept phase

3. Preservation solutions explored, how resolved and why, including:
 - Location of new work: visual impact, protection of ornamental finishes
 - Design of new work/installation: visual and physical compatibility with existing original materials and design; materials/finishes proposed (as specified)
 - Methods of supporting new work/installation
 - Preservation and protection of historic materials during construction through tenant move in
4. Effects, describing:
 - How project will affect the building's architecturally significant qualities
 - Measures proposed to mitigate any adverse effects on historic materials or design

Photographs.

- General and detail views showing existing conditions at affected preservation zones, keyed to plan showing location and orientation of each photo view
- Captions identifying location, subject, condition shown

Drawings.

Reduced to 8.5" x 11, 11" x 17" foldout or placed in cover pocket:

- Site and floor plans, as applicable
- Elevations, plans, and section details showing preservation design solutions for each issue identified, as approved by Regional Preservation Officer

Cover.

Building name, Address, Project title, Project Control Number, Author (Preservation Architect), Preservation Architect's Signature, Date of Submission.

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.

1. Gravity load calculations.
2. Lateral load calculation.
3. Foundation calculations.
4. Calculations showing that system is not vulnerable to progressive collapse.
5. Vibration calculations.
6. Results of any other studies necessary for the project design.

Narrative.

1. Description of structural concept, including:
 - Choice of framing system, including lateral load resisting elements.
 - Proposed foundation design.
 - Verification of adequacy of all assumed dead and live loads.
2. Code analysis.
 - Building classification, required fire resistance of structural elements, identification of seismic zone, wind speed, etc.
 - Identification of special requirements, such as highrise.
 - Summary of special requirements resulting from applicable local codes.
3. Proposed methods of corrosion protection, if applicable.
4. Geotechnical Engineering Report, including boring logs (if part of scope of work).
 - See Appendix A.5 for specific requirements.
5. Geologic Hazard Report.

Drawings.

- 1. Demolition plans (where applicable).
- 2. Preliminary framing plans and key details.
 - Include column locations, bay sizes and location of expansion and seismic joints.
- 3. Preliminary schedules, including:
 - Column, beam, slab, metal deck, and wood framing schedules, as applicable.
 - Preliminary seismic details.

Mechanical

Calculations.

HVAC.

- 1. Block loads for heating and refrigeration.
- 2. Heat and air balance calculations.
- 3. HVAC calculations for air handling units.
- 4. Heat loss calculations for walls and roofs.
- 5. Energy analysis.
 - Projections for the annual energy consumption of the building, taking into account architectural wall and roof design and lighting.

Plumbing

- 1. Water supply calculations.
 - Include pressure for domestic hot and cold water.
- 2. Roof drainage calculations, should new roof drainage be part of the project.

Narrative.

- 1. Life Cycle Cost Analysis of at least three potential HVAC systems.
 - The analysis should compare first cost and operating costs. One of the systems must be the base line system described in the Chapter 1 of this document.

- 2. Description of the HVAC systems studied.
 - The general features, configuration, and functional advantages and disadvantages of each system should be compared qualitatively.
- 3. Description of recommended HVAC system.
 - Include cost and other considerations.
- 4. Recommendations for HVAC systems for special spaces.
 - Automated data processing rooms, auditoria, conference rooms, kitchens and other special spaces identified in the building program.
- 5. Proposed plumbing system.
 - Include lists of typical fixtures.
- 6. Evaluation of alternate sources for preheating of domestic water (solar or heat recovery).
- 7. 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.

Drawings.

- 1. Demolition plans.
- 2. Site plan.
 - Proposed inverts of sewers, stormwater pipes and gas lines at the building service entrance, showing match to existing utilities.
- 3. Floor plans.
 - Proposed HVAC scheme, showing building zoning and major duct and piping runs.
- 4. Floor plans.
 - Sketch layouts of mechanical rooms, showing locations of major equipment. including size variations by different manufacturers.

5. Floor plans.
 - Locations of proposed plumbing fixtures and equipment.
6. Systems schematics and flow diagrams.
7. Typical schematics for plumbing systems.

Fire Protection

Fire protection and life safety submission requirements shall be identified as a separate Fire Protection section as outlined in this document.

Calculations.

1. Occupant load and egress calculations.
2. Fire protection water supply calculations.
 - Includes water supply flow testing data.
3. Fire pump calculations where applicable.
4. Smoke control calculations where applicable (e.g., atrium, etc.).
5. Stairway pressurization calculations where applicable.
6. 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.

Narrative.

1. Building egress system.
 - Includes egress calculations and stairway exit capacities, remoteness, exit discharge, etc.
2. All building fire alarm and suppression systems.
3. Smoke control system(s), where applicable.

4. Special fire protection systems (e.g., kitchen extinguishing system), where applicable.
5. Fire resistance rating of building structural elements.
 - Coordinate with structural engineer.
6. Fire alarm system.
7. Interface of fire alarm system with Building Automation system and Security Systems.
8. Review of building for compliance with life safety requirements and building security requirements.
9. Interior finish requirements as they pertain to the life safety requirements.

Drawings.

1. Floor Plans showing:
 - Equipment spaces for fire protection systems (e.g., fire pump, fire alarm, etc.).
 - Fire protection water supply lines, fire hydrant locations, fire apparatus access roads, and fire lanes.
 - Standpipes and sprinkler risers.
 - Riser diagrams for sprinkler system.
 - Riser diagram for fire alarm system.
 - Remoteness of exit stairways.
 - Location of firewalls and smoke partitions.
 - Identification of occupancy type of every space and room in building.
 - Calculated occupant loads for every space and room in the building.
 - Location of special fire protection requirements (e.g., kitchens, computer rooms, storage, etc.).

Electrical

Calculations.

1. Lighting calculations for a typical 186 m² (2,000 sf) open plan office with system furniture.
2. Lighting calculations for a typical one person private office.
3. Power calculations from building entry to branch circuit panel.
4. Load calculations.
5. Life cycle cost analysis of luminaire/lamp system.
6. Life cycle cost study on the options to integrate related building systems.

Narrative.

1. Proposed power distribution scheme.
 - Provide a detailed description and justification for the selected scheme.
2. Interface with Building Automation System.
 - Methods proposed for energy conservation and integration with Building Automation System.
3. Engineering analysis for demand limit controls.
4. Description of each proposed signal system.
5. Description of proposed security systems features and intended mode of operation.
 - Proposed zone schedule.
 - Proposed card access controls, CCTV assessment and intrusion protection system, if applicable.

Drawings.

1. Demolition plans.
2. Site plan.
 - Proposed site distribution for power and communications, proposed service entrance and location of transformers, generators, and vaults, etc.

3. Floor plans.
 - Proposed major electrical distribution scheme and locations of electrical closets.
4. Floor plans.
 - Major routing of communications system, communications equipment rooms and closets.
5. Underfloor distribution system.
 - Show typical detail for power and communications services.
6. One-line diagram.
7. Typical lighting layout.
 - Include lighting for special areas.
8. Exterior lighting scheme.
9. Layout of electrical rooms.
 - Show locations of major equipment.
10. One-line diagrams of other signal systems.
11. Security system site plan.
 - 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.
12. Security system floor plans.
 - Access controls, intrusion detection devices and CCTV locations shown. Preliminary local panel locations shown.

Design Development Cost Estimate

A cost estimate must be provided. It should comply with the requirements for design development phase stated in the *Cost Estimating Requirements* of the Appendix's Section A.1 of this *Facilities Standard*.

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 shall 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

Cover Sheet. 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.

Drawings. General: The plans listed below, except the demolition plans, may be combined on small projects.

1. Demolition plans.
2. Site layout plan.
 - Location of all buildings, roads, walks, accessible routes, parking and other paved areas and planted areas.
 - Limits of construction.
 - Locations of fire protection water supply lines, fire hydrants, fire apparatus access roads, and fire lanes.

3. Grading and drainage plan, showing:
 - Existing and new contours [use 500 mm (2 foot) interval minimum in area around buildings].
 - Spot elevations at all entrances and elsewhere as necessary.
 - Elevations for walls, ramps, terraces and plazas.
 - All surface drainage structures.
4. Site utilities plan, showing:
 - All underground utilities, including inlets, manholes, clean-outs and invert elevations.
5. Planting plan, showing:
 - Building outline, circulation, parking and major utility runs.
 - Size and location of existing vegetation to be preserved (include protection measures during construction).
 - Location of all new plant material (identify function, such as windbreak or visual screen where appropriate).
6. Planting schedule, showing:
 - Quantity of plants, botanical names, planted size and final size.
7. Irrigation plan, if applicable.
 - Include schematic of irrigation control system.
8. Construction details, profiles and sections and notes as necessary to fully describe design intent.
9. Construction phasing, if part of project.

Calculations.

1. Final drainage calculations, including stormwater detention.
2. Final parking calculations, if applicable.
3. Pipe sizing calculations for water and sewer pipes.
4. Pavement design calculations.

Architectural

Drawings.

1. Demolition plans.
2. Floor plans.
 - Show planning grids and raised access floor grid, if applicable.
3. Reflected ceiling plans.
 - Show ceiling grid and location of all elements to be placed in the ceiling.
4. Building sections.
 - Vertical zoning for electrical and mechanical utilities must be indicated on sections.
5. Roof Plans.
 - Roof plans must show slopes, low points, drains and scuppers, if applicable.
6. Exterior elevations.
7. Wall sections.
8. Interior elevations.
9. Details.
10. Schedules

Specifications.

1. Instructions to bidders.
2. Division 1, edited to suit specific GSA requirements.
3. Room finish, color and door schedules can be incorporated into either the specifications or drawings.

Historic Preservation

Specifications. Competency of bidder and restoration specialist qualification requirements, Sections 00120 and 009[00], cross referenced in material specifications

Technical specifications for repair and restoration of historic materials, including:

- Specialized materials and procedures for repair and restoration of historic materials
- Procedures for protecting historic materials in areas being altered
- Sample review requirements of repair and restoration procedures
- Sample submittal requirements for replacement materials and new installations in preservation zones

Structural

Drawings.

1. Demolition plans (where applicable).
2. Full set of structural construction drawings.
 - Drawings must be fully dimensioned, noted and detailed for accurate bidding and construction.
 - 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, shall be indicated.
 - 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.

- 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.
- Soil bearing pressure and lateral earth pressure must be indicated.

3. Schedules.

- Schedules for foundations, columns, walls, beams, slabs, and decks, as applicable.

4. Structural details. (All typical details must be shown on the drawings.)

- Include details for steel connections.
- Include details for all fire-rated assemblies, indicating Underwriters Laboratories Inc. or other nationally recognized testing laboratory fire resistance directory design numbers.
- 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).
- Include details for anchorage of nonstructural building elements.

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.

1. Final structural calculations, including:

- Gravity loads.
- Lateral loads.
- Foundations.
- Thermal loads where significant.
- Vibration propagation.
- Progressive collapse.

- Supports for nonstructural elements, including mechanical and electrical equipment.
- Steel connections.

Mechanical

Drawings. Systems must be fully drawn and sized to permit accurate bidding and construction.

HVAC

1. Demolition plans.
2. HVAC piping layouts.
 - All valves must be shown. Indicate locations where temperature, pressure and flow gauges are required.
3. HVAC duct layouts.
 - All dampers, both fire dampers and volume control dampers, must be shown. Ductwork ahead of the distribution terminal must be indicated in true size (double line).
4. Automatic control diagram.
 - Diagram to show control signal interface, complete with sequence of operation.
5. Layout of equipment rooms showing all mechanical equipment.
6. Mechanical details.
7. Complete equipment schedules.
8. HVAC duct riser diagram.

Plumbing

1. Demolition plans.
2. Floor plans.
 - Plumbing layout and fixtures; large scale plans should be used where required for clarity.
3. Riser diagrams for waste and vent lines.
4. Riser diagrams for domestic cold and hot water lines.

Calculations.

1. HVAC calculations for the entire building, arranged by individual air handling and pumping system.
 - Block loads for heating and refrigeration.
 - Room load and supply air calculations.
 - System load and supply air calculations (for VAV systems).
 - System pressure static analysis at peak and minimum block loads (for VAV systems).
 - Heat loss calculations for walls and roofs.
 - Acoustical calculations (for VAV systems use peak air flow).
 - Flow and head calculations for pumping systems.
2. Plumbing calculations.
 - Include entire building, including roof drainage calculations and hot water heating calculations.
 - Water supply calculations, including pressure.
 - Sanitary waste sizing calculations.
3. Sizing of fuel storage and distribution and vibration isolation.

Fire Protection

Fire protection and life safety submission requirements shall be identified as a separate Fire Protection section as outlined in this document.

Drawings.

1. Demolition plans.
2. Full set of fire protection construction drawings.
 - Drawings must be carefully dimensioned, noted and detailed for accurate bidding and construction.
3. Fire Protection details. (All typical details must be shown on the drawings.)

Building Construction

- Building's construction type (e.g., 443, 222, etc.).
- Firewalls and smoke partitions.
- Panel and curtain walls.
- 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.

Life Safety

- Each stair.
- Horizontal exits.
- Each required fire door.
- Stairway pressurization fans.
- Security door hardware, including operation procedures.

Water Supply

- Fire pump configuration.
- Anchorage of underground fire protection water supply line.
- Standpipe riser.

Water Based Fire Extinguishing Systems

- Installation of waterflow switches and tamper switches.
- Sprinkler floor control valves, sectional valves, and inspector test assembly.

Non-Water Based Fire Extinguisher Systems

- Special fire extinguishing systems (e.g., wet chemical, etc.).

Fire Alarm System

- Fire alarm riser.
- Typical firefighter telephone station.
- Typical firefighter telephone jack.
- Electrical closets for fire alarm system panels.
- Fire alarm telephone panel (includes voice paging microphone and firefighter telephone system).
- Visual indicating device control and power detail, typical for floors (state location).
- Amplifier rack (state location).
- Typical location of duct smoke detectors.
- Outdoor fire alarm speaker.
- Wall mounted cone fire alarm speaker.
- Typical terminal cabinet.
- Lay in ceiling mounted fire alarm speaker.
- Lay in ceiling mounted fire alarm combination speaker/strobe.
- Wall mounted strobe device.
- Typical manual fire alarm box installation.
- Fire alarm system input/output matrix.
- Graphic annunciator panel.
- Installation of the graphic annunciator.
- Fire command center showing the locations of each panel to be installed.

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 shall be part of the calculations.

1. Final occupant load and egress calculations.
2. Final fire protection water supply calculations.
 - Includes water supply flow testing data.
3. Final fire pump calculations where applicable.
4. Final smoke control calculations where applicable (e.g., atrium, etc.).
5. Final stairway pressurization calculations.
6. Fire modeling.
7. 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

Drawings.

1. Demolition plans.
2. Floor plans.
 - Show lighting, power distribution and communications raceway distribution.
3. Single-line diagram of primary and secondary power distribution.
 - Include normal power, emergency power and UPS.
4. Single-line diagram of fire alarm system.
5. Single-line diagram of telecommunications system.
6. Circuit layout of lighting control system.
7. Details of underfloor distribution system.
8. Site plan.
 - Indicate service locations, manholes, ductbanks and site lighting.
9. Layout of electrical equipment spaces.
 - Show all electrical equipment. Include elevations of substation transformers and disconnect switches.
10. Schedules for switchgear, switchboards, motor control centers, panelboards and unit substations.
11. Grounding diagram.
12. Complete phasing plan (if required) for additions and alterations.
13. Security systems site plan.
 - Final locations of all security devices and conduit runs.
14. Security system floor plans.
 - Layout of all security systems.
15. Storage areas for electrical equipment/spare parts.

Calculations.

1. Illumination level calculations.
2. Short circuit calculations.
3. Voltage drop calculations.
4. Overcurrent coordination study.
5. Generator calculations.
 - Include starter loads.
6. UPS calculation (if UPS provided).

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.

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.
 - 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. A cost estimate must be provided. It should comply with the requirements for construction documents phase estimate stated in the *Cost Estimating Requirements* of the Appendix's Section A.1 of this *Facilities Standard*.

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 would 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 foot) 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 datum 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 include 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 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.

Analysis of Existing Conditions. The report should address the following:

- Description of terrain.
- Brief geological history.
- Brief seismic history.
- Surface drainage conditions.
- Groundwater conditions and associated design or construction problems.
- Description of exploration and sampling methods and outline of testing methods.
- Narrative of soil identification and classification, by stratum.
- Narrative of difficulties and/or obstructions encountered during previous explorations of existing construction on or adjacent to the site.
- Description of laboratory test borings and results.
- Plot plan, drawn to scale, showing test borings or pits.
- Radon tests in areas of building location.
- Soils resistivity test, identifying resistivity of soil for corrosion protection of underground metals and electrical grounding design.

- Boring logs, which identify:
Sample number and sampling method.
Other pertinent data deemed necessary by the geotechnical engineer for design recommendations, such as:
 - Unconfined compressive strength.
 - Standard penetration test values.
 - Subgrade modulus.
 - Location of water table.
 - Water tests for condition of groundwater.
 - Location and classification of rock.
 - Location of obstructions.
 - Atterberg tests.
 - Compaction tests.
 - Consolidation tests.
 - Triaxial compression test.
 - Chemical test (pH) of the soil.
 - Contamination.

Engineering Recommendations. Engineering recommendations based on borings and laboratory testing should be provided for the following:

Recommendations for foundation design, with discussion of alternate solutions, if applicable, include:

- Allowable soil bearing values.
- Feasible deep foundation types and allowable capacities, where applicable, including allowable tension (pull-out) and lateral subgrade modulus.
- Feasibility of slab on grade versus structurally supported floor construction, including recommended bearing capacities and recommended subgrade modulus (k).
- Discussion of evidence of expansive soils and recommended solutions.
- Lateral earth design pressures on retaining walls or basement walls, including dynamic pressures.

- Design frost depth, if applicable.
- Removal or treatment of contaminated soil.
- Discussion of potential for consolidation and/or differential settlements of substrata, with design recommendations for total settlement and maximum angular distortion.
- Use and treatment of in-situ materials for use as engineered fill.
- Recommendations for future sampling and testing.
- Recommendations for pavement designs, including base and sub-base thickness and subdrains.
- Recommendations for foundation and subdrainage, including appropriate details.
- Discussion of soil resistivity values.
- Discussion of radon values and recommendation for mitigating measures, if required.

Geologic Hazard Report

A geologic hazard report shall 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 which 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 shall 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 shall 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 shall 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 shall 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 shall 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 which affect slope stability include slope angle, soil type, bedding, ground water conditions, and evidence of past instability. The geologic hazard investigation shall 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 shall 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 shall 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 shall 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 shall 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 shall identify feasible mitigative measures.

Required Documentation. Investigations of geologic hazards shall be documented. As noted in the paragraph entitled “Required Investigation” above, a preliminary geologic hazard investigation shall 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 shall 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, shall as 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.



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United States Courthouse

Hammond, Indiana

Architect: Pei Cobb Freed & Partners Architects, LLP

GSA Project Managers: John Siegel, Mary Walsh, and Jason Gerloff

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