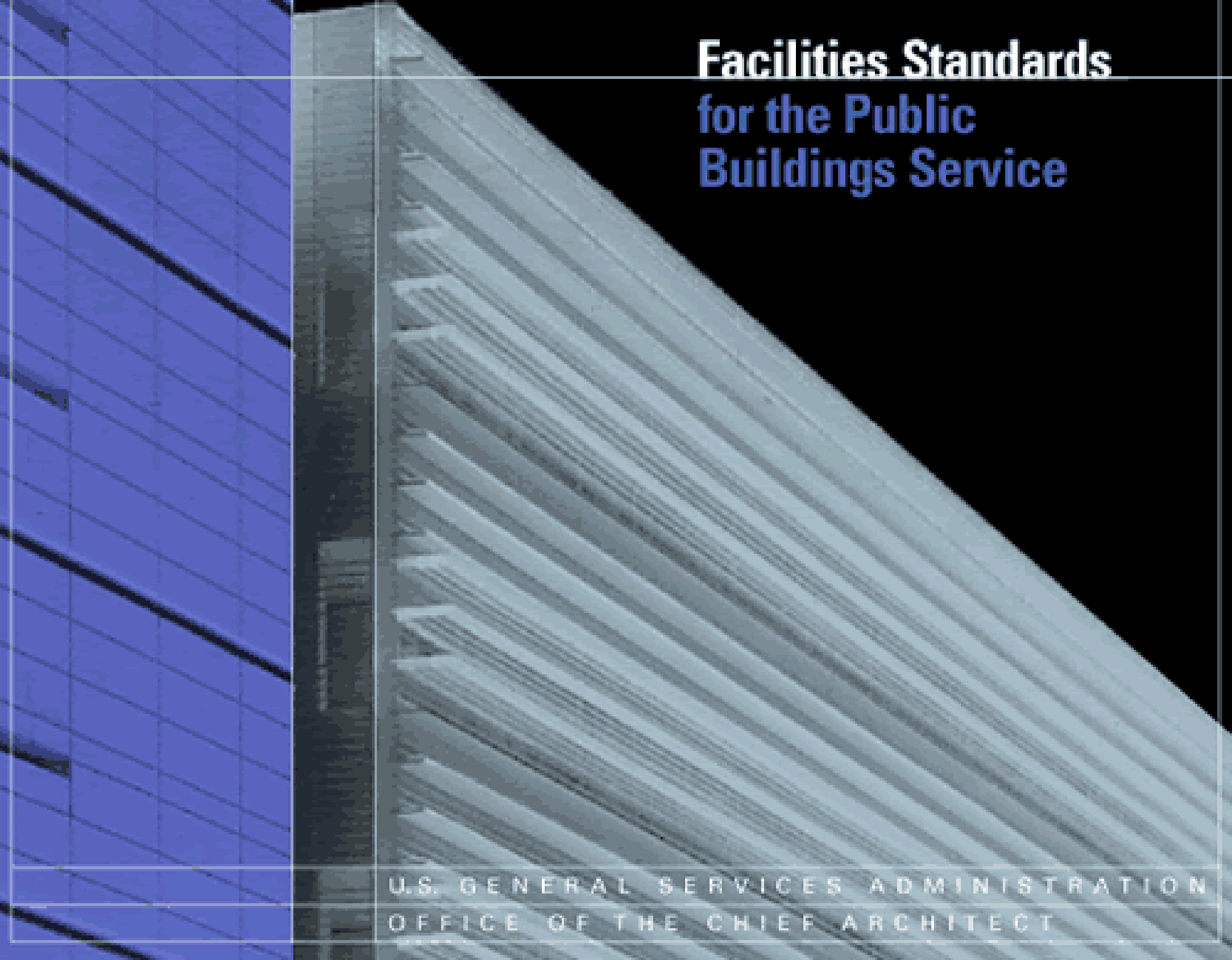
Facilities Standards for the Public Buildings Service



U.S. GENERAL SERVICES ADMINISTRATION

OFFICE OF THE CHIEF ARCHITECT

General Requirements

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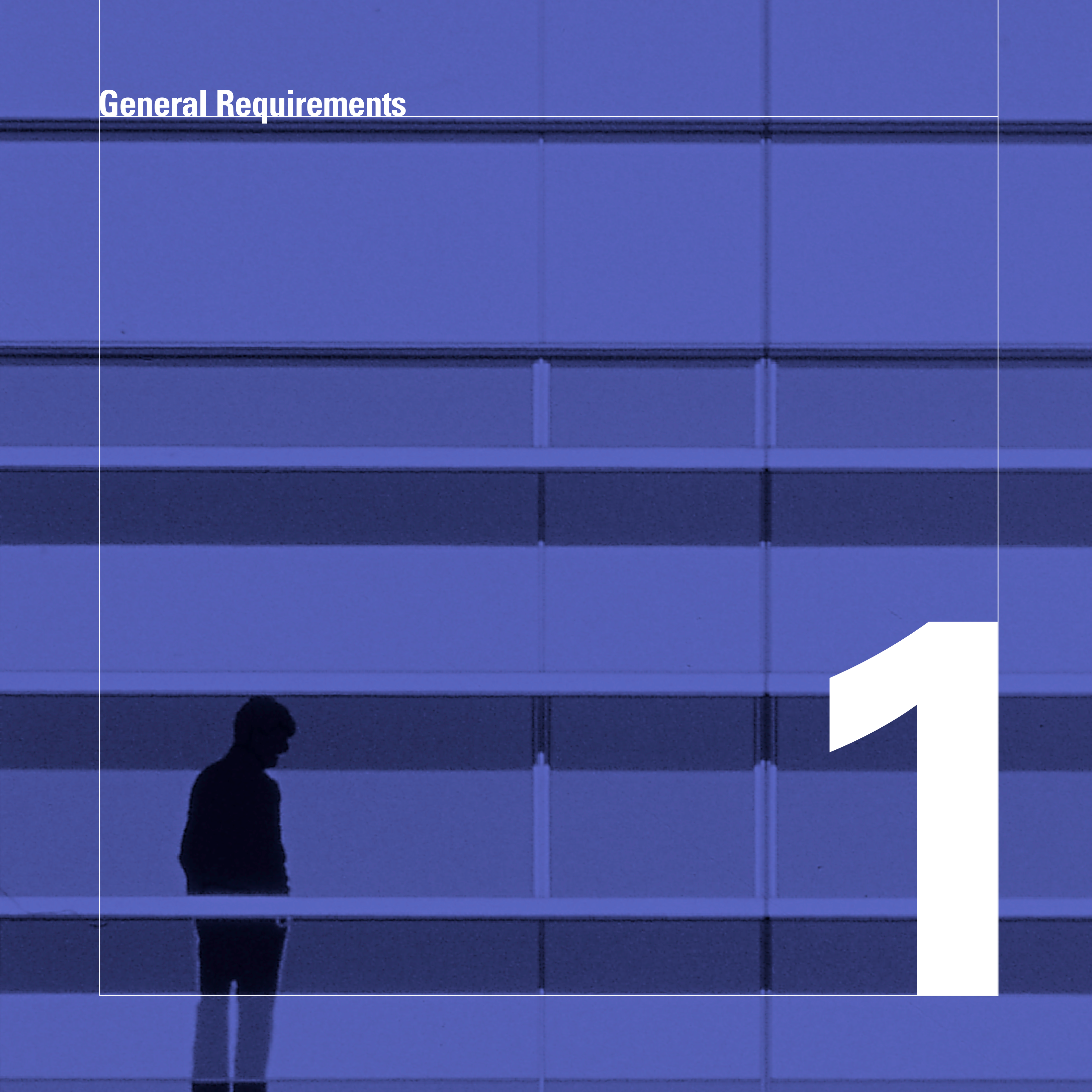

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1.1 Purpose of the Facilities Standards for the Public Buildings Service

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 for GSA owned or lease construction, and contains policy and technical criteria to be used in the programming, design, and documentation of GSA buildings. It is intended to be a building standard; it is not a 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

The following characterize GSA facilities:

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 reuse of 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 our public spaces. The main goal of First Impressions is to ensure that programs like GSA's Design Excellence, Construction Excellence and routine facilities repairs and alterations incorporate the interdependence between design, function and visual appeal of the buildings' common elements.

See national Web Site: www.gsa.gov/pbs/firstimpressions

Integrated Workplace/Productivity
To provide physical work environments that will enhance work flow, GSA uses the concept of the Integrated Workplace. As defined by Franklin Becker of Cornell University and Michael Joroff of the Massachusetts Institute of Technology:

It is a system that creatively combines wisdom about the nature of physical settings (where the work is conducted); the information technologies used in the performance of work (how data, opinions, and ideas are accessed, processed, and communicated); the nature of work patterns and processes (when and how tasks must be performed to achieve business objectives); and finally organizational culture and management (the formal and informal values, exceptions, policies, and behaviors that influence all the other factors).

Productivity (individual and group performance) is greatly affected by the working environment. GSA strives to provide workplace environments that physically and psychologically enhance work performance.

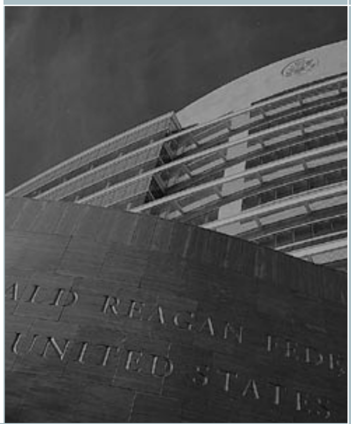
Figure 1-1 Guiding Principles for Federal Architecture

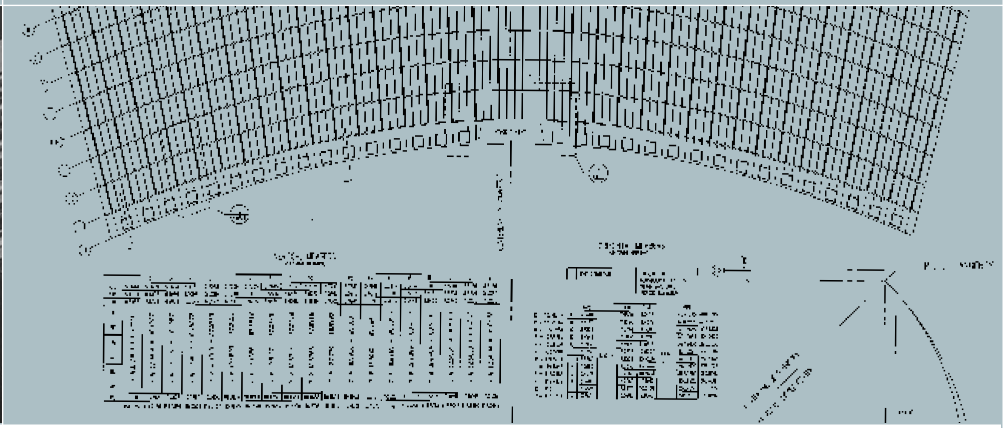
In the course of its consideration of the general subject of Federal office space, the committee has given some thought to the need for a set of principles which will guide the Government in the choice of design for Federal buildings. The committee takes it to be a matter of general understanding that 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.



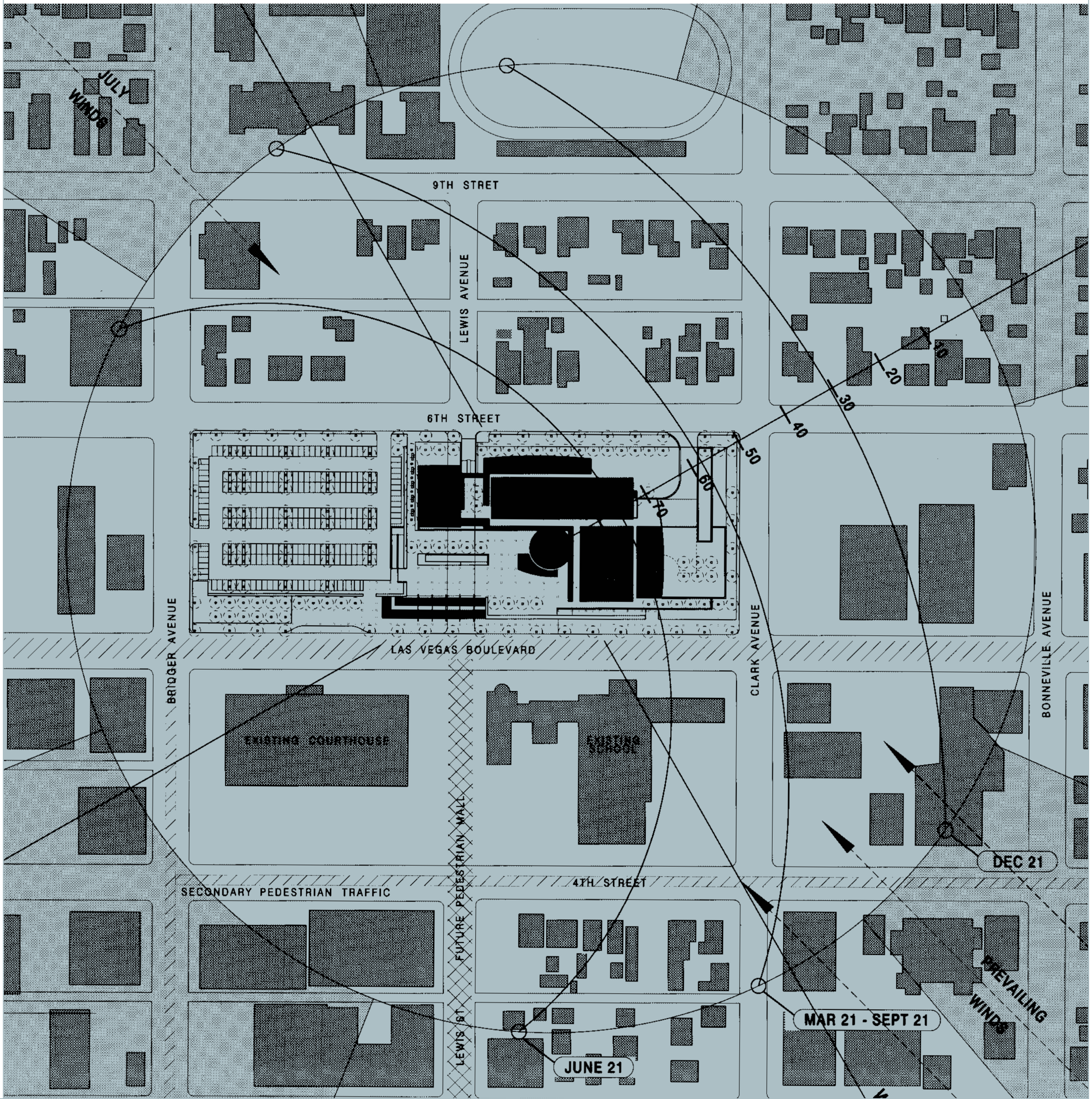


The policy shall be to provide requisite and adequate facilities in an architectural style and form which is distinguished and which will reflect the dignity, enterprise, vigor and stability of the American National Government. Major emphasis should be placed on the choice of designs that embody the 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. 1

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. 3

— *Daniel Patrick Moynihan*



JULY WINDS
9TH STRET
LEWIS AVENUE
6TH STREET
10
20
30
40
50
60
70
BRIDGER AVENUE
LAS VEGAS BOULEVARD
CLARK AVENUE
BONNEVILLE AVENUE
EXISTING COURTHOUSE
EXISTING SCHOOL
FUTURE PEDESTRIAN MALL
SECONDARY PEDESTRIAN TRAFFIC
4TH STREET
DEC 21
PREVAILING WINDS
MAR 21 - SEPT 21
JUNE 21
LEWIS ST

1.3 Codes and Standards

National Codes. The Public Buildings Amendments of 1988, Public Law 100-678, section 21, requires that for new construction and renovation projects, GSA 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. The following national building codes applied.

- Uniform Building Code (UBC), maintained by the International Conference of Building Officials www.icbo.org/
- National Building Code (BOCA), maintained by the Building Officials and Code Administrators www.bocai.org/
- Standard Building Code (SBC), maintained by the Southern Building Code Congress International www.sbcci.org/
- International Building Code (IBC), maintained by the International Code Counsel www.intlcode.org/

As directed by the GSA Project Manager, the design shall adhere to one of the above national building codes, as further qualified herein.

Other National Codes. For all projects, the egress requirements of the National Fire Protection Association (NFPA), Life Safety Code shall apply in lieu of other code references. For all projects, the electrical requirements of the NFPA National Electric Code shall be adopted in lieu of other code references.

For all projects, the electrical requirements of the National Fire Protection Association (NFPA), National Electrical Code have been adopted by GSA in lieu of the electrical requirements of the national model building codes.

State and Local Codes. GSA recognizes that the above referenced national building codes art typically the foundation of state and local building codes. State and local codes also represent important regional interests and conditions. As such, State and Local building codes shall also be followed to the extent possible.

Code Editions. The current edition of each applicable code, in effect at the time of design contract award, shall be used throughout the project's design and construction.

Conflicts Between Codes and GSA Requirements. To ensure flexibility, it is GSA policy to make maximum use of equivalency clauses in all recognized codes. Should a conflict exist between GSA requirements and either national or state/local 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 codes used within the designated GSA regional office and interpreted by GSA. If only a portion of the building is being renovated, the national model building code that is used in the specific GSA Region should be checked to see if the entire building must be brought up to compliance. Any questions or concerns should be discussed with the 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 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.

Local regulations must be followed without exception in the design of systems that have a direct impact on off-site terrain or utility systems.

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. GSA shall provide to the appropriate officials of the State and/or local governments the opportunity to review the project for zoning compliance, building code compliance, and construction inspections. 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. Local jurisdictions have the option of performing construction inspections to verify code compliance. If they elect to do so, special provisions will be included in the A/E's and contractor's contracts to handle the additional requirement of coordinating their work with local authorities. However, GSA and its contractors shall not be required to pay any amount for any action taken by the State and/or local government officials to carry out their mission. Project teams should consult on the plans for the neighborhood and surrounding properties to design a building that works well and contributes to that context.

GSA shall review all recommendations made by State and/or local 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.

Legally, buildings built on Federal property are exempt from local building codes. These codes are followed, however, to the extent possible. In case of buildings developed on private land to be leased to GSA, however, the applicable local codes govern instead of the codes adopted by GSA; the developer/owner must obtain permits necessary in such cases.

Oakland Federal Building, Oakland, CA.

1.4 Guides

The *Facilities Standards* and the noted guides should be used for the following buildings:
(In case of conflict between the Facilities Standards *and a specific building guide, the guide takes precedence.)*

Metric Design Guide (PBS-PQ260)

Federal Courthouses	See also: *U.S. Courts Design Guide; U.S. Marshals Service Requirements and Specifications for Special Purpose and Support Space Manual - sections 1,2 &,3*
Border Stations	See also: *United States Border Station Design Guide (PBS – PQ130)*
Child Care Centers	See also: *Child Care Center Design Guide (PBS – P140)*
Other Building Types	*Facilities Standards* generally apply, within specific building functional requirements Libraries Warehouses Laboratories Archives Museums Others

Historic Buildings

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

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.*

Ronald Reagan Building, Washington, D.C.

1.5 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.wbdg.org.

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 buildings 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. The A/E shall design to these targets.

Building Materials

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

- Products containing asbestos.
- Products containing 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 that 8 percent lead.
- Paint containing more than 0.06 percent lead.

Ronald Reagan Building, Washington, D.C.

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.

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 1095.2: *Considerations of Flood Plains and Wetlands in Decision Making.*
- 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.*

1.6 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 435. ASHRAE Standard 90.1-1999 meets or exceeds 10-CFR 435, 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 90.1-1999. 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

1.7 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. 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.*

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. 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.eren.doc.gov.femp.)

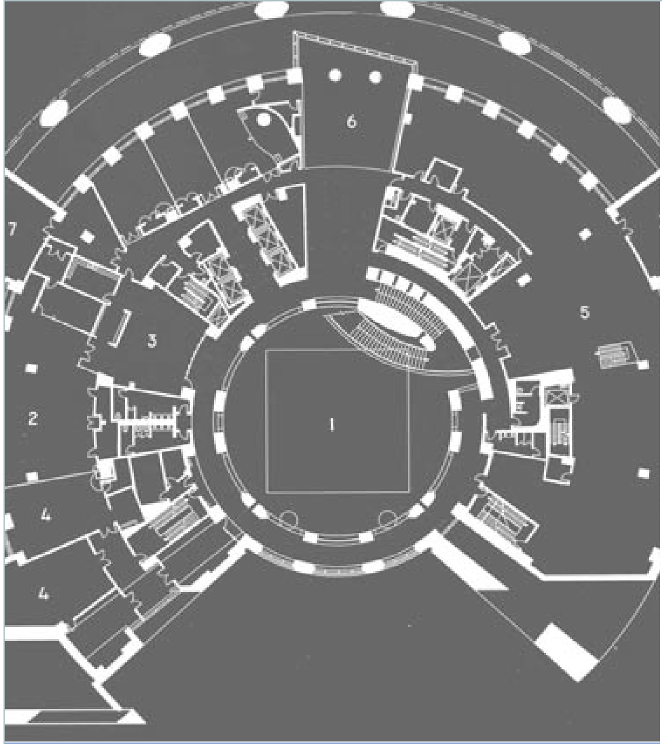
Procedures and Approach

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. 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	• Design Fees	Not Applicable	Costs are not included in the Analysis
First	• Investment Costs • Construction Costs	PV = TV	For those investment costs that begin at the start of the analysis period
Salvage Value	• Scrap value of equipment at the end of its service life	$PV = \frac{FV}{(1+d)^n}$ where $FV=TV(1+e)^n$	Present value equals the future value at the end of the service life, discounted by n service years
Future Investment	• One time investments occurring after the start of the analysis period • Non-Annual maintenance or repair • Major alterations to initial investment work	$PV = TV \frac{(1+e)^n}{(1+d)^n}$	Discount the future value (Today's Value escalated at rate e to year n) back to the present.
Residual Value	• Equipment with a service life extending beyond the analysis period	$PV = \frac{FV}{(1+d)^n}$	Future value equals the residual value at the end of the analysis period, discount costs to the Present Value
Annually Recurring Fixed	• Fixed payment service contracts with inflation adjustments • Preventative maintenance	PV = TV(UPW) where $UPW = \frac{(1+d)^n - 1}{d(1+d)^n}$	Annually Recurring Cost, relating to today's value, which increase in price at the same rate as general inflation. The UPVn factors are tabulated in the previously referenced NIST publication, Energy Prices and Discount Factors

Type of Cost	Cost Examples	Present Value Relationships	Comments
Annually Recurring Escalating	• Service or maintenance which involve increasing amounts of work • Frequent replacements that escalate at a rate different than inflation	PV = TV(UPW*) where $UPW^* = \frac{\left[\frac{(1+e)}{(1+d)}\right]^n - 1}{1 - \frac{(1+d)}{(1+e)}}$	The present value of such costs are calculated by using a modified version of the UPW formula (UPW*) which allows for cost escalation.
Energy	• Fuel related costs, such as fuel oil, natural gas or electricity	PV = TV(UPW*)	Energy related UPW* factors are found in the NIST publication and the BLCC program.
Escalation Rates	• Relating Budgetary Escalation to Real Growth Escalation	E = e + I + eI	Needed to convert budgetary assessments.

Definitions

- FV = future value
- PV = present value
- TV = today's value
- d = real discount rate
- e = real growth escalation rate (the differential escalation rate that exists after removing the influence of general inflation)
- n = number of years to occurrence or the analysis period, as appropriate
- E = Budgetary Escalation
- I = Inflation Rate
- UPW = Uniform Present Worth factor for fixed recurring costs
- UPW* = Modified Uniform Present Worth factor for escalating recurring costs

- 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.

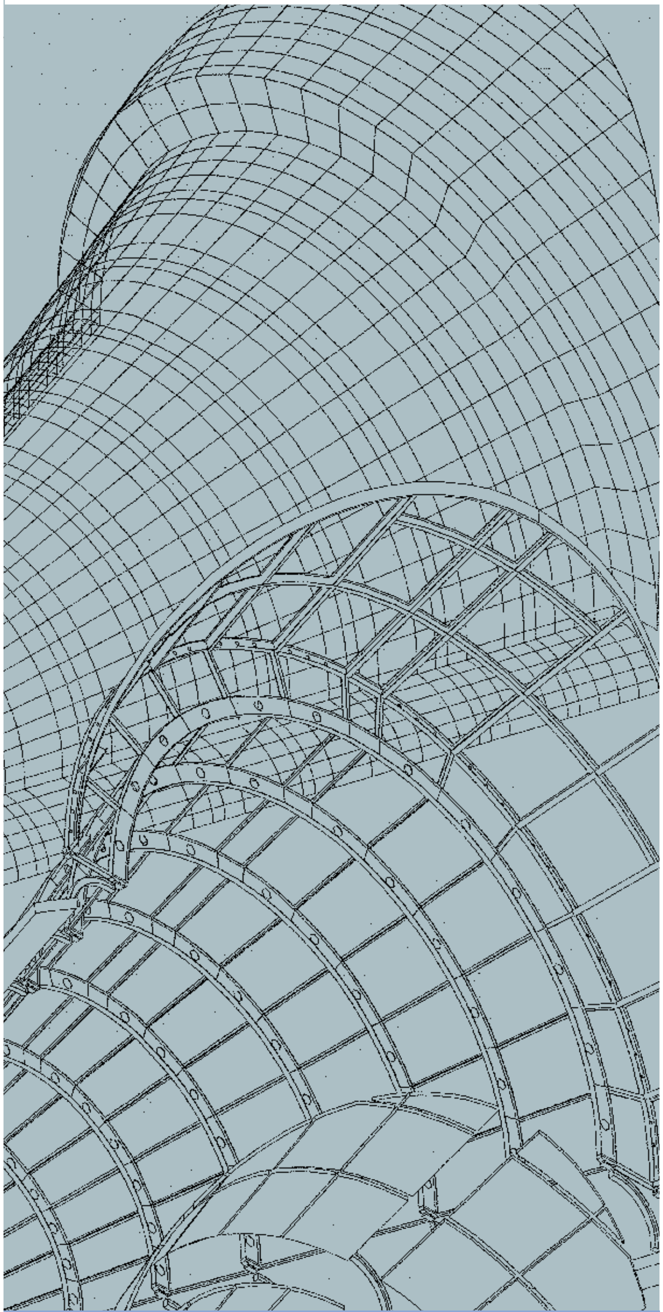
- Investment and replacement actions over time may impact recurring costs. For simplicity, unless otherwise directed, fluctuating recurring cost savings may be assumed to be proportionate to the savings realized at the start of the analysis period.

- 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 use for alternatives that are influenced by weather and/or varying loads/schedules, the modeling program DOE2 or other approved software shall be used.



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

1.8 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).

Reinforcing Bars For concrete reinforcing bars, specify U.S. Standard Bar Number because currently there are no consistent metric standards for this product.

English and Metric Measurement Reference
Most critical 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.

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

1.9 Accessibility Design Guidelines

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.

Uniform Federal Accessibility Standards (UFAS) is mandatory on all GSA projects. Current GSA policy also encourages compliance with the requirements of the Americans with Disabilities Act Accessibility Guidelines (ADAAG) where those requirements are stricter than UFAS. The A/E is responsible for checking whether there are local accessibility requirements. If they exist, the most stringent will prevail between local and UFAS/ADA.

The criteria of these standards should be considered a minimum in providing access to the physically disabled. Where dimensions for clearances are stated, allowance should be made in the design for construction tolerances to ensure the finished construction is in full compliance. (Compliance demonstration is mandatory.)

The following information lists provisions where UFAS is more stringent or contains different requirements than ADAAG. The bold type designates which standard should be used.

Federal Office Space
In office space the following two conditions apply:

a. Those where UFAS provisions are clearly more stringent than ADAAG
b. Those where differences are "de minimis," or where provisions result in an equivalent level of access, do not significantly impact accessibility, or are outdated and no longer serve the intended purpose. In these cases, GSA has the option to choose between relevant options.

Where UFAS Clearly is More Stringent:

Work Areas UFAS requires that all areas which may result in employment of physically disabled persons be accessible. ADAAG requires only that people with disabilities be able to approach, enter, and exit a work area (**UFAS 4.1.4**; ADAAG 4.1.1(3)).

Work Surface Scoping UFAS requires that 5 percent of all fixed or built-in employee work surfaces be accessible. ADAAG does not require work surfaces in work areas to be accessible. Both UFAS and ADAAG require that 5 percent of fixed tables in public or common use areas be accessible **(UFAS 4.1.2(17) and 4.32**; ADAAG 4.1.1(3) and 4.1.3(18)).

No Elevator Exception UFAS has no exception to the elevator requirement and requires elevators in all multi-story buildings and facilities. ADAAG provides an exception to the elevator requirement in certain buildings that are under three stories or have less than 3000 square feet per story **(UFAS 4.1.2(5)**; ADAAG 4.1.3(5) Exception 1).

U.S. Courthouse, White Plains, NY

Entrances in Multi-Grade Buildings UFAS requires at least one principal entrance at each grade floor level to a building to be accessible. ADAAG requires: (1) that at least 50% of all public entrances be accessible; and (2) that the number of exits required by the applicable building/ fire code be used in determining the total number of accessible entrances required in a building or facility. UFAS would require more accessible entrances in certain "multi-grade" buildings (**UFAS 4.1.2(8)**; ADAAG 4.1.3(8)).

Elevator Controls UFAS requires elevator controls to be mounted no higher than 48 inches "unless there is a substantial increase in cost," in which case 1400 mm (54 inches) is allowed. ADAAG allows 1400 mm (54 inches) whenever a parallel approach is provided **(UFAS 4.10.12(3)**; ADAAG 4.10.12(3)).

UFAS/ADAAG Differences "De Minimis"

Entrance Signage UFAS always requires the International Symbol of Accessibility (ISA) at accessible entrances. ADAAG requires the ISA at accessible entrances only when there are inaccessible building entrances in the facility. If all entrances are accessible the ISA is not required under ADAAG (UFAS 4.1.1(7); ADAAG 4.1.2(7)).

Stairs Exception UFAS exempts stairs from complying with 4.9 only if an elevator connects the same levels the stairs do. ADAAG exempts stairs from section 4.9 when there is any accessible means of vertical access connecting the same levels that are connected by the stairs (UFAS 4.1.2(4); ADAAG 4.1.3(4)).

Handrail Height UFAS requires that handrails at stairs and ramps be placed with the gripping surface between 800 mm and 900 mm (30 and 34 inches) above the surface of the stair or ramp. ADAAG requires that such gripping surfaces be placed between 900 mm and 1000 mm (34 and 38 inches) (UFAS 4.8.5(5) and 4.9.4(5); ADAAG 4.8.5(5) and 4.9.4(5)).

Tactile Warnings UFAS requires that doors to hazardous areas be equipped with tactile warnings. This provision is reserved in ADAAG (UFAS 4.1.2(14), 4.13.9, 4.29.3, 4.29.7; ADAAG 4.13.9, 4.29.3).

Pictograms UFAS requires pictogram symbols to be tactile and does not allow tactile simple serif characters. ADAAG does not require pictogram (pictorial symbols signs) to be raised and does allow the use of simple and sans serif tactile characters. UFAS only allows sans serif characters (UFAS 4.30.4; ADAAG 4.30.4).

Special Occupancies

Assembly Areas

Scoping for 101 or More Fixed Seats. UFAS requires a greater number of wheelchair locations than ADAAG in larger assembly areas where the number of fixed seats exceeds 101 (UFAS 4.1.2(18); ADAAG 4.1.3(19)(a)).

Dispersion for 300 or Fewer Fixed Seats. UFAS requires that wheelchair spaces be dispersed throughout the seating area, regardless of seating capacity. ADAAG requires that wheelchair spaces be provided in more than one location when seating capacity exceeds 300 (UFAS 4.33.3; ADAAG 4.33.3).

Transient Lodging

Scoping. UFAS requires 5 percent of transient lodging facilities to be accessible to persons with mobility impairments which, in very large facilities, would result in a higher number of accessible units than ADAAG would require. As required by the ADA, ADAAG provides for an exception for facilities with five or fewer units that contain the residence of the proprietor. UFAS does not provide for such an exception (UFAS 4.1.4(11); ADAAG 9.1.1 Exception, 9.1.2).

Scoping and Technical Provisions. UFAS has scoping and technical provisions for housing. Section 13 Housing of the ADAAG interim final rule has not been adopted as a standard by the Department of Justice. The Board is considering reserving Section 13 in its entirety when the

Ronald Reagan Building, Washington, D.C.

final guidelines for State and local government facilities is issued (UFAS 4.1.1(5)(d), 4.1.4(11), 4.34; ADAAG – proposes to reserve housing).

Restaurants and Cafeterias

Table Aisles. UFAS requires that there be access aisles between tables in restaurants and cafeterias which comply with 4.3 Accessible Routes. ADAAG requires that all accessible fixed tables shall be accessible by means of an access aisle at least 900 mm (36 inches) clear between parallel edges of tables or between a wall and the table edges (UFAS 5.1; ADAAG 5.3).

Vending Machine Controls. UFAS requires that the controls and operating mechanisms of vending machines in restaurants and cafeterias comply with all of 4.27. ADAAG only requires that the spaces where vending machines are located comply with the space allowances and reach ranges requirements (UFAS 5.4; ADAAG 5.8).

Bureau of Labor Statistics

Health Care

Canopy at Passenger Loading Zone. The application of the term "Health Care buildings and facilities" in UFAS, which is not expressly defined, may require more facilities to provide a canopy or roof overhang and a passenger loading zone at their entrances. ADAAG specifically defines "Medical care facilities" which must have a roof canopy or overhang and a passenger loading zone at an accessible entrance (UFAS 6.1; ADAAG 6.1).

Patient Bed Spacing. UFAS requires that there be 900 mm (36 inches) along each side of a bed in patient bedrooms, 1200 mm (48 inches) between beds, 1100 mm (42 inches) between the foot of a bed and the wall, and 1200 mm (48 inches) between the foot of a bed and the foot of the opposing bed. UFAS separately identifies requirements for one-bed rooms, two-bed rooms, and four-bed rooms. ADAAG treats beds in all rooms the same and requires that there be 900 mm (36 inches) along each side of a bed (UFAS 6.3; ADAAG 6.3).

Mercantile

Service Counters. UFAS requires that "a portion" of service counters in mercantile facilities be between 700 mm and 860 mm (28 and 34 inches) high. ADAAG requires a 36 inch length of service counter which is a maximum of 900 mm (36 inches) high (UFAS 7.2; ADAAG 7.2).

Check-Out Counter Height. UFAS requires at least one check-out counter to be no higher than 900 mm (36 inches). ADAAG requires that a specific number of check- out counters be no higher than 970 mm (38 inches) and that the top of the lip of the counter not exceed 1000 mm (40 inches) (UFAS 7.3(2); ADAAG 7.3(2)).

Libraries

Knee Space at Check-Out Area. UFAS requires that at least one lane at each check-out area provide a counter surface that is between 700 mm and 860 mm (28 to 34 inches) high with knee clearances that is 700 mm (27 inches) high, 800 mm (30 inches) wide and 500 mm (19 inches) deep in libraries. ADAAG requires that at least one lane at each check-out area provide a 900 mm (36-inch) length of counter which is a maximum of 900 mm (36 inches) high. ADAAG does not require knee space (UFAS 8.3; ADAAG 8.3).

Postal Facilities

Customer Service Counters. UFAS requires that the aisles in front of customer service counters in postal facilities be at least 1200 mm (48 inches) wide. ADAAG requires services counters to be on an accessible route 900 mm (36 inches minimum width) (UFAS 9.2; ADAAG 7.2).

Partitions. UFAS requires that in postal facilities all fixed partitions withstand 372 kg/m (250 lb/f) from any direction. ADAAG does not have a similar provision (UFAS 9.2(1); ADAAG – no provision).

Handrails. UFAS requires that in postal facilities, where handrails are provided (regardless of whether they are required or not), the walls must be capable of supporting 372 kg/m (250 lb/f) in any direction. ADAAG requires the support only where handrails are required (UFAS 9.2(2); ADAAG 4.26.3).

Lockers. UFAS has technical requirements for lockers in postal facilities. The scoping in UFAS is vague, providing that "lockers in easily accessible areas must be provided for use by physically disabled people." ADAAG does not have a similar provision (UFAS 9.5; ADAAG – no provision).

Attendance Recording Equipment. UFAS requires that attendance recording equipment (i.e. time clocks, etc.) be mounted no higher than 1200 mm (48 inches) in postal facilities and that counter space at these check-in areas be no higher than 900 mm (36 inches) above the floor. ADAAG does not have a similar provision (UFAS 9.6; ADAAG – no provision).

Detention and Correctional Facilities

Scoping. UFAS requires 5 percent of residential units in detention and correctional facilities to be accessible. This figure is greater than the percentage proposed in Section 12 of the final rule on ADAAG for State and local government facilities (UFAS 4.1.4(9); ADAAG 12.4.1). The UFAS and ADA Title III standards do not cover clearly, nor in great detail, many of the facilities which the GSA constructs such as courthouses and detention facilities. These facilities are, however, covered in detail in the Interim Final Guidelines proposed for Title II of the ADA which apply to State and local government facilities.

Federal Courthouses

It is GSA design policy that all Federal courtroom designs have the witness stand and jury box accessible, and the judge's bench, clerks' station, etc., to be adaptable.

Additions and Alterations

UFAS is more stringent or different than ADAAG.

Additions. UFAS requires that if an addition to a building or facility does not provide an accessible route, an accessible entrance, or accessible toilet facilities, and such facilities are provided in the existing building then at least one of each shall be made accessible. ADAAG may require these items to be accessible under the path of travel obligation, depending on the amount of money required to build the addition (UFAS 4.1.5; ADAAG 4.1.5).

Substantial Alterations. UFAS requires greater accessibility when substantial alterations are made to a facility depending on the amount of money spent on the alteration and the size of the building or site. ADAAG requires that when an alteration is made to an area containing a primary function that the path of travel to that altered area and the restrooms, telephones, and drinking fountains that serve that area be made accessible unless the additional cost of doing so would be disproportionate to the overall cost and scope of the original alteration to the primary function area. The level of disproportionality is set at 20 percent of the cost of the original alteration to the primary function area (UFAS 4.1.6(3); ADAAG 4.1.6(2)).

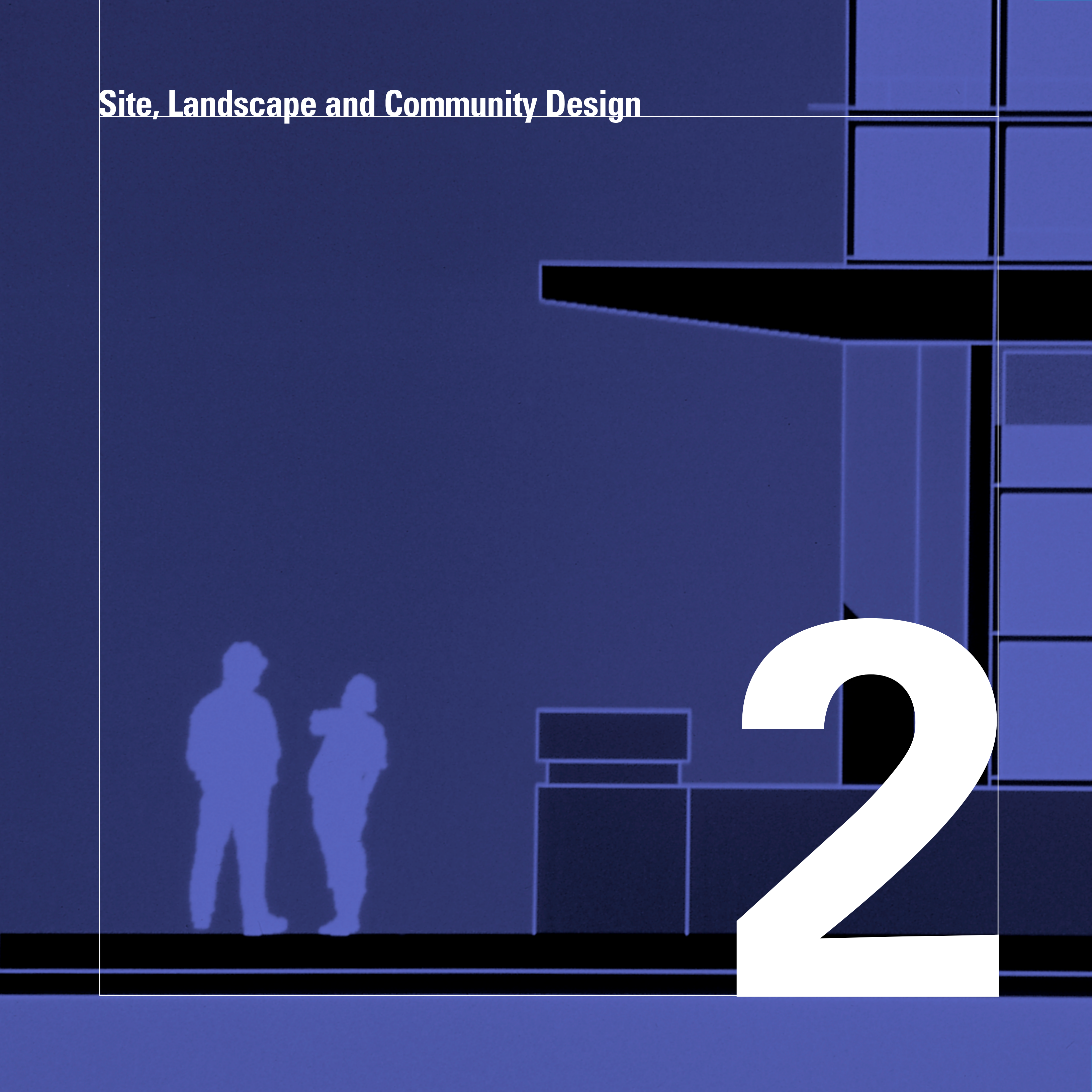
Alterations. ADAAG provides that in alterations, the requirements of 4.1.3(9), 4.3.10 and 4.3.11 concerning egress and areas of rescue assistance do not apply. UFAS does not have a similar exception (UFAS – no exception; ADAAG 4.1.6(g)).

Both the UFAS and ADAAG references used for this comparison were current as of the date of publication. (The A/E should check all updates to the respective requirements before proceeding with the building design.)

NASA Auditorium, Washington, D.C.

Site, Landscape and Community Design

2



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2.1 Goals and Objectives

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

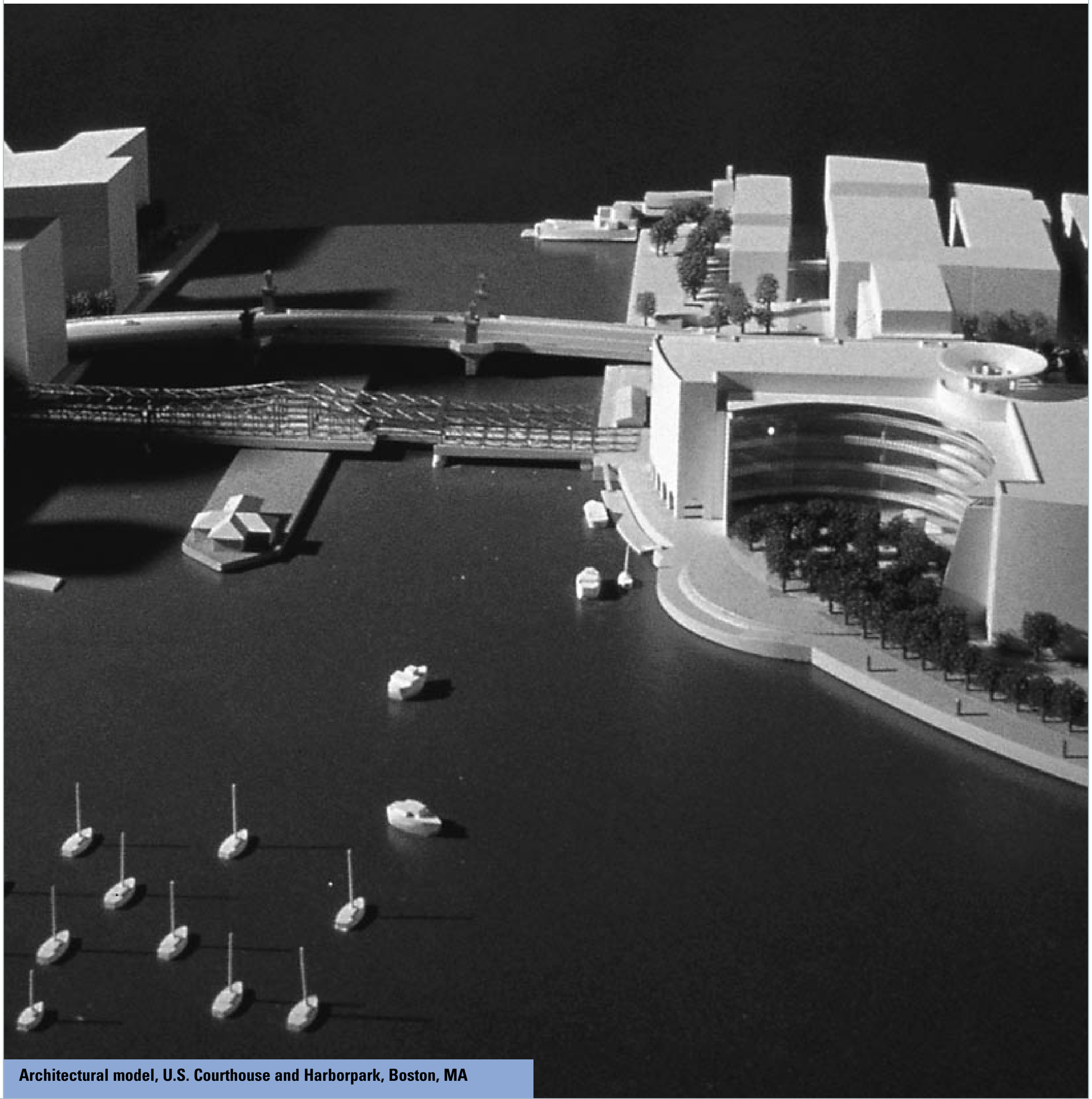
The quality of the site design will be a direct extension and integration of the building design intent. It represents significant Federal investment and should, wherever possible, make a positive contribution to the surrounding urban, suburban or rural landscape in terms of conservation, community design and improvement efforts, local economic development and planning, and and environmentally responsible practices.

2.2 Codes and Standards

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.

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 walls should be avoided; lower walls with sitting edges are preferable, but should be designed to discourage skateboarders.

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. See Chapter 8 for access controls and intrusion detection systems.



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

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.

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.

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 Safe Practices. GSA promotes practices that are friendly to the environment and conserve resources, such as low water and minimum chemical usage, etc. Plant material and landscape designs should reflect regional environmental concerns, such as xeriscaping, where geographically appropriate.

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 National Model Building Code.

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).

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

Grading and Flood Plains. No buildings shall be built within the 100 year flood plain. Exceptions will be approved by the 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 1500 mm (5 feet) above the level of the 100 year flood plain.

No grading will be performed within the boundaries of any wetland.

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 national code used.

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*, 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 source that can supply a minimum of 10,000 gallons.

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 an open system of ditches, channels and culverts or of a piped system with inlets and manholes.

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. Piped systems are preferred. In large campus settings, open ditches or paved channels should be avoided as much as possible.

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. Rainwater harvesting may be considered as an alternative source for such purposes as irrigation, etc. 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, and the like.

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 National Model Fire Code that is used, 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.

Vehicular Drives, Parking Lots and Service Areas

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

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

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

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 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.

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.

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.

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

For projects located in a district designated for special landscaping by the local Government, local design guidelines should be followed.

Maintenance Considerations

Before initiating the landscape design, the landscape architect should discuss with the facility manager how the landscaping 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 which rely less on pesticides, herbicides and fertilizers, minimize water use, require less maintenance and increase erosion control.

Russell B. Long Federal Building and United States Courthouse

The long-term upkeep and maintenance of landscape elements such as lighting, plaza or courtyard areas, fountains and similar elements must be considered during design. Equipment required for maintenance should be readily available standard equipment such as forklifts or electrical lifts, and its use approved by the facility manager.

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.

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 are encouraged to carefully consider how these landscape plans affect the use and feel of adjacent public spaces and properties. Design teams need to carefully consider landscape design and how it effects neighboring properties.

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

Outdoor Plazas and Courtyards. Consideration should be given to development of plazas and courtyards for employee break areas. It may also be possible to incorporate program requirements into these spaces, for example: outdoor food service areas. These areas need to be confined to limit access and maintain security.

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. It is not addressed by the site designer except as a coordination effort since the sculptor is selected under a separate contract. Although under a separate contract, it is crucial in such cases for the artist

Old Post Office historical preservation

and the A/E to 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.

Ronald Reagan Courthouse, Santa Ana, CA

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 turf should be minimized, and avoided if possible.

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.

Growth Habits. Plants need to be chosen with their mature size and growth habit in mind to avoid overplanting 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.

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.

2.11 Irrigation for Landscaping

System Design

General Criteria. An irrigation system (if required) will provide water to plants only when needed. Drip irrigation should be considered where appropriate. 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.

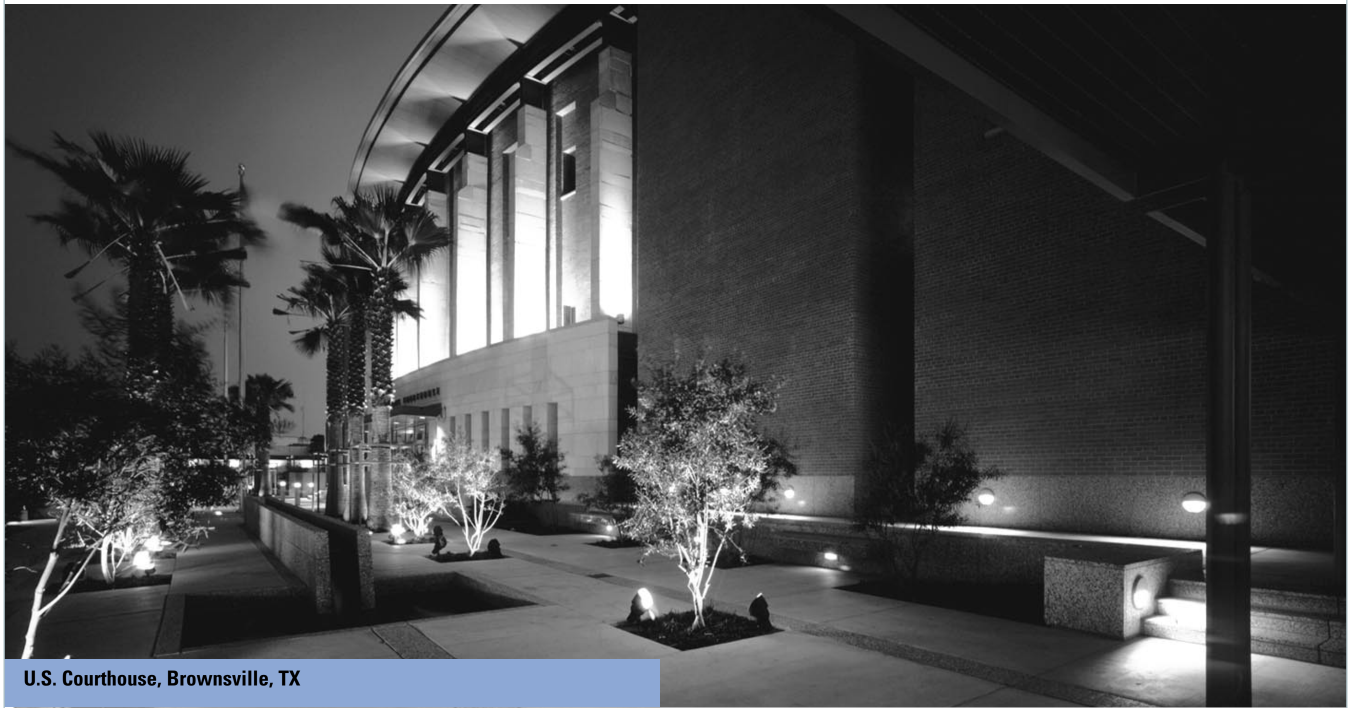
Controls. Irrigation controls should be easily understood by maintenance personnel. The designer should coordinate with the Building Manager as to the appropriate controls. Provide automatic controls to allow for scheduling of watering times for late night and early morning to reduce water losses due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



U.S. Courthouse, Brownsville, TX

Landscape lighting should be used to enhance safety and security on the site, to provide adequate lighting for night-time activities and to highlight special site features. See Chapter 6: *Electrical Engineering, Lighting, Exterior Lighting*.

The primary purpose of any particular application of landscape lighting will help determine the requirements for light coverage and intensity. Generally, unobtrusive lighting schemes are preferred. Where the intent of the lighting is primarily aesthetic, the A/E is encouraged to consider low-voltage systems.

Color. It is desirable to maintain a single, or at least similar, light color throughout the project site.

Fixtures. Site lighting fixtures should complement other site elements. Fixtures should be placed so people do not look directly at the light source. To avoid plant damage and fire hazard, high intensity or heat generating fixtures shall not be located immediately adjacent to plant material. Fixtures 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.

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.

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.

2.14 Site Signage

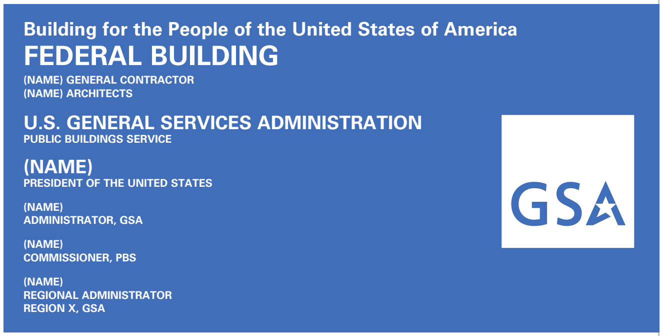
A well-designed site should use as few signs as possible. Signs should make the site clear to the first-time user by identifying multiple site entrances, parking and the main building entrance.

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.

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.

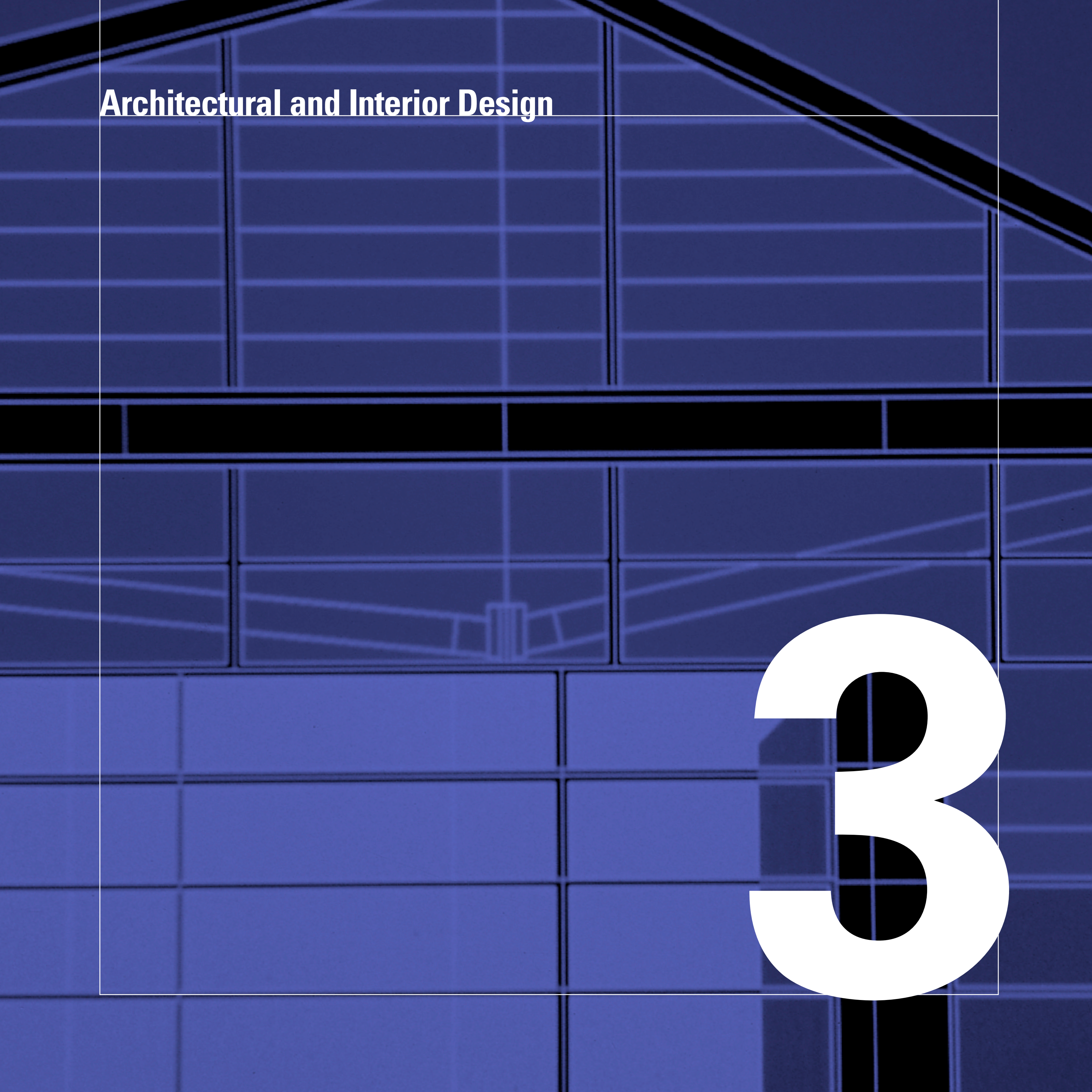
New Construction Signs. Signs at new construction sites shall include the name of the architect and general contractor and may contain an artist's rendering or photograph of the model of the building under construction.

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

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3.1 Basic Building Planning Principles

Integrated Design. Landscape and Architectural designs must be integrated with all project design disciplines in order to optimize building performance and aesthetics. Prior to initiating any schematic design, the Architect must perform a series of coordination meetings with all project design disciplines/consultants to explore performance and functional objectives that could impact building orientation, massing, space adjacencies, material selections, and assemblies. A project's functional and performance needs are integral to achieving the Principles of Federal Architecture, noted in Chapter 1.

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 61 000 mm (200 feet).
- See Chapter 7: *Fire Protection Engineering* for all egress requirements.

Table 3-1
System Placement in Planning Grid

Element	Relationship to Planning Grid	Comments
Planning Grid	600 mm by 600 mm (2-foot by 2-foot)	Uniform between buildings allows interchange of parts between GSA buildings.
Exterior Window Mullions	align on grid	Allows interior partitions to terminate on mullions and ceiling grids to align visually with the mullions.
Columns	center on grid	
Partitions	center on grid can be aligned on face of columns	Normally split columns between two separate offices.
Trench Ducts	offset by up to 50 percent	Allow access to trenches without walls being placed along trenches.
Raised Floor Grid	offset pedestals by a minimum of 75 mm (3 inches) in both directions	Facilitate future removal of floor panels and to avoid excessive cutting of panels in instances where partitions must extend to the structural slab.
Cellular Floor Insets	Offset from grid in both directions, placed every 1800 mm (6 feet) in both directions	Placed between grids so they are never covered by partitions.
Floor Outlets for power, telephone and data	Offset from grid in both directions so centerline of the three may fall a minimum of 300 mm (1 foot) off the planning grid line	Placed between grids so they are never covered by partitions.
Ceiling Systems	Align, or offset by 300 mm (1 foot) or 50 percent in both directions	If aligned with grid, ceiling will visually align with window mullions. If offset by 50%, tops of walls will never fall on ceiling grids, allowing more choice in placement of ceiling elements such as lights.
Lay-In Lights	In ceiling grid	For 600 mm by 600 mm (2-foot by 2-foot) or 600 mm by 1200 mm (2-foot by 4-foot) fixtures.
Downlights and Pendant Mounted Lights	In ceiling grid	
HVAC Diffusers & Return Air Grilles	Staggered, located within the 600 mm by 600 mm (2-foot by 2-foot) ceiling framing	Experience has shown that a staggered diffuser layout in a uniform pattern adapts most easily to future changes in wall configurations
HVAC Slot Diffusers	Placed on grid line	

- 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 45 000 mm (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 FIPS Standard 175 Federal Building Standard for Telecommunications Pathways and Spaces. 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

Four 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.

The Federal Information Processing Standard 175: *Federal Building Standard for Telecommunication Pathways and Spaces* 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.

Horizontal Pathway Systems. Three options exist for delivering power and communications to general office areas: raised access floor, cellular floor duct, and underfloor duct encased in concrete deck. After decades of experience with moves and changes within Federal office space, GSA now provides a general life cycle cost study to determine which of these three options should be used. See Chapter 6: *Electrical Engineering, Placing Electrical Systems in Buildings, Horizontal Distribution of Power and Communications.*

Access Floors. Access floors shall be incorporated into all new construction where office functions will take place. Permanent corridors can be exempted from this requirement.

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.

Floor Air Plenum distribution systems are preferred in office applications with raised floors, eliminating ceiling ductwork and facilitating personal climate control systems. If this technology is considered, then the interstitial floor height shall be adjusted to accommodate the HVAC system.

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:

Usable Area x Floor R/U Ratio = 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:

Floor Rentable Area/Floor Usable Area = Floor R/U Ratio

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

Oakland Federal Building, Oakland, CA

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:

(sum of Office and Store Usable Areas on the floor) x Floor R/U Ratio = 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.

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. 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:

Floor R/U Ratio x Building R/U Ratio = 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:

Usable Area x R/U Ratio = Rentable Area

It may also be calculated by the following two-step formula:
Step 1)

Usable Area x Floor R/U Ratio = Basic Rentable Area

then Step 2)

Basic Rentable Area x Building R/U Ratio = 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 m^2. 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 m^2 (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.

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)

Conveying Systems

All elevators must be designed to comply with ASME A17.1 and with the UFAS/ADA *Accessibility Guidelines*.

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, UFAS/ADA *Accessibility Guidelines* 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).

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.

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 elevator control system should be used. The extent of control should be defined by the GSA Project Manager. 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 m^2 (150 ft^2) 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.

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

Fire Protection

See Chapter 2: *Site Planning and Landscape Design* and Chapter 7: *Fire Protection Engineering* for fire protection 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.

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. 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.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.


U.S. Courthouse, Boston, MA

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.

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

Closed Offices Versus Open Plan. The open plan approach (with a very limited number of ceiling height partitions for offices) is encouraged. It has a higher degree of efficiency and flexibility, and provides easier distribution of natural light and daylighting techniques, heating and cooling to the working areas. This approach can be adapted to a larger building depth and still present an open and airy atmosphere. It also encourages interaction between individuals and work groups.

Ceiling Height. Above all, the general office space should have a uniform ceiling height to provide 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 m^2 (150 square feet). The clear ceiling height of individual office rooms not exceeding an occupiable 14 m^2 (150 square feet) is a minimum of 2400 mm (8 feet). The clear ceiling height of private toilets and small closets, which are ancillary to other office spaces is a minimum of 2300 mm (7 feet 6 inches).

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 Engineering*, for essential electronic facilities.

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.

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).

Reagan Building, Washington, D.C.

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.

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.

Maintenance 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

Public Lobby space.

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 clear hierarchy should be visible 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 lights.

Building Support Spaces

Toilet Spaces. Toilet space includes general use toilets and associated vestibules, anterooms 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 UFAS and ADA *Accessibility Guidelines*. All other toilets must have provision for future adaptation to accessible requirements.

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 m^2 (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. 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 Engineering,* 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.

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.

Communications Equipment Rooms. In addition to the criteria stated for general mechanical and electrical equipment rooms, equipment rooms for communications equipment must comply with FIBS 175: *Federal Building Standard or Telecommunication Pathways and Spaces*.

Equipment rooms shall be sized to accommodate the equipment planned for the room. At a minimum, the room should have 69 660 mm^2 (0.75 square feet) of equipment room space for every 9.3 m^2 (100 square feet) of occupiable space. The equipment room should be no smaller than 14 m^2 (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 Closets. Communications closets must be stacked vertically within the building. Closets 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 FIPS Standard 175: *Federal Building Standard for Telecommunications Pathways and Spaces*. 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 should 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 UFAS/ADA Accessibility Guidelines, 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 m^2 (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 Engineering,* 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.

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.

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

Outleased Space. This term defines building space leased to businesses as commercial stores.

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

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 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 UFAS/ADA *Accessibility Guidelines* 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 utilizes 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

Food and Drug Administration District Headquarters

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.

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

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 Special Design Considerations

Incorporation of Recycled-Content Materials

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. The GSA is committed to maximizing the use of recycled and recycled-content materials specified in the construction of Federal building projects.

The greatest opportunity to implement these requirements is in the selection of architectural materials.

The most common building products incorporating recycled materials currently available on the market are:

1. Fiberboard;
2. Laminated paperboard;
3. Insulation;
4. Carpet;
5. Cement;
6. Concrete;
7. Paint;
8. Resilient flooring.

The EPA Comprehensive Procurement Guidelines (CPG) provide extensive information on the designated products containing recycled materials for purchase and use by Federal agencies and their contractors.

The Recovered Materials Advisory Notice (RMAN) is a document provided by EPA that recommends levels of recycled content for items listed in the CPG.

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

Recovered content levels for selected construction products are shown in Table 3-5. Additional requirements for landscape, park and recreation, and miscellaneous products can also be found on the EPA website.

Concrete

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 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."

Table 3-5
Recovered Content Levels for Construction Projects

Product	Material	Percentage of Postconsumer Materials	Percentage of Total Recovered Materials
Structural Fiberboard	Recovered Materials	—	80 – 100
Laminated Paperboard	Postconsumer Paper	100	100
Rock Wool Insulation	Slag	—	75
Fiberglass Insulation	Glass Cullet	—	20 – 25
Cellulose Insulation (loosefill & spray-on)	Postconsumer Paper	75	75
Perlite Composite Board Insulation	Postconsumer Paper	23	23
Plastic Rigid Foam, Polyisocyanurate/Polyurethane: Rigid Foam Insulation	Recovered Material	—	9
Foam-in-Place Insulation	Recovered Material	—	5
Glass Fiber Reinforced Insulation	Recovered Material	—	6
Phenolic Rigid Foam Insulation	Recovered Material	—	5
Floor Tiles (heavy duty/ commercial use)	Rubber Plastic	90 – 100 —	— 90 – 100
Patio Blocks	Rubber or Rubber Blends Plastic or Plastic Blends	90 – 100 —	— 90 – 100
Polyester Carpet Fiber Face	Polyethylene terephthalate (PET) Resin	25 – 100	25 – 100
Latex Paint:			
— Consolidated[1]	Recovered Material	100	100
— Reprocessed[2]			
— White, Off-White, Pastel Colors	Recovered Material	20	20
— Grey, Brown, Earthtones, and Other Dark Colors	Recovered Material	50-99	50-99
Shower and Restroom Dividers/Partitions	Plastic Steel	20 – 100 16	20 – 100 20 – 30
Carpet Cushion:			
— Bonded Polyurethane	Old Carpet Cushion	15 – 50	15 – 50
— Jute	Burlap	40	40
— Synthetic Fibers	Carpet Fabrication Scrap	—	100
— Rubber	Tire Rubber	60 – 90	60 – 90
Signage	Plastic Aluminum	80 – 100 25	80 – 100 25

Acoustics

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

Parameters Used in Acoustic Design. Acoustics, like room temperature, is an environmental condition. Every element of the space, its shape, surfaces, furniture, light fixtures and mechanical systems contribute to its acoustical characteristics. The following parameters are used to establish acoustical standards for GSA buildings:

Ambient Noise Level. This parameter refers to the level of noise *within* a space. Generally, the lower the level of ambient noise the more comfortable inhabitants will feel. On the other hand, mechanical sound is sometimes introduced into a space to mask background noise and/or raise the level of speech privacy. Ambient noise level is quantified by Noise Criterion (NC) Curves, published in ASHRAE *Handbook of Fundamentals*.

Noise Isolation. This parameter refers to the amount of noise transmitted through the *perimeter* of a space. The better the sound barrier, the higher its Sound Transmission Class (STC).

Noise Isolation Class. This is a classification established by ASTM E-336 for determining noise isolation between existing building spaces. A modification of this rating, *Speech Privacy Noise Isolation Class (NIC)*, is used to rate ceiling tile and free-standing space dividers in open plan office space.

Reverberation Control. Reverberation defines the amount and direction of sound reflected from a given material. A harder surface produces a reflected noise level. Soft surfaces absorb sound waves and reduce the ambient noise level. The ability of a given material to absorb sound is expressed by its *Noise Reduction Coefficient (NRC)*.

Design Criteria for Building Spaces. The most effective way to control noise propagation in buildings is to provide buffers between noisy and quiet areas. Buffers can be unoccupied space, shafts, filing or archive areas.

Class A Spaces: These are critical, noise sensitive spaces. The category includes auditoria and court rooms. The acoustical treatment of these spaces must be designed by a qualified acoustical consultant or specialist. U.S. court facilities must be designed in accordance with Chapter 9: *Design Standards for U.S. Courts Facilities*. Technical criteria and design variables should be established by an acoustical specialist based on an analysis of the user's needs.

Class B1 Spaces: This category describes spaces where meetings take place on a regular basis, including conference rooms and training rooms. The design ambient noise level must not exceed NC 30. Air supply and return systems should be equipped with sound traps or insulated ductwork to meet this criterion. Sound isolation at partitions enclosing Class B1 space is a minimum STC of 45. Doors must be gasketed. Acoustical ceilings must have a minimum NRC of 0.55 if the space is carpeted or 0.65 if not carpeted. Background masking should not be used.

Class B2 Spaces: This category consists of spaces where people are likely to speak in a higher than normal tone of voice and spaces where concentrations of noisy equipment are located, including dining areas, ADP areas, computer equipment rooms and rooms housing high speed copiers. The design ambient noise level must not exceed NC 40. Sound isolation at partitions enclosing Class B2 space must be a minimum STC of 45. Doors must be gasketed. Acoustical ceilings must have a minimum NRC of 0.55 if the space is carpeted or 0.65 if not carpeted. If background sound masking is used, the NRC criteria do not apply.

Class C1 Spaces: Enclosed general office space falls in this category. The design ambient noise level must not exceed class NC 35. Partition and ceiling assemblies must have a minimum STC of 40. Partitions should terminate at the underside of the ceiling. Floors should be carpeted, unless unusual circumstances exist. Acoustical ceiling units must have a minimum NRC of 0.55 if the space is carpeted or 0.65 if not carpeted. This does not apply to spaces with background masking systems.

Class C2 Spaces: This category describes open plan offices. The design ambient noise level must not exceed NC 35. Noise isolation must meet the requirements of at least NIC 20. Acoustical ceiling units must have a minimum NRC of 0.55 if the space is carpeted or 0.65 if not carpeted. Ceiling ratings do not apply to spaces with background sound masking systems.

Where background sound masking is used, the system should be designed by a qualified acoustical consultant.

Class D Spaces: Occupied space where speech privacy is not a significant consideration, such as internal corridors, circulation stairs and file rooms, are part of this category. The same criteria apply as for Class C1, except that noise isolation is not a requirement.

Class E Spaces: These are public spaces and support spaces: lobbies, atria, toilets and locker rooms. The design ambient noise level must not exceed class NC 40. There are no specific sound isolation requirements, but Class E spaces should be separated as far as possible from quiet areas. In large lobbies, acoustical treatment must be provided on some surfaces to mitigate reverberation, especially if the space is programmed for assembly uses.

Class F Spaces: These are warehouses, parking garages and fire stairs not used for normal circulation. The design ambient noise level must not exceed NC 50. Class F spaces should be separated as far as possible from quiet areas.

Class X Spaces: These are spaces where noisy operations are located, including kitchens, mechanical, electrical and communications equipment rooms, elevator machine rooms and trash compactor rooms. The design ambient noise level has no fixed limit, but treatment should be considered if NC 60 is exceeded. Sound isolation between Class X spaces and other spaces shall be a minimum of STC 45. Consideration must be given to sound transmission through floors and ceilings to spaces above and below. Sound isolation floors are recommended for all mechanical room floors where space below is occupied.

Sound Isolation from Exterior Noise Sources. The exterior construction systems recommended in these standards will screen out ordinary traffic noise. Buildings located near airports or other sources of high noise levels shall have special exterior glazing and gasketing systems, designed with the assistance of a qualified acoustical consultant.

Emergency Protection

Federal law requires that Federal buildings provide protection suitable for emergency shelters within program and budgetary limits. The program will state if shelters are required on a given project. Emergency shelters are not designated building spaces: they are spaces used for other purposes, which can serve as shelters in an emergency.

Shelter locations should be identified during the early stage of design. The optimum shelter location is below grade. Basement levels, including underground parking facilities, offer good protection.

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

3.4 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 special requirements on fire protection see Chapter 7: *Fire Protection Engineering*.

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 m^2 (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 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 sun screens may be used in addition to interior sun control devices where they are beneficial for building operation and energy conservation. Exterior shutters, blinds and awnings should not be used.

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 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 sun screens or sun control devices.

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

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

Sam Gibbons U.S. Courthouse, Tampa, FL

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 munton 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.

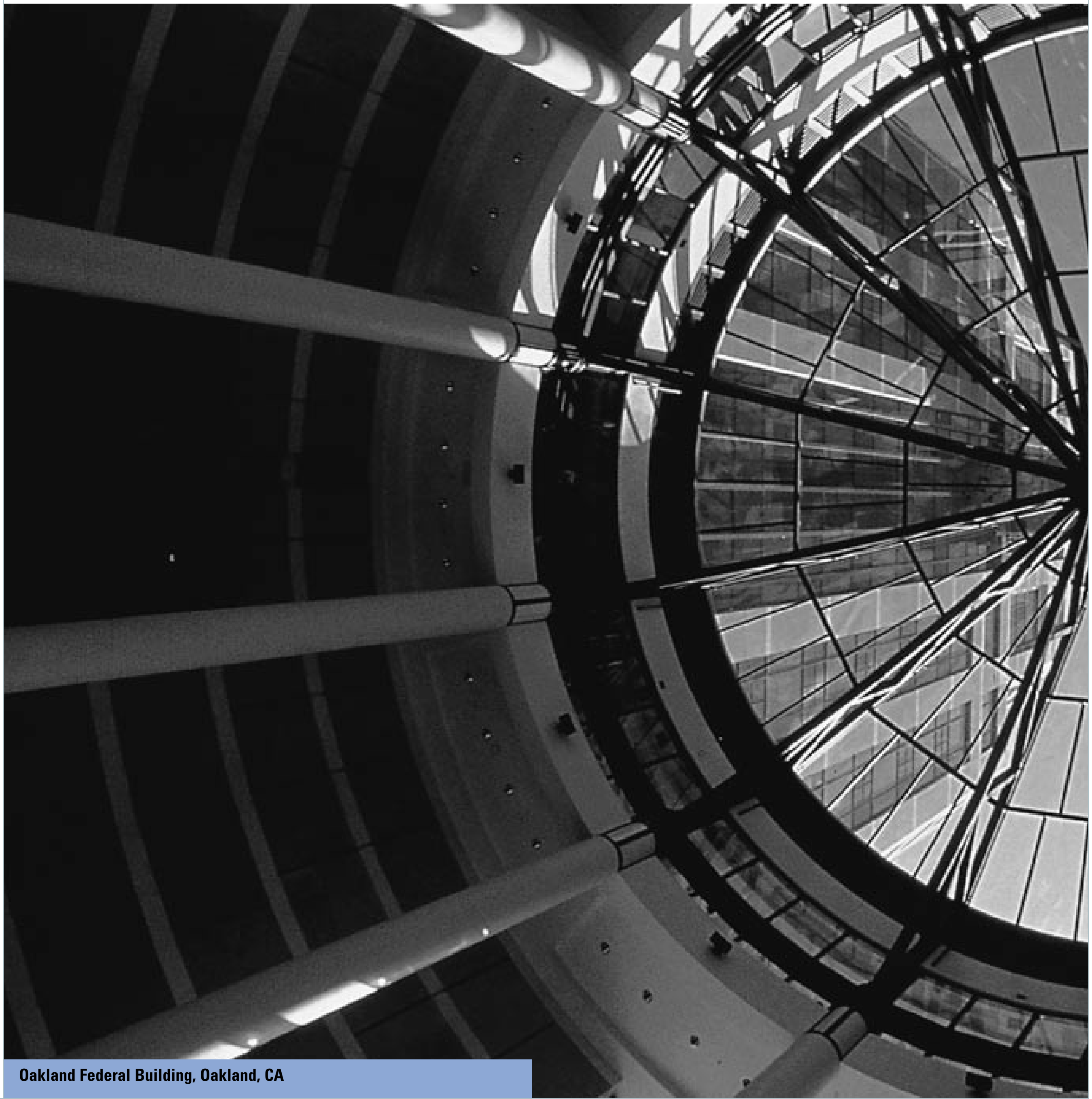
Window cleaning. The design of the building must include provisions for cleaning the interior and exterior surfaces of all windows. Window washing systems used in the region must be considered and a preferred system and equipment identified during design. In large and/or high-rise buildings, such glass 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.

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, hingepins and hasps must be secured against unauthorized removal by using spot welds or peened mounting bolts. All exterior doors must have automatic closers. The exterior side of the door 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.

Robert C. Byrd Courthouse, Charleston, WV



Oakland Federal Building, Oakland, CA

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 tappered 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 during project development prior to construction, if construction is completed during a subsequent President's term of office.

Interior Construction

Partitions. Partitions should be selected for use based on the type of space and the anticipated activity within that space. 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.

Postal Square, AOC Workstation

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*.

Access Flooring

Accessible floor systems are a high priority for incorporation in all GSA buildings, where it is practical. They have the potential of requiring the least impact on floor to floor heights for accommodating building systems. The flexibility allowed by accessible flooring recognizes the dynamic changes that occur in the use of the space and the continual upgrades that occur to building environmental and communication systems. Refer also to the *Technology Infrastructure* section of Chapter 3.

If no load requirements are stated in the building program, design access flooring for 1210 kg/m^2 (250 PSF) uniform load and 910 kg (2,000 pound) point load. Generally, floor panels should be concrete filled metal or concrete. Both pedestal and stringer systems are acceptable; however, for heavy cart traffic, stringer systems are preferred. The system must be coordinated with the design of the underfloor junction box for electrical power and communications. Designs should be selected recognizing the potential for frequent removal and replacement of raised access floor tiles. Systems that require extensive bolting and unbolting are not desirable.

For tiles with hard-surface finishes, access floor tiles shall have a high pressure plastic laminate surface; this will reduce static and dust associated with these areas. In order to reduce static in computer areas, consider the use of conductive laminated plastic, bonded to the access panels with a conductive adhesive. The building flooring under the access flooring, typically concrete, should be sealed to prevent the accumulation of concrete dust in this area. Access floor tiles may be finished with carpet tile. Bolted connections between pedestal and floor are preferred in seismic zones.

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.

Ronald Reagan Federal Courthouse, Santa Ana, CA

Sculpture, Charles Evans Whittaker Courthouse, Kansas City, MO

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.

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* (March 1998) 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 pictures and printed messages are recommended since they are easier to understand for people who do not read English. Sign design shall comply with 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 signs indicating accessibility to the physically challenged. Signage in historic buildings should be compatible with original signage design, using historic finishes, colors, and typefaces as a guide for new signage design. Serif typeface is 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. The specifications shall ensure that GSA will be provided with the equipment and supplies required to make future signage changes.

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.

3.5 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 Engineering, Interior Finishes*. An example is the need to provide carpet tile rather than continuous carpet over access flooring. Architects are encouraged to select materials of higher quality, within the budget constraints of the project.

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 is a serious health concern in some carpet installations, as PVC-backed carpet is very common in both carpet tile and six-foot broadloom. It is important that when installing PVC-backed carpet to assure that there are no old adhesives or floor treatments that may react with the PVC, as off-gassing may result. The Carpet and Rug Institute (CRI) has developed the "Green Label" test program to test for off-gassing of carpet, cushion and adhesives. These materials should meet the "Green Label" criteria.

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.

Vinyl Wall Covering. The minimum quality of vinyl wall covering is Type II with a minimum finished weight of 620 grams per lineal meter (137 cm average width) (20 ounces per lineal yard with an average width of 54 inches).

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.

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. Suspended acoustical materials should be selected for all general office space. Grid size and spacing should be based on the building planning module. Avoid inaccessible ceiling systems.

It is desirable to standardize acoustic ceiling tile within the building as much as possible to minimize the amount of replacement stock. The recommended standard ceiling tile is a commercial quality, 600 mm by 600 mm tegular lay-in (2-foot by 2-foot) tile. See the section *Building Planning, Planning Module* in this chapter.

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

Martin Luther King Courthouse, Newark, NJ

Training and Conference Rooms

These areas should be finished at levels of quality equivalent to the adjacent office areas. In addition, the application of tackable acoustic wall panels and rails for the display of presentation materials within these spaces is appropriate.

Internal Corridors

Corridors within general office areas should receive the same finishes as the office areas themselves. Color changes 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.

U.S. Courthouse, White Plains, NY

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 high finish levels as those spaces. It is appropriate to introduce special floor, wall and ceiling treatments, and special lighting that can 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. Avoid completely sealed systems as they make access to elements above the ceiling difficult.

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.

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.

National Archives, College Park, MD

3.6 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, tile or plastic laminate should be designed for lavatories. 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 theses 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.

3.7 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 the fire protection engineer 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: *General Requirements, Codes and Standards, Building Codes*. 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, *General Requirements* for additional information. Architects will be expected to work closely with the GSA regional fire

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

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 Engineering*, 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.

Raised Access Flooring is an attractive choice for buildings that are being completely remodeled. Raised flooring can be lower than the minimum of 200 mm (8 inches) indicated for new buildings if floor-to-floor height is insufficient. It offers the same systems quality and flexibility as a new building.

The other option is to create a deep ceiling space and zone it carefully for the most efficient fit of all engineering systems. See section *Building Planning, Planning Module, Floor-to-Floor Heights and Vertical Building Zoning* of this chapter for zoning of ceiling space. 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.

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 m^2 (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 and poorly lit spaces. Major renovations are a good opportunity to correct this situation. Cost considerations may prohibit moving the kitchen, but light and air can be brought into dining areas by excavating and then glazing to provide views of sunken courtyards outside the dining room.

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.


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

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.

Sam Gibbons U.S. Courthouse, Tampa, FL

3.8 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.

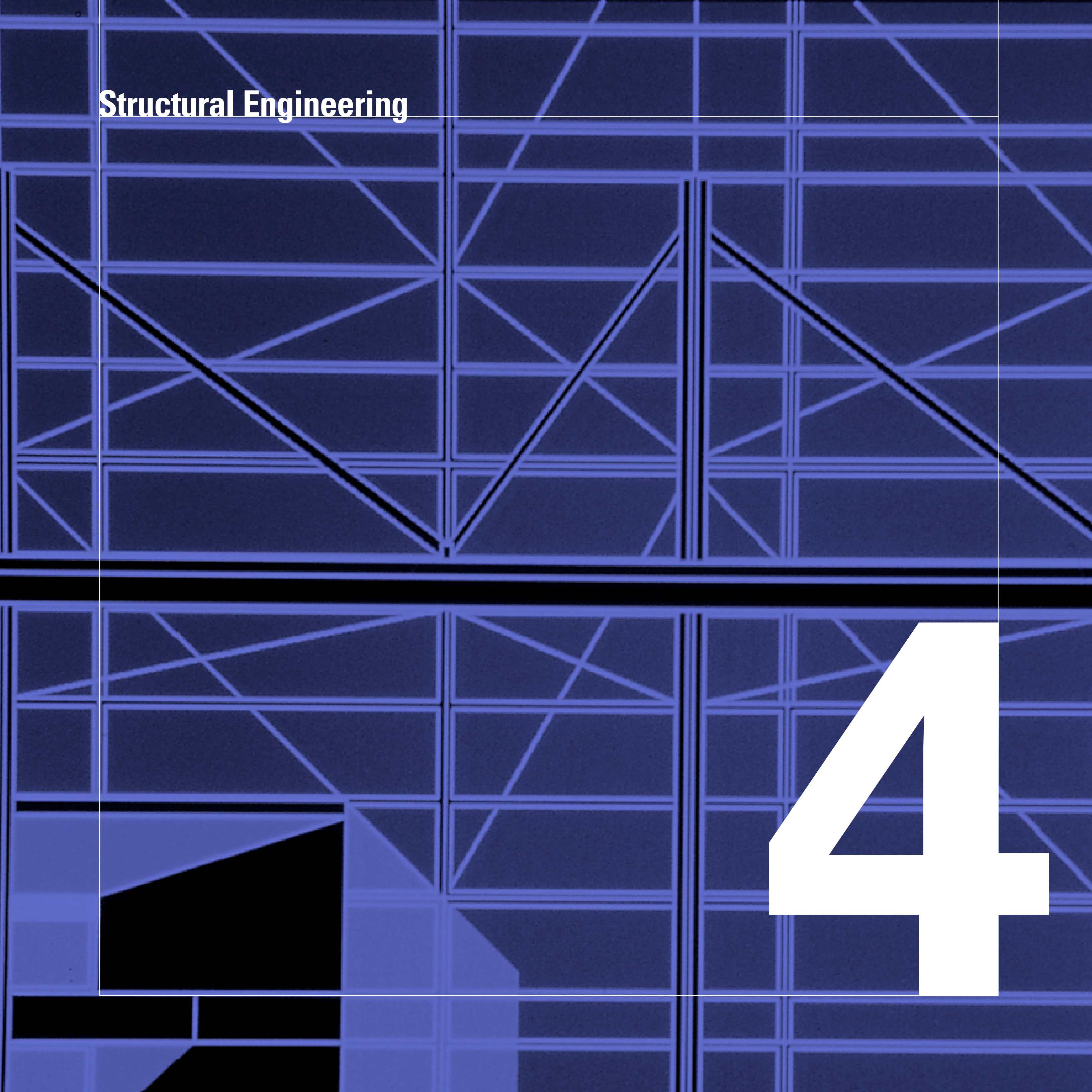
Vincent E. McKelvey Federal Building, Menlo Park, CA

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.

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

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

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4.1 General Approach

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.

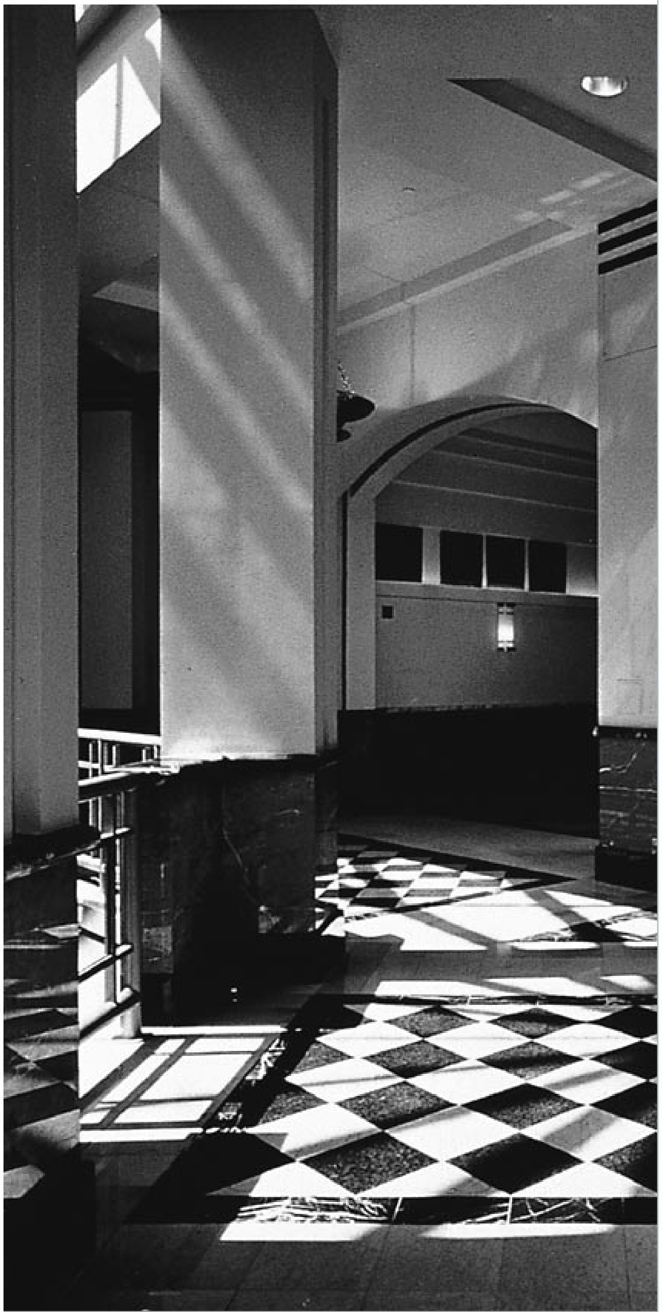
GSA generally owns and operates its buildings much longer than private sector owners. Accordingly, a higher level of durability and serviceability is required for all systems. In terms of structural design, this has resulted in more stringent requirements than those stipulated in model building codes;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

During the life span of a typical Federal 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

Model codes and mandatory standards adopted by GSA for the design of all new buildings are discussed in Chapter 1: *General Requirements, Codes and Standards, Building Codes.*

The following FEMA Guidelines shall be incorporated into the structural design for all projects:

- Federal Emergency Management Agency (FEMA) publications:

  NEHRP (National Earthquake Hazards Reduction Program) *Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, Part 1: Provisions* (FEMA-302A, with 15 maps) and *Part 2: Commentary* (FEMA-303A).

  Interim Guidelines: Evaluation, Repair, Modification and Design of Steel Moment Frames (FEMA-267) and Interim Guidelines: Evaluation, Repair, Modification and Design of Welded Steel Moment Frame Structures (FEMA-267B).

  NEHRP (National Earthquake Hazards Reduction Program) *Handbook for the Seismic Evaluation of Buildings–A Pre-standard* (FEMA–310).

  NEHRP (National Earthquake Hazards Reduction Program) *Recommended Guidelines for the Seismic Rehabilitation of Buildings, Part 1: Guidelines* (FEMA-273, with the NEHRP maps) and *Part 2: Commentary* (FEMA-274).

- American Society of Civil Engineers: *Minimum Design Loads for Buildings and Other Structures, ASCE 7.*

- *Standards of Seismic Safety for Existing Federally Owned or Leased Buildings and Commentary* (ICSSC RP 4) prepared by the Interagency Committee on Seismic Safety in Construction – Recommended Practice 4.

Use of Recycled Materials

The EPA Comprehensive Procurement Guidelines indicate the materials that must contain recycled content in the construction of buildings with federally appropriated funds. (Refer to: Chapter 1, *Recycled Materials*; and Chapter 3, *Incorporation of Recycled-Content Materials*.)

Chapter 3, *Incorporation of Recycled-Content Materials* includes a listing of ASTM Specifications for cement and 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 Forces

GSA promotes flexibility in the use of space. Since corridor locations may not be known until after construction begins and are subject to change over time, use an "office" uniform live load of 3.8 kPa (80 pounds per square foot) in lieu of the tabulated uniform live load in the model building codes. Spaces with higher live loads than this should be designed for the code required minimum or the actual live load, whichever is greater. Do not use live load reductions for (1) horizontal framing members, (2) transfer girders supporting columns, and (3) columns or walls supporting the top floor or roof.

Special live load requirements are specified for telecommunications equipment rooms by the FIPS 175: *Federal Building Standards for Telecommunication Pathways and Spaces*.

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 FIPS 175, 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 FIPS 175 standard 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

Earthquake Design

The minimum design lateral force shall be determined as follows:

To obtain a more accurate, site-specific ground motion, the latest National Hazard Reduction Program (NEHRP) maps shall be used in lieu of the acceleration and velocity contour maps found in the 1999 BOCA National Building Code, in the 1999 Standard Building Code, and the zonation map found in the 1997 Uniform Building Code. The procedure for determining the design lateral force shall be as follows:

UBC Procedure

To calculate C_a and C_v the following two formulas shall be used in lieu of using Tables 16-Q and 16-R in the 1997 UBC:

$$C_a = 0.266\ F_a\ S_s$$
$$C_v = 0.666\ F_v\ S_1$$

S_s and S_1 shall be taken directly from the NEHRP maps (2500-year return period) for 0.2-second and 1.0-second periods, respectively. F_a and F_v shall be taken from Tables 4.1.2.4a and 4.1.2.4b of FEMA 302, respectively. The Site Class definitions of FEMA 302 are identical to the Soil Profile Types of the 1997 UBC.

The new values of C_a and C_v, as calculated above, shall be employed to derive other design seismic forces, as prescribed in the code.

All other provisions of the 1997 UBC shall be followed without additional modification, except as noted herein. Whenever the design seismic force, as calculated via the procedures noted above, is lower than those forces derived by the use of the 1997 UBC without modification, the larger derived seismic force shall govern the design.

BOCA and SBCCI Procedure

To calculate A_a and A_v the following two formulas shall be used in lieu of using Figure 1610.1.3(2) and Figure 1610.1.3(1) in the 1999 BOCA and Figure 1607.1.5B and Figure 1607.1.5A in the 1999 SBCCI, respectively:

$$A_a = S_s / 2.5$$
$$A_v = S_1$$

S_s and S_1 shall be taken directly from the NEHRP maps (2500-year return period) for 0.2-second and 1.0-second periods, respectively.

To calculate C_s the following two formulas shall be used in lieu of the formulas noted in BOCA and SBCCI:

$$C_s = 0.666\ F_v\ A_v / RT$$
$$C_s = 1.666\ F_a\ A_a / R$$

F_a and F_v shall be taken from Tables 4.1.2.4a and 4.1.2.4b of the FEMA 302, respectively. The Site Class for the derivation of F_a and F_v shall be taken from Section 4.1.2.1 and Table 4.1.2.2 of FEMA 302 in lieu of using the S1 through S4 site coefficients noted in these codes.

The new value of C_s, as calculated above, shall be employed to derive other design seismic forces, as prescribed in the code.

All other provisions of the 1999 BOCA and 1999 SBCCI shall be followed without additional modification, except as noted herein.

Whenever the design seismic force, as calculated via the procedures noted above, is lower than those forces derived by the use of the 1999 BOCA, or 1999 SBCCI without modification, the larger derived seismic force shall govern the design.

4.4 Structural Considerations

LRFD versus ASD. Both Load Resistance Factor Design (LRFD) and Allowable Stress Design (ASD) are acceptable design procedures for GSA buildings; however, for larger building structures LRFD is generally recognized as resulting in more economical steel framing and is preferred by GSA.

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.

Base Isolation. Base isolation shall be considered in UBC Earthquake Zones 3 and 4 or equivalent NEHRP seismic zones 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 cost effective. 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 in moderate to high-risk seismic zones.

Progressive Collapse

The structure must be able to sustain local damage without destabilizing the whole structure. The failure of a beam, slab, or column shall not result in failure of the structural system below, above, or in adjacent bays. In the case of column failure, damage in the beams and girders above the column shall be limited to large deflections. Collapse of floors or roof must not be permitted. For additional information refer to the *GSA Security Design Criteria* and the American Society of Civil Engineers: *Minimum Design Loads for Buildings and Other Structures, ASCE 7*.

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 an equivalent vibration perception/acceptance criteria.

Seismic Instrumentation for Buildings

Seismic instrumentation to measure horizontal and vertical motions of certain floors relative to the ground shall be provided in accordance with the national codes referenced in Chapter 1 and Appendix B of *Seismic Instrumentation of Buildings (with Emphasis on Federal Buildings)*, Special GSA/USBS Project, USGS Project No: 0-7460-68170.

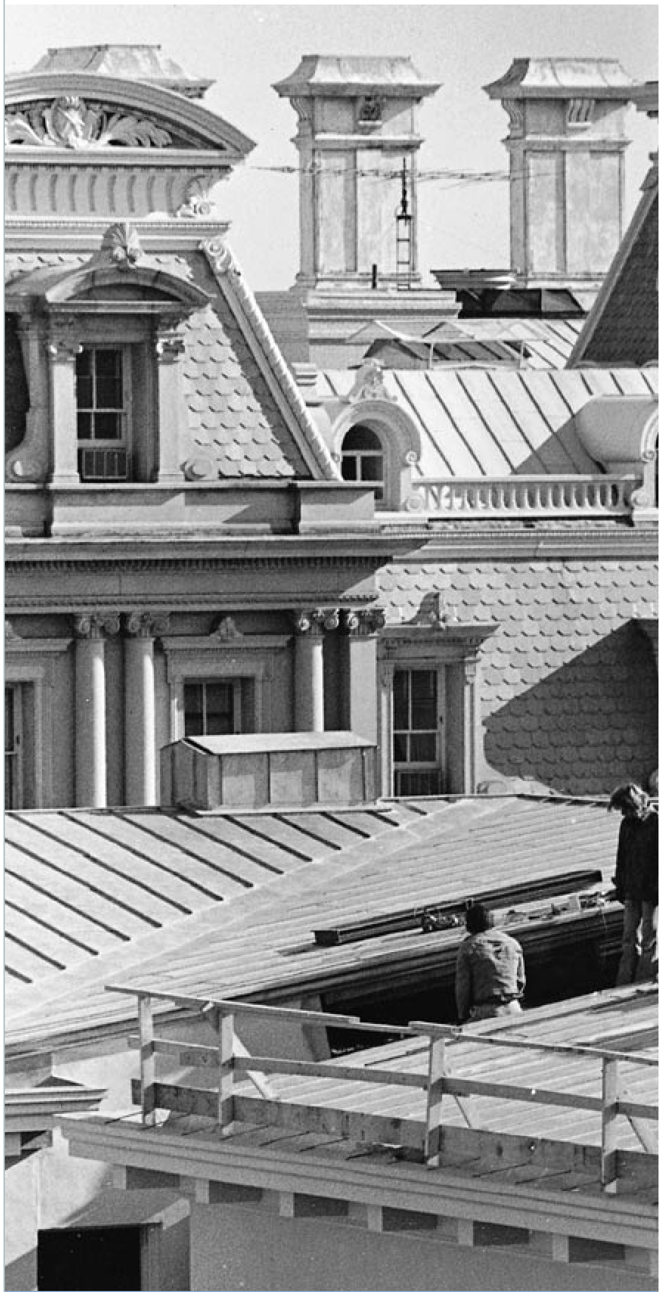
Geotechnical Considerations

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 to withstand gravity, wind, seismic, temperature, and other loads as required by the applicable codes.



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

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 4 (NISTIR 5382), *Standards of Seismic Safety for Existing Federally Owned or Leased Buildings*. with the following modifications:

- Evaluation of existing buildings shall be in accordance with provisions of the Handbook for the Seismic Evaluation of Building–A Prestandard (FEMA 310).
- Seismic rehabilitation of existing buildings shall be in accordance with the provisions of the NEHRP Guidelines for the Seismic Rehabilitation of Buildings and Commentary (FEMA 273 and 274).

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 4. See Chapter 1: *General Requirements, Codes and Standards, Mandatory Design Standards, Conflicts with Historic Preservation*.

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.

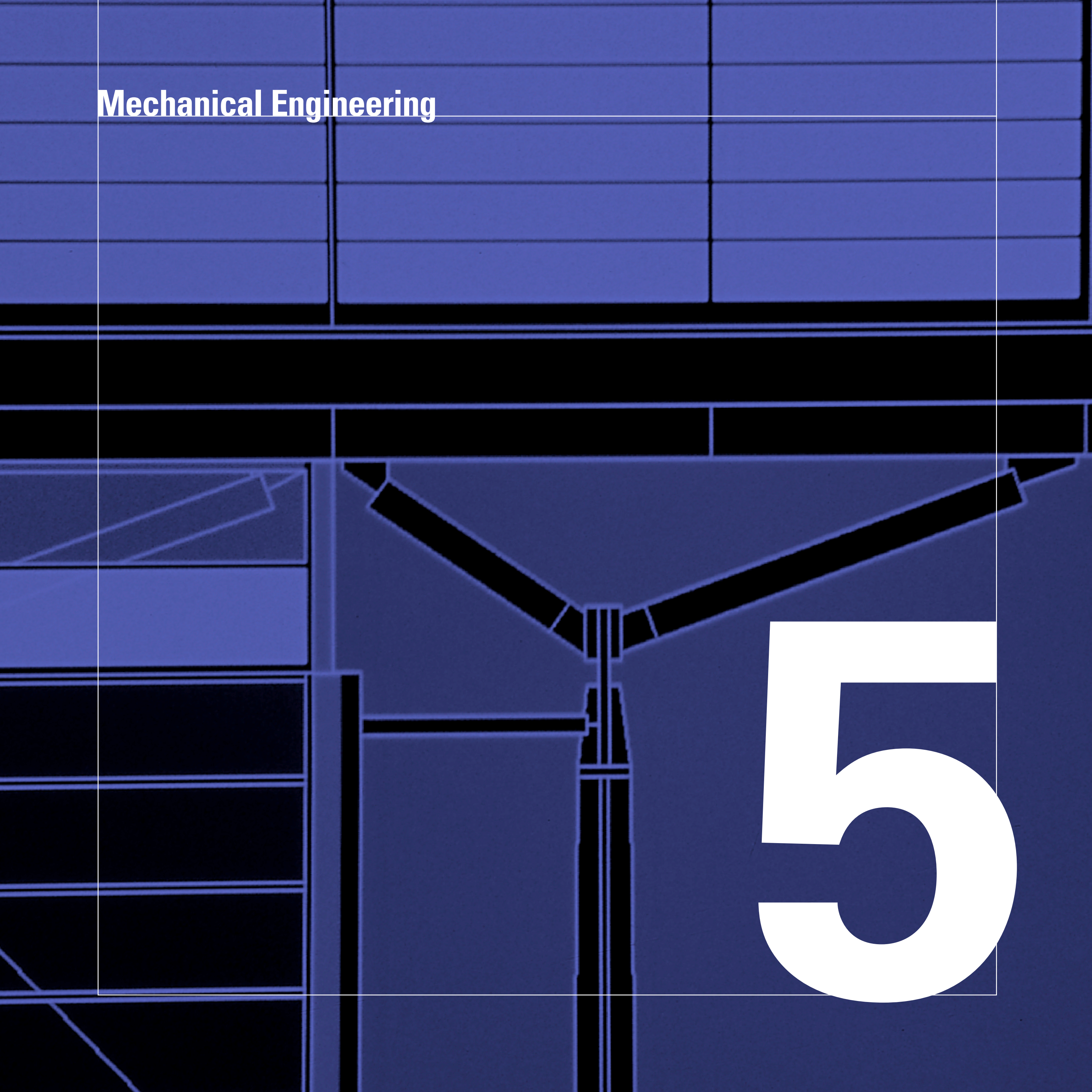
4.6 Seismic Requirements for Leased Buildings

New Construction

New buildings or the construction of an addition to an existing building shall conform to the seismic standards for new construction of the current edition (as of the date of the solicitation) of one of the National Model Building Codes. For more 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 or Leased Building and Commentary*, ICSSC RP 4, as modified by the latest edition of GSA's Solicitation for Offers (SFO).



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5.18 Alterations in Existing Buildings and Historic Structures

5.1 General Requirements

The heating, ventilating, and air-conditioning (HVAC) and plumbing systems shall be selected for long-term durability, energy efficiency, flexibility, accessibility, redundancy, ease of operation and maintenance, and efficient life cycle owning and operating costs.

Mechanical systems shall be specifically designed to support all known occupancies and modes of operation, but shall also accommodate planned future occupancies and modes of operation. (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 reverting Courtroom facilities for other Agencies' use).

Maintainability and reliability are major concerns in the operation of Federal buildings. As such, the design and installation for all mechanical equipment and components shall allow for ease of removal and replacement, including major equipment such as boilers, chillers, cooling towers, pumps and air-handling equipment. Vehicular access to mechanical equipment areas shall be provided to facilitate off-site and on-site movement of all major system components.

Sufficient redundancies shall be designed into mechanical systems, enabling continuous services during repair or replacement of a failed piece of equipment or component. Redundant equipment shall not be designed into systems as "stand-by" units but rather shall be used as part of the operating system with equal time cycling through automatic control sequencing.

Proposed systems and equipment will be evaluated for their offerings of advanced technology; however, GSA does not allow the use of experimental, unproven 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.

Mechanical systems must be coordinated and integrated with the designs of other involved/impacted building systems and features. As addressed in Appendix A.2, mechanical systems shall be adapted to support all performance objectives, typically involving sustainability, workplace performance (productivity), firesafety, security, historic preservation, and improved operations and maintenance.

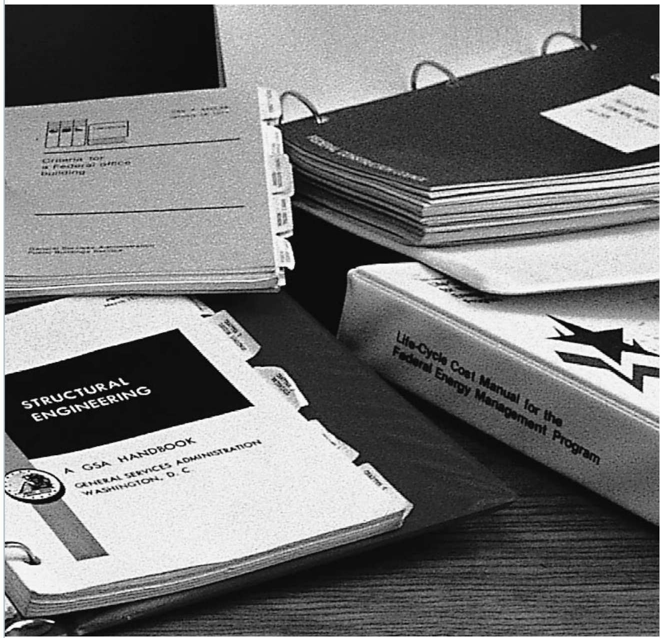
All mechanical systems shall be designed to respond to the local climatic conditions and shall utilize ambient conditions for all possible energy conservation measures while still maintaining desired indoor conditions.

Mechanical systems shall be fitted with automatic controls and devices to assure desired performance in all operating modes. Interface with a Building Automation System shall be as addressed later in this chapter.

Mechanical systems shall generally be selected for lowest life cycle cost, comparing alternatives that meet all required functional objectives. As indicated herein, GSA defined baseline alternatives shall be reflected in these analyses.

Submission requirements are addressed in Appendix A.

5.2 Codes and Standards



As stated in Chapter 1: *General Requirements, Codes and Standards, Building Codes*, facilities should comply with the requirements of site applicable building, mechanical and plumbing codes, including the mechanical and plumbing standards and guidelines referenced therein.

Mechanical Design Standards

The latest editions of the 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. The term "Recommended" as used in the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) Standards shall be considered "Required."

- ASHRAE: *Handbook of Fundamentals.*
- ASHRAE: *Handbook of HVAC Applications.*
- ASHRAE: *Handbook of HVAC Systems and Equipment.*
- ASHRAE: *Standard 15: Safety Code for Mechanical Refrigeration.*
- ASHRAE: *Standard 52: Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.*
- ASHRAE: Standard 55: *Thermal Environmental Conditions for Human Occupancy*.
- ASHRAE: Standard 62: *Ventilation for Acceptable Indoor Air Quality*.
- ASHRAE: *Standard 90.1: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.*
- ASHRAE: *Standard 100.1995: 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&R 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.*
- 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):
  - *HVAC System Duct Design.*
  - *HVAC Duct Construction Standards: Metal and Flexible.*

- *HVAC Air Duct Leakage Test Manual.*
- *Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.*
- *Seismic Restraint Manual Guidelines for Mechanical Systems.*

- National Electrical Code.
- Federal Information Processing Standard (FIPS) Standard 175: *Federal Building Standard for Telecommunication Pathways and Spaces*.
- All site-specific codes.

Energy and Water Conservation - Life Cycle Costing
Mechanical systems shall be selected to achieve cost effective attainment of "Energy Conservation Standards," addressed within Chapter 1.

Energy and water conservation measures involving mechanical systems must be effectively integrated with other building systems. In particular, energy and water use needs/loads must first be minimized.

Consideration of an Energy Savings Performance Contract (ESPC) for any authorized prospectus level project requires written notification to the Office of the Chief Architect of GSA and the Office of Portfolio Management. All ESPCs shall maintain design control conditions of temperature, humidity, ventilation, acoustics, and other design parameters, for all modes of operation.

Analyses of energy-conserving designs shall include all relevant effects of the building envelope, lighting energy input, domestic water heating, efficient use of local ambient weather conditions, building zoning, efficient part load performance of all major HVAC equipment and the ability of involved building automation equipment to automatically adjust for building partial occupancies, optimized start-stop times and systems resets.

Water conservation shall be a requirement of all mechanical systems design. All water cooled mechanical equipment shall be provided with a recirculating cooling water system and water to air heat rejection equipment (e.g. cooling towers, fluid coolers) shall have drift eliminators (and shall be designed with indoor retention tanks to minimize evaporative losses and eliminate the need of basin heaters for facilities in northern climates). No domestic water-cooled system that results in water wasting is allowed.

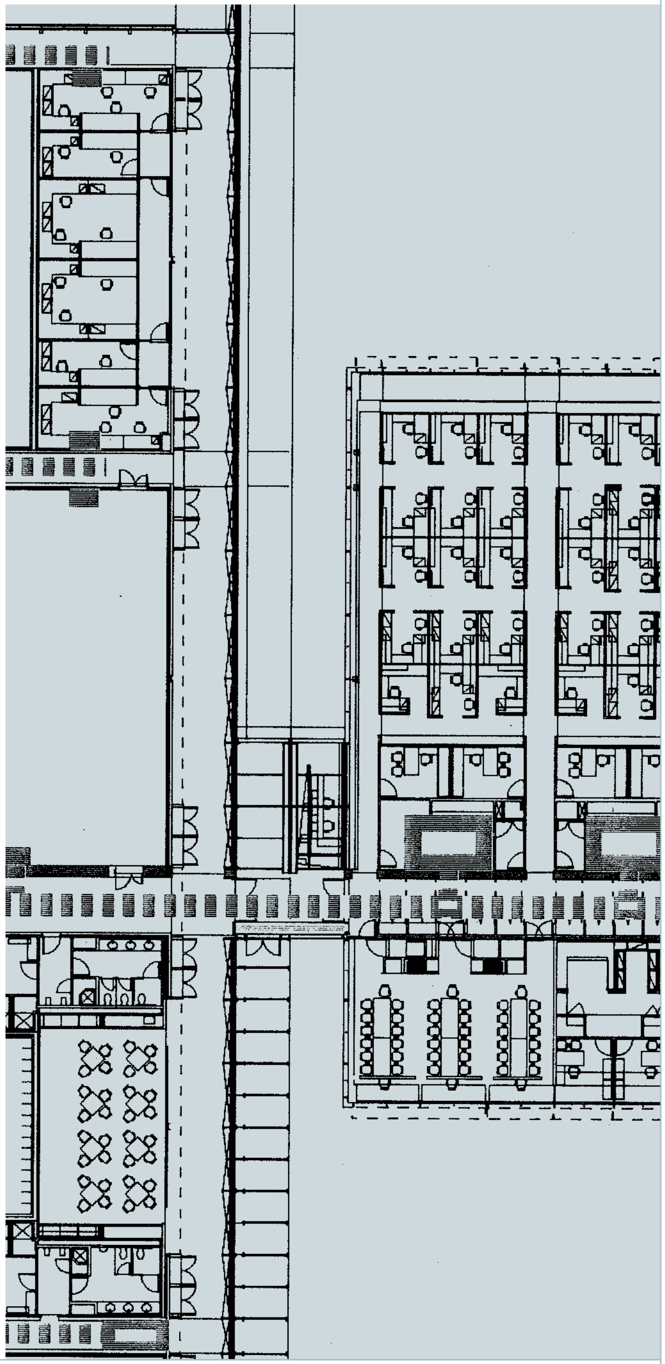
HVAC system designs shall include a life cycle cost analysis of a described baseline plus a minimum of two GSA-approved alternate HVAC systems. For new construction, one HVAC alternative shall utilize a renewable energy source, and one shall be appropriate for the particular site conditions (e.g. if district steam or chilled water is available).

Life cycle cost submittals must utilize the computer program entitled *Building Life Cycle Cost*, latest version. As addressed in Chapter 1: *General Requirements*, this program is available from NIST free of charge via the Internet.

Reference should also be made to the *Life Cycle Costing Manual for the Federal Energy Management Program (NIST Handbook 135) and Energy Prices* and *Discount Factors for Life Cycle Cost Analysis*, both of which are available through the Internet.

The period over which the costs must be calculated will typically be 25 years. The design/construction period is not to be included in this 25 years. The life cycle cost analysis must include investment costs, energy costs, non-fuel operation and maintenance costs, repair and replacement costs, and salvage values. The submittal must utilize the subprogram *Federal Analysis-Projects Subject to OMB's A-94 Guidelines*. There is no need to break down the facility into component parts. The disk has a users guide and reference manual which can be printed out. For the purpose of computing energy requirements, the submittal shall assume the building shall operate under the occupied cycle from 6:00 a.m. to 6:00 p.m. Monday through Friday for every week of the year. Holiday schedule, occasional extended hours of operation or special areas requiring 24 hours per day, every day, shall not be considered as variables to the 60 hours per week occupancy. For operations and maintenance personnel costs (i.e. labor rates or employee burden cost), use a local rate, including fringes.

The baseline HVAC system described in the following section indicates an acceptable system and sets the reference from which advantages and disadvantages of other systems can be compared through the life cycle cost analysis.



5.3 Baseline HVAC System

General. Unless otherwise directed in design programming documents, the following description of a baseline HVAC system shall be used when comparing system alternatives. Refer to the specific sections of this chapter for more detailed information on all HVAC and plumbing system requirements.

Zoning Requirements. Interior control zones shall not exceed 180 m^2 (2000 square feet) for open office areas or a maximum of three offices per zone for closed office areas. Corner offices shall be a dedicated zone. Perimeter zones shall be no more than 4.6 meters (15 feet) from an outside wall along a common exposure. Independent zones shall be provided for spaces such as conference rooms, entrance lobbies, atria, kitchen areas, dining areas, child care centers, physical fitness areas, and courtrooms.

Separate systems shall be provided for buildings where perimeter zones have heating and/or cooling loads very different from interior zones.

Large air-handling units serving multiple floors for buildings with scattered loads after normal office hours is not acceptable. Multiple air-handlers or floor-by-floor systems shall be considered as baseline. For federal courthouses no more than two courtrooms shall be served by any single air-handling unit, with that air-handling unit dedicated to serve those courtrooms. Separate piping loops and systems shall be used for off-hours systems.

The supply of zone cooling and heating shall be sequenced to prevent (or at the very least, minimize) the simultaneous operation of heating and cooling systems for the same zone. Supply air temperature reset control shall be utilized to extend economizer operations and to reduce the magnitude of reheating, recooling or mixing of supply air streams.

Hot Water Heating Systems and Equipment. The baseline heating system shall be comprised of dual fueled natural gas and fuel oil boilers producing low temperature heating hot water at 205 kPa (30psi) working pressure and a maximum heating hot water temperature of 120°C (250°F). For northern climates, a minimum of three equally sized units shall be provided, with all three units having sufficient combined capacity to satisfy 120 percent of the total peak load of heating and humidification requirements. For southern climates, a minimum of two equally sized units at 67 percent of the peak capacity (each) shall be provided. The units shall be packaged with all components and controls factory pre-assembled.

All required auxiliaries for the boiler system shall be provided, including expansion tanks, heat exchangers, water treatment, and air separators, as required. Pressurized diaphragm expansion tanks shall be considered baseline. Pumps shall be centrifugal type and shall generally be selected to operate at 1750 RPM.

A primary-secondary piping arrangement with a modulating mixing control valve and higher primary flow rate shall be provided to assure that the boiler return water temperature does not drop too low, as commonly occurs with night setback. The baseline system shall utilize parallel piping systems with a two-pipe main distribution system arranged in a reverse return configuration.

The baseline system utilizes a dedicated hydronic heating system with convectors to offset heat losses through the building envelope in perimeter zones.

Materials acceptable for piping systems are black steel and copper. (No PVC or other types of plastic pipe are permitted.) Dielectric unions shall be provided between ferrous and copper-based materials (or other dissimilar metals). All piping systems must be insulated in accordance with ASHRAE Standard 90.1. Piping systems conveying fluids, those having design temperatures less than 18°C (65°F) or greater than 40°C (105°F), shall be insulated.

Cooling Systems and Equipment. The baseline cooling system shall be comprised of electric-powered water-cooled chilled water-generating equipment producing chilled water at a design supply temperature between 4°C and 7°C (40°F and 44°F) and a temperature differential of 7°C (12°F). When the peak cooling load is 1760 kw (500 tons) or more, a minimum of three equally sized units shall be provided with all three units having sufficient combined capacity to satisfy 120 percent of the total peak cooling load. If the peak cooling load is less than 1760 kw (500 tons), a minimum of two equally sized machines shall be provided, each at 67 percent of the peak load.

All required auxiliaries for the chiller systems shall be provided, including expansion tanks, heat exchangers, water treatment, and air separators, as required. No chlorofluorocarbon (CFC) refrigerants are permitted in new chillers.

Induced draft cooling towers with multiple-speed or variable speed condenser fan controls shall be considered baseline. The number of cells shall match the number of chillers. Cooling towers shall be constructed of corrosion-resistant materials (stainless steel, fiberglass and PVC) particularly in coastal areas, and for tower components that are typically wet in the normal operation of the tower.

Pumps shall be 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 separate pump shall be designed for each condenser water circuit. Variable volume pumping systems should be considered for all secondary piping systems with pump horsepower greater than 10 kW (15 HP). The specified pump motors shall not overload the entire range of the pump curve.

A primary/secondary chilled water pumping and piping arrangement shall be considered as baseline, with constant volume primary pumping and variable volume secondary pumping. The primary and secondary circuits shall be separate, with neither having an effect on the pumping head of the other. The primary circuit serves the source equipment (chillers), while the secondary circuit serves the load. The baseline system shall utilize parallel piping systems with a two-pipe main distribution system arranged in a reverse return configuration.

Materials acceptable for piping systems are black steel and copper. Dielectric unions shall be provided between ferrous and copper-based materials (or other dissimilar materials). All piping systems must be insulated in accordance with ASHRAE Standard 90.1. Piping systems conveying fluids, those having design temperatures less than 18°C (65°F) or greater than 40°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 to whether piping is concealed or exposed. Chilled water piping systems shall be insulated with non-permeable insulation (of perm rating 0.00) such as cellular glass.

Air Distribution Systems and Equipment. The baseline air-handling system is a simple VAV system providing cooling only. Any heating requirement (except freeze protection) shall be handled by a separate, dedicated perimeter system. The VAV supply fan shall be designed for the largest block load, not the sum of the individual peaks. Refer to *HVAC System Components and Air Distribution Systems* sections later in this chapter for detailed requirement.

The baseline air-handling units shall be sized not to exceed 12.1 m^3/s (25,000 cfm) per air-handling unit. Casings and coils of air-handling units shall be sized so that the volume capacity can be increased in the future by 10 percent by replacing the fan. Speed control shall be achieved via variable speed drives. Air supply temperature (at the discharge of the cooling coil) shall not be below 11.7°C (53°F).

In buildings without operable windows, air handling/ventilation systems shall involve controls/devices to assure outdoor air exchange rates shall be in accordance with ASHRAE Standard 62.

Individual finned tube coils shall be between six and eight rows and at least 2.1 mm between fins (12 fins per inch) to ensure coil cleanability.

Refer to *HVAC System Components, Drains and Drain Pans* later in this chapter for drain requirements. Ultra-violet light (C band) emitters shall be incorporated down-stream of all cooling coils and above all drain pans to control airborne and surface microbial growth and transfer.

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. Pre-filters shall be 30 percent to 35 percent efficient. Final filters shall be 80 percent to 85 percent efficient for particles at 3 microns.

Fans shall be selected on the basis of 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 operation curve. The fan and fan motor shall be internally mounted and isolated on a full-width isolator support frame using isolation springs.

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 should be provided in ventilation equipment, ductwork and plenums as required for inspection and cleaning.

The baseline air-handling system shall incorporate an air-side dry bulb economizer.

Terminals shall be designed for their specific location. For new construction, manually adjustable floor terminals shall be provided for raised floor plenum distribution. For repair and alterations involving ceiling distributions, VAV terminals shall be pressure-independent type units, specifically designed for VAV air distribution.

For raised floor applications, provide a dedicated outside air ventilation/distribution system, effectively limiting outside air interface of central air-conditioning units to only economizer cycle operations.

Supply and return air ducts shall be designed and constructed to allow no more than 3 percent leakage of total airflow in systems up to 750 Pa (3 inches WG). In systems from 751 Pa (3.1 inches WG) through 2500 Pa (10.0 inches WG) ducts shall be designed and constructed to limit leakage to 0.5 percent of the total air flow. Generally, ductwork shall be fabricated from galvanized sheet metal, in accordance with SMACNA guidelines.

All supply air ducts shall be externally insulated, in accordance with ASHRAE Standard 90.1. Supply air duct insulation shall have a vapor barrier jacket. Internal duct lining is not acceptable. Refer to *HVAC System Components, Insulation* section later in this chapter for detailed requirements.

Sound and Vibration. The baseline system shall include sound and vibration provisions that have given appropriate consideration to airborne equipment noise, equipment vibration, ductborne fan noise, duct breakout noise, air flow generated noise, duct borne crosstalk noise and structure borne vibration.

HVAC Controls and Instrumentation. A Direct Digital Control (DDC) system with host computer remote monitoring and control shall be considered as baseline. Minimum control and monitoring points for typical HVAC equipment as listed in Table 5-6 of this chapter shall be provided, along with all associated instrumentation. Refer to *Meters, Gauges, and Flow Measuring Devices* section later in this chapter for detailed requirements on instrumentation.

Building Automation System (BAS). A computer based BAS shall be provided as part of the baseline system. Refer to the BAS section later in this chapter for specific requirements.

5.4 Heating, Ventilating, and Air-Conditioning (HVAC)

General Parameters

HVAC system parameters are provided here for reference, but specific energy performance directives are also listed in CFR 10-435. Compliance with the latest versions of ASHRAE Standard 90.1 and ASHRAE Standard 62 is required for the elements of the project (architectural, mechanical, and electrical).

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-percent column dry-bulb temperature in the ASHRAE Fundamentals Volume. Summer design conditions shall be based on the 0.4-percent column dry-bulb temperature with its corresponding mean coincident wet-bulb temperature.

Indoor Design Temperatures and Relative Humidity. Indoor design temperatures and relative humidity requirements are stated in Table 5-1.

The following spaces 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. The air from these spaces must be exhausted directly to the outdoors at 100 percent.

Table 5-1
Indoor Design Conditions[3]

Type of Area	Summer DB[1]	Summer RH[2]	Winter[8] DB[1]	Winter RH[2]
General Office	24 (75)		22 (72)	30[12]
ADP Rooms[9]	22 (72)	45[4]	22 (72)	45[4]
Corridors	24 (75)		22 (72)	
Building Lobbies	24 (75)		22 (72)	
Toilets	24 (75)		22 (72)	
Locker Rooms	26 (78)		21 (70)	
Electrical Closets	26 (78)		13 (55)	
Tunnels, Bridges	24 (75)		22 (72)	
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)	30[12]

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.

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

* Intakes for roofs must be at least 0.2 m (8 inches) above the average maximum snow depth and consider the potential for drifts at the intake location. 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 that 0.2 m (8 inches) inside of the outside face of the intake grille, louver, or rain hood entry.

Indoor Air Quality

When a building is new, volatile compounds (VOC) can be released in large quantities from materials, such as adhesives, vinyl and carpets. A purge cycle of 100 percent outside air is recommended to run for several days prior to occupancy and at late evening/early morning to purge VOC build-up during the first weeks of occupancy.

GSA recognizes the importance of adequate ventilation to maintain indoor air quality. The outside air and 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 within 90% of required levels 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.

Dilution with outside air is the primary method of maintaining acceptable indoor air quality. The site shall be surveyed to determine if there are sources of contaminants that may be unacceptable for use indoors with respect to odor and sensory irritation. The location of outside air intakes must be carefully evaluated to avoid intake of outside pollutants, such as contamination by car and truck emissions or by other equipment, and short-circuiting of building exhaust. Outdoor intakes should be located with consideration of the distances listed in Table 5-2, except in consideration of air borne security where intakes shall be elevated to roof levels or well above pedestrian access.

Internal Heat Gain

Occupancy Levels. For office spaces, the average density of the *occupiable floor area* of a GSA building is one person per 9.3 square meters (100 square feet). Within areas occupied by work stations, the occupancy load can be as dense as one person per 7 square meters (75 square feet) in local areas. Block loads and room loads should be calculated accordingly. Sensible and latent loads per person should be based on the latest edition the ASHRAE *Handbook of Fundamentals*.

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

Equipment Densities. Internal heat gain from all appliances—electrical, gas, or steam—should be taken into account. When available, manufacturer provided heat gain and usage schedules should be utilized to determine the block and peak cooling loads. Typical rate of heat gain from selected office equipment should be based on the latest edition of the ASHRAE *Handbook of Fundamentals*. The cooling load estimated for the connected electrical load should be based on the electrical load analysis, and the minimum connected receptacle load outline in Chapter 6: *Electrical Engineering, Electrical Load Analysis*, and anticipated needs of GSA's Office of Chief Information officer.

Lighting Levels. For preliminary design loads, heat gain from lighting levels described in Chapter 6: *Electrical Engineering, Lighting, Interior Lighting, Illumination Levels* shall be used.

If a building program shows an office building with 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 will be occupied by closed offices at some point in the future. Internal heat gains shall be designed to adapt.

Acoustical Requirements

See Section *Vibration Isolation, Acoustical Isolation, and Seismic Design for Mechanical Spaces* of this chapter. Acoustical criteria for all building spaces are described in Chapter 3: *Architectural and Interior Design, Special Design Considerations, Acoustics*.

Zoning Criteria for HVAC Systems

Interior control zones must not exceed 180 m^2 (2000 square feet) per zone for open office areas or a maximum of three offices per zone for closed office areas. Corner offices shall be a dedicated zone. Perimeter zones shall be no more than 4.7 meters (15 feet) from an outside wall along a common exposure. Independent zones should be provided for spaces such as conference rooms, entrance lobbies, atria, kitchen areas, dining areas, child care centers and physical fitness areas.

If a building program shows that an office building will 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 will be occupied by closed offices at some point in the future. Zoning should be designed to adapt.

Separate systems shall be provided for buildings where perimeter zones have heating and/or cooling loads very different from interior zones.

Large air-handling units serving multiple floors for buildings with scattered loads after normal office hours is not acceptable to GSA. Multiple air-handlers or floor-by-floor systems shall be used. AHU's are not permitted for air delivery capacity greater than 12.1m^3/s (25,000 cfm). Courtrooms shall be provided with dedicated air-handling units, with each unit serving no more than two courtrooms. Separate piping loops and systems shall be used for off-hours systems.

The supply of zone cooling and heating shall be sequenced to prevent (or at the very least, minimize) the simultaneous operation of heating and cooling systems for the same zone. Supply air temperature reset control shall be utilized to extend economizer operations and to reduce the magnitude of reheating, recooling or mixing of supply air streams.

HVAC System Components

AHU's. Air supply temperatures (at the discharge of the cooling coil) shall not be below 11.7°C (53°F).

Coils. Individual finned tube coils should generally be between six and eight rows with at least 2.1 mm between fins (12 fins per inch) to ensure coil cleanability. Dehumidifying coils shall be selected for no more than negligible water droplet carryover beyond the drain pan at design conditions. Equipment and other obstructions in the air stream shall be located sufficiently downstream of the coil that it will not come in contact with the water droplet carryover. Cooling coils shall be selected at or below 2.5 m/s face velocity (500 fpm) to minimize moisture carryover. Heating coils shall be selected at or below 3.8 m/s face velocity (750 fpm).

Drains and Drain Pans. Drain pans located in supply air ducts, plenums, air-handling units, and fan coil units shall be 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 or greater than the design static pressure. Ultraviolet light (C band) emitters shall be incorporated downstream of all cooling coils and above all drain pans to control airborne and surface microbial growth and transfer.

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 should be provided in ventilation equipment, ductwork and plenums as required for in-situ inspection and cleaning. Equipment access doors or panels should be readily operable and sized to allow full access. Large central equipment shall be situated to facilitate its replacement.

In addition, adequate methods of access shall be included for items such as: chillers; boilers; heat exchangers; cooling towers; reheat coils; VAV boxes; pumps; hot water heaters; and all devices which have maintenance service requirements.

Access to elevated major equipment (such as AHU's, cooling towers, chillers, and boilers) must be by stairs, not by ladders.

Humidifiers, Air Washers, and Direct Evaporative Coolers. Make-up water for direct evaporation humidifiers, air washers, direct evaporative coolers, or other water spray systems shall originate directly from a potable source or from a source that has equal or better water quality with respect to both chemical and microbial contaminants. Humidifiers and water spray systems shall be designed so that microbiocidal chemicals or water treatment additives are not emitted in ventilation air unless they are registered for this application.

Insulation. All insulation materials 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 fire and smoke hazard ratings.

Materials used as internal insulation exposed to the air stream in ducts shall be in accordance with UL 181 or ASTM C 1071 erosion tests, and shall not promote or support the growth of fungi or bacteria, in accordance with UL 181 and ASTM G21 and G22. Internal duct lining shall only be used for courtroom return air transfer grilles, and only if required for acoustic purposes.

Insulation shall be provided on all cold surface mechanical systems, such as ductwork and piping, where condensation has the potential of forming and 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).

Sizing and Selection Standards for Equipment and Systems. Mechanical components for HVAC systems shall be sized and selected to satisfy the heating and cooling loads determined by the building thermal performance analysis and within the requirements provided in the latest version of ASHRAE Standard 90.1 and ASHRAE *HVAC Systems and Equipment Handbook.*

Special Mechanical Requirements for Building Spaces

Entrance Vestibules. Sufficient heating and cooling should be provided to offset the infiltration load of the space. The entrance vestibule should be positively pressurized relative to atmospheric pressure to minimize infiltration.

Mechanical Rooms. All mechanical rooms must be mechanically ventilated. Mechanical ventilation shall be sufficient to maintain room space conditions as indicated in Table 5-1. Water lines shall not be located above motor control centers or disconnect switches and shall comply with requirements of NEC 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.

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.

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 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 efficiently and economically. The operation of the kitchen exhaust systems should not effect the pressure relation between the kitchen and surrounding spaces.

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

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.

United States Courthouse, White Plains, NY

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 outdoors. Refer also to requirements of USMS Publication 64.

Firing Range. Special HVAC considerations will 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 participant 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 gun powder residue into the atmosphere. Discharge of firing range exhaust air to outdoors shall be carefully located to prevent recirculation into the outside air intake of any HVAC system. Firing ranges shall be capable of continuous, isolated from other building systems.

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 electric generating system and sufficient heating capacity to maintain space temperature of 21°C (70°F) with design winter outdoor temperature.

Electrical Equipment Rooms. No water lines are permitted in electrical rooms, except as associated with fire protection.

Communications Closets. Communications closets must be ventilated and cooled like offices. Communications closets shall meet the requirements of EIA/TIA Standard 569. Closets which house critical communications components shall be provided with dedicated air-conditioning systems which can operate on the emergency power circuit.

Elevator Machine Rooms. In climates where heating and/or cooling of the elevator machine room is required, ventilation louvers shall be equipped with motorized dampers (normally open) that close when the heating or cooling system is in operation and that open when the fire alarm is actuated. Cooling or heating must be provided to maintain room conditions required by equipment specifications, and in accordance with Table 5-1 of this chapter.

Emergency Generator Rooms. The environmental systems shall meet the requirements of NPPA 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 air supply and exhaust shall be located so air does not short circuit. Generator exhaust should 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 is least desired.

UPS Battery Rooms. Battery rooms must be equipped with eye wash, emergency showers and floor drains. 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 circuit. Fans shall be spark- resistant, explosion proof, with motor outside the air stream, ductwork to be negative pressure system of corrosion-resistant material, with exhaust directly to outdoors in a dedicated system.

Loading Docks. Outside air intakes must not be located near loading docks. The entrances and exits at loading docks and service entrances shall be provided with a positive means to reduce infiltration and outside debris.

24-Hour Spaces. Spaces that have requirements for environment condition maintenance at continuous times shall be supplied from independent systems. All areas designated for the housing of computer-based central processing of the Fire Alarm Monitor and Control System, the Security Monitor and Control Systems and the BAS shall be provided with HVAC systems to maintain temperature and humidity requirements at all times regardless of building occupancy.

Miscellaneous. Refer to Chapter 7: *Fire Protection Engineering*, for smoke control requirements.

Placing Mechanical Systems in Buildings

In order to achieve system flexibility and thorough integration between building architecture and engineering systems, **a concept for the distribution of mechanical systems must be established during the architectural schematic design**. The locations of vertical and horizontal mechanical elements should be established before the architectural concept is finalized. The structural design must be sufficiently developed in order to incorporate structural components' depth and width in the sizing of vertical and horizontal chases, to minimize the core drilling and sleeving of critical structural members, and to provide sufficient plenum height for the mechanical, plumbing, fire protection and electrical systems.

Planning Grid, Floor Grid, and Ceiling Grid. A common planning module is to be used. The relationship of this module to wall placement, ceiling grids, and location of mechanical and electrical elements is described in detail in Chapter 3: *Architectural and Interior Design, Building Planning, Planning Module, Floor-to-Floor Heights and Vertical Building Zoning* and *Space Planning, Office Space, Floor and Ceiling Grids*. Mechanical elements on floors and in ceilings—equipment, air diffusers, air distribution ducts and branch sprinkler piping—are given measurable locations. Supply air devices for perimeter zones shall be located within 1.5 meters (5 feet) of the outside wall.

Horizontal Distribution of HVAC Elements. Ceiling diffusers shall be located within the ceiling framing. If slot diffusers are used, as in integrated architectural ceilings, they can be placed on the grid line. Experience has shown that a staggered diffuser layout in a uniform pattern adapts most easily to future changes in wall configurations.

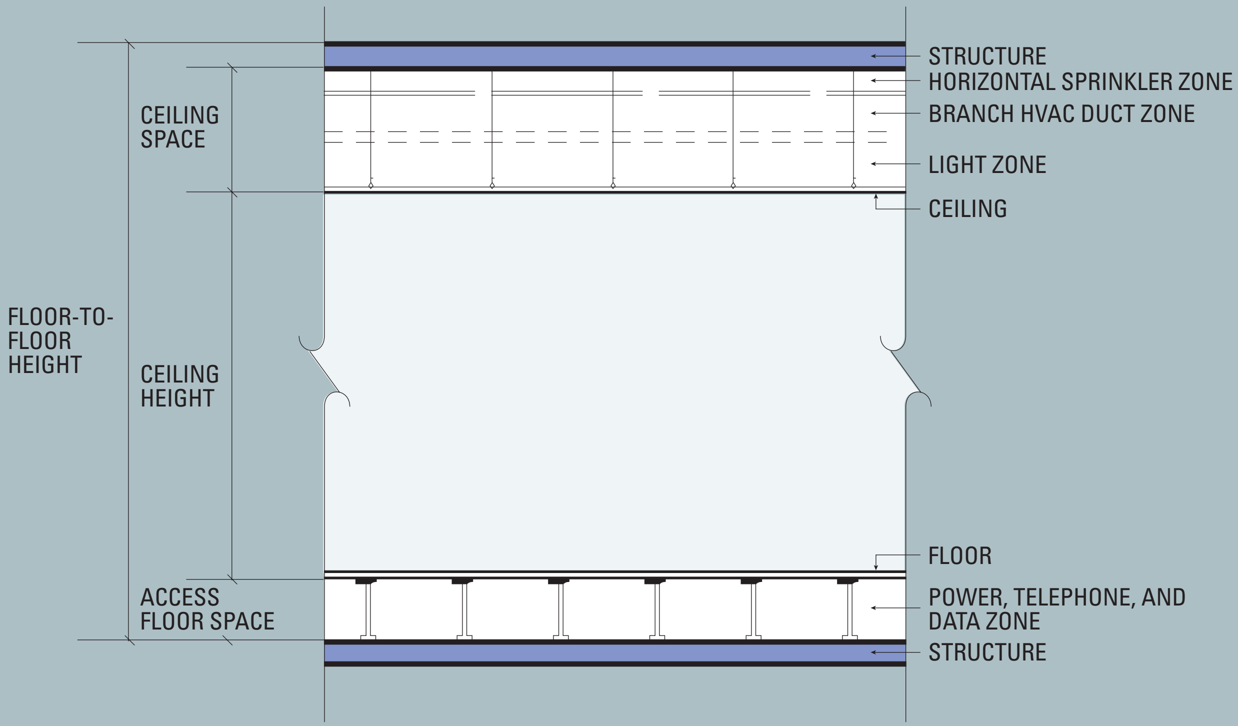
Vertical Zoning of Ceiling Plenum Space. The ceiling plenum must be laid out to provide distinct zones for the placement of different utilities (see Figure 5-1). The depth of the ceiling plenum and floor space must be determined early in the design, in order to arrive at the necessary floor-to-floor height of the building.

To the maximum extent possible, each mechanical system shall be given a distinct horizontal layer in the available ceiling plenum space. As practical, the systems should be routed within these designated zones. Adherence to the horizontal layering system will aid in the coordination between trades in the field and to accommodate future modifications to systems without moving other components. The pressured piping systems, domestic water supply and the sprinkler piping should be located in the highest zone, 150 mm to 200 mm (first 6 to 8 inches), near the underside of the structure, or possibly through it if steel joists are used. The lighting systems should be provided with a zone, 200 mm to 255 mm (8 to 10 inches), immediately above the ceiling level. The HVAC ductwork (supply, return and exhaust) should be layered in a middle zone below the pressure piping zone and above the lighting zone. Gravity systems, sanitary and storm drainage must be coordinated with all three zones so they maintain the proper slope. Power and systems conduit and cable trays also need to be coordinated with all three zones. Hydronic systems shall not be located above power and cable trays and adequate space must be provided to allow access. All piping and ductwork shall be kept out of spaces above electrical rooms, and limited above elevator equipment rooms. Enough space must be left between the HVAC and lighting zones, 150 mm (6 inches), to accommodate future lighting moves and changes without moving other components.

Horizontal routing of major HVAC and plumbing systems shall be kept above the corridors and open spaces. The design and layout of mechanical systems should minimize the maintenance requirements of all items located above private offices, lobbies, conference rooms and ornamental ceilings. As practical, terminal air devices, fan coils, and valves should be located above accessible ceilings and in service areas, such as janitors closets and storage areas. If valves for piping systems and balancing dampers for ducted systems cannot be avoided above inaccessible ceilings, ceiling access panels must be provided at each location.

Routing of ductwork and piping outside of the building exposed to the weather shall be kept to an absolute minimum. Refer to Arrangement of Mechanical Spaces, Roof-Mounted Equipment section of this chapter for additional requirements.

Figure 5-1 Vertical Zoning of Floor-to-Floor Height



Vertical Distribution. Risers for ducts and hydronic piping shall be combined with other core elements to form compact groups and maximize usable floor space. Wet columns (domestic cold water, waste and vent) should be placed in each core and distributed in general office space at a maximum distance of 36 m (120 feet) on center. Ductwork and plumbing piping shall be run in separate chases.

Valves and piping placed in the exterior wall shall be located on the conditioned side of insulation and vapor barrier. Extended runs should be avoided in unheated garage space (except in southern climates).

Gas piping shall not be placed in unventilated spaces, such as trenches or unventilated shafts, where leaking gas could accumulate and explode.

5.5 Arrangement of Mechanical Spaces

Minimum Space Requirements. A minimum of 2 percent the typical floor's gross floor area shall be provided on each floor for air-handling plant. A minimum of 3 percent the typical floor's gross floor area shall be provided for the central heating and cooling plant (location to be agreed). A minimum of the 1.5 percent of the typical floor's gross floor area shall be provided for the cooling system's water-cooled heat rejection equipment (location to be agreed).

Vertical Clearances. Mechanical equipment rooms generally shall have clear ceiling heights of not less than 3.6 m (12 feet). Catwalks shall be provided for all equipment that cannot be maintained from floor level. Where maintenance requires the lifting of heavy parts (90 kg (200 pounds) 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 600 mm (2 feet). Air-handling units require a minimum clearance of 750 mm (2 feet 6 inches) on all sides, except the side where filters and coils are accessed. The clearance on that side should equal the length of the coils plus 600 mm (2 feet). Arrangement of large (over 400 mm (4 feet)) or heavy (over 20 kg (50 lbs.)) equipment shall allow access by cranes or include hoists for repair and maintenance.

Roof-Mounted Equipment. All equipment that is installed above grade, either on a roof or mechanical room, shall be provided with adequate access to the equipment for routine maintenance. Access to above-grade equipment shall be by a permanent means, such as an elevator cab stop, stairway, or ladder. Stairway and ladder access shall be provided with a landing at any access hatchway. All rooftop equipment, except for cooling towers and exhaust fans manufactured for outdoor services, shall be located inside the building or in a penthouse enclosure and protected from the weather to insure that equipment can be properly maintained in inclement weather. Roof access shall be by stair, having approximately 11-inch by 7-inch high treads, not by ladder or steep stairs.

Lighting. Lighting in equipment rooms shall be arranged so as not to interfere with equipment.

Housekeeping Pads. Housekeeping pads shall be at least 75 mm (3 inches) larger than the mounted equipment on all sides and a minimum of 100 mm (4 inches) thick.

Piping. Piping shall be arranged in an orderly fashion, parallel to building lines wherever possible. Access to the underside of the structure should not be completely blocked.

Ductwork. Ductwork shall be arranged with a minimum of bends. Access to piping and the underside of the structure should not be obstructed.

5.6 Heating Systems

College Park, MD

Steam Heating

District steam heating, if available, shall be used for heating if determined to be economical and reliable through a life cycle cost analysis. If steam is furnished to the building, such as under a district heating plan, it should be converted to hot water with a heat exchanger 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.

Hot Water Heating Systems

GSA prefers low-temperature hot-water heating systems; 205 kPa (30 psi) working pressure and maximum temperature limitation of 120°C (200°F). 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*.

Water Treatment. See section *Cooling Systems, Chilled Water Systems, Water Treatment* of this chapter.

Temperature and Pressure Drop. Supply temperatures and the corresponding temperature drops for space heating hot water systems must be set to best suite the equipment being served. Total system temperature drop should not exceed 22°C (40°F). Design water velocity in piping should not exceed 2.5 meters per second (8 feet per second) or design pressure friction loss in piping systems should not exceed 0.4 kPa per meter (4 feet per 100 feet), whichever is larger.

Pump and Piping Systems. The baseline system shall utilize parallel piping systems with a two-pipe main distribution system arranged in a reverse return configuration. Series loop piping for terminal or branch circuits of commercial or institutional systems shall be equipped with automatic flow control valves at terminal units (all types of heat transfer units). Reverse return is considered baseline because it provides the best overall control and maintenance of a balanced system as the system is modified. 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 branches, such as at each floor level, building wing or mechanical room.

Each boiler shall be provided with a control and piping arrangement, which protects the boiler from thermal shock. A primary-secondary piping arrangement with a modulating mixing control valve and higher primary flow rate will assure that the boiler return water temperature does not drop too low, as commonly occurs with night setback. Hydronic hot water space heating pumps should generally be selected to operate at 1750 RPM. Variable volume pumping systems should be considered for all secondary piping systems with pump horsepower greater than 10 kW (15 HP).

Refer also to provisions in *Piping Systems* in this chapter.

Pressurized diaphragm expansion tanks shall be used when available 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.

Freeze Protection. Propylene or ethylene glycol manufactured specifically for HVAC systems shall be used to protect hot water systems from freezing, where extensive runs of piping are exposed to weather, where heating operations are intermittent or where coils are exposed to large volumes of outside air. 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 should 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.

Boilers and Heat Exchangers

Boilers. Boilers for hydronic hot water heating applications shall be 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, with all three units having sufficient combined capacity to satisfy 120 percent of the total peak load of heating and humidification requirements. For southern climates, a minimum of two equally sized units at 67 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 outside air reset, shall be utilized to maximum efficiency and performance.

Boiler gas trains shall be in accordance with International Risk Insurance (IRI) standards.

Gas valve actuators shall not contain NaK (sodium-potassium) elements since these pose a danger to maintenance personnel.

Individual boilers with ratings higher than 29 MW (100 million Btu/hour) or boiler plants with ratings higher than 75 MW (250 million Btu/hour) are subject to review by the Environmental Protection Agency. GSA will coordinate this review.

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.

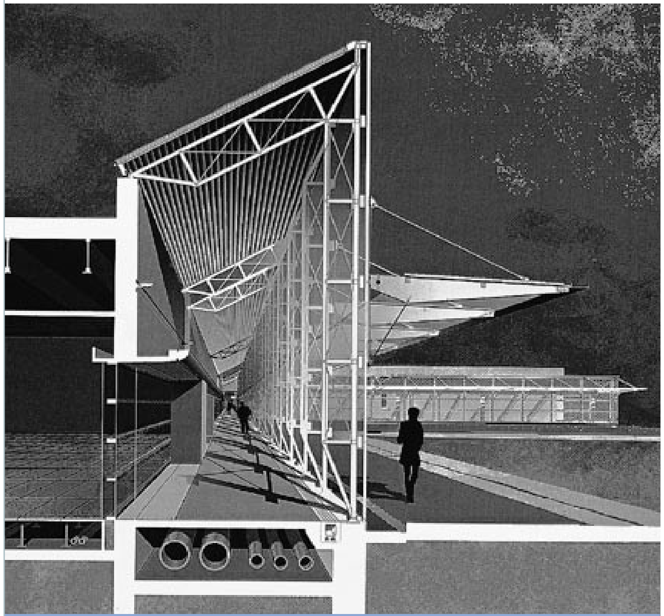
Heat Exchangers. Steam-to-water heat exchangers shall be used in situations where district steam is supplied and a hot water space and domestic hot water heating system have been selected. In high rise buildings, it may be an advantage to create zones by distributing steam vertically and installing several heat exchangers, each serving a number of floors. Double-wall heat exchangers shall be used in domestic hot water heating applications.

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.

5.7 Cooling Systems



U.S. Census Bureau

Chilled Water Systems

Chilled water systems include chillers, chilled water and condenser water pumps, cooling towers, piping and piping specialties.

The chilled water systems shall have a 7°C (12°F) temperature differential, with a design supply water temperature between 4°C and 7°C (40°F and 44°F). In climates with low relative humidity, an 8°C (14°F) differential may be used.

District chilled water, if available, shall be used for cooling only if determined to be economical and reliable through a life cycle cost analysis.

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) should be analyzed. Likewise, the feasibility of gas-engine driven chillers and absorption chillers should be considered.

Microprocessor-based controls shall be used. 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.

Chilled water machines shall be installed in a common mechanical room area. When the peak cooling load is 1760 kw (500 tons) or more, a minimum of three equally sized units shall be provided with all three units having sufficient combined capacity to satisfy 120 percent of the total peak cooling load. 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.

Chillers shall be piped to a common chilled water header with provisions to sequence chillers 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 chiller systems shall be provided with expansion tanks, heat exchangers, water treatment and air separators, as required.

Chiller condenser bundles shall be equipped with automatic reversing brush-type tube cleaning systems.

Chiller condenser piping shall be equipped with recirculation/bypass valves to maintain incoming condenser water temperature within chiller manufacturer's minimum when outdoor conditions are favorable.

Chiller shall be equipped with base and piping vibration isolation.

Part load efficiency must be considered in the operating features of the design. Specified efficiencies shall be as listed in ARI's application part load value increments to match expected site performance. Refer to ARI Standard 550/590.

Environmental Protection. 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.*

No chlorofluorocarbon (CFC) refrigerants are permitted in new chillers. Acceptable non-CFC refrigerants are listed in EPA regulations implementing Section 612 (Significant New Alternatives Policy (SNAP)) of the Clean Air Act, Title VI: *Stratospheric Ozone Protection*. Note: GSA accepts this criteria in documenting certification of LEED ratings.

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.

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.

Chilled Water and Condenser Water Pumps. Pumps shall be 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 separate pump shall be designed for each condenser water circuit. Variable volume pumping systems should be considered for all secondary piping systems with pump horsepower greater than 10 kW (15 HP). The specified pump motors shall not overload the entire range of the pump curve.

Piping. In general, HVAC systems shall utilize parallel piping systems with a two-pipe main distribution system arranged in a reverse return configuration. If applied, series loop piping for terminal or branch circuits of commercial or institutional systems shall be equipped with automatic flow control valves at terminal units (all types of heat transfer units).

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 branches, such as at each floor level, building wing or mechanical room.

For new chilled water HVAC distribution, a pumping and piping arrangement is generally appropriate, with constant volume primary pumping and variable volume secondary pumping. The primary and secondary circuits shall be separate, with neither having an effect on the pumping head of the other. The primary circuit serves the source equipment (chillers), while the secondary circuit serves the load. Refer also to Pumping Systems in this chapter for additional requirements.

Freeze Protection. Propylene or ethylene glycol manufactured specifically for HVAC Systems is used for freeze protection, primarily in low temperature chilled water systems (less than 4°C) (less than 40°F). The concentration of antifreeze should 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 which have outside 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.

Condenser Water. All water-cooled condensing units must be connected to a recirculating heat-rejecting loop.

Water Treatment. The water treatment for all hydronic 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 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*.

Cooling Towers. Refer to *HVAC, General Parameters, Outdoor Design Criteria* of this chapter for the conditions on which the cooling tower sizes should be based. 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. Cooling towers shall have ladders and platforms for ease of inspections and replacement of components.

Induced draft cooling towers with multiple-speed or variable speed condenser fan controls shall be considered baseline. 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 readily 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 44 m/s (100 MPH) wind design load. Cooling towers shall be constructed of corrosion-resistant materials (stainless steel, fiberglass and PVC) particularly in coastal areas, and for tower components that are typically wet in the normal operation of the tower. If the cooling tower is located on the building structure, vibration and sound isolation must be provided. Cooling towers shall be elevated to maintain a 4-foot minimum clear space beneath the bottom of the lowest structural member, piping or sump, to allow reroofing beneath the tower.

To improve system efficiency, the sequence of operations controlling the cooling tower leaving water temperature should be designed to provide the coldest condenser water that the chillers are designed to handle. Special consideration should be given to deicing cooling towers' fill 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.

Criteria for cooling towers shall also apply to dry fluid coolers.

See Chapter 7: *Fire Protection Engineering*, for fire protection provisions for cooling towers.

Special Cooling Applications

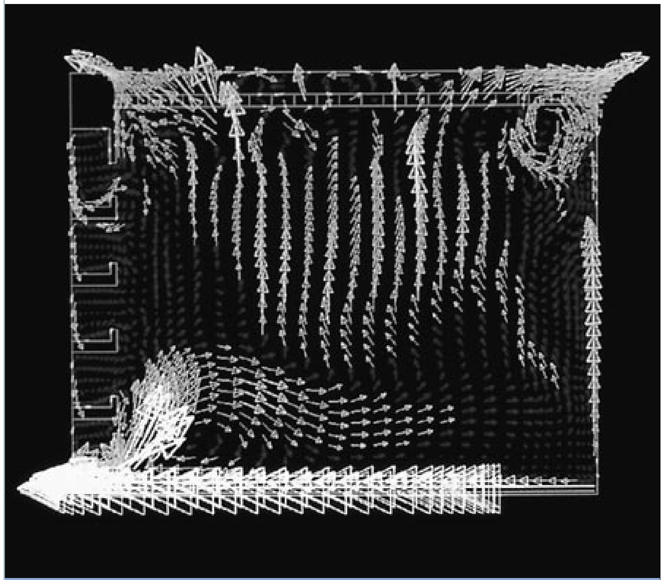
Water-Side Economizer Cycle. In certain climate conditions cooling towers are capable of producing condenser water cold enough to cool the chilled water system without chiller operation. This option shall be considered in life cycle cost comparisons of water cooled chillers. Water-side economizer cycles are particularly cost effective in the low humidity climates of the western United States. In the eastern United States, air-side economizer cycles tend to produce lower operating costs. See section *Air Distribution Systems, Air-Handling Units, Air-Side Economizer Cycle* of this chapter.

Computer Room Air-Conditioning Units. Mainframe computer rooms shall be cooled by self-contained units for loads up to 280 kW (80 tons). These units are 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 280 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 24-hour cooling needs of a computer room should be identified in the *HVAC, HVAC System Components, Sizing and Selection Standards for Equipment and Systems* section of this chapter. 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.

For ventilation, air-handling, and humidification requirements of computer rooms, see section *Air Distribution Systems, Air-Handling Units, Computer Room Air-Handling* of this chapter. The room temperature conditions shown in Table 5-1 provide a higher available temperature for reduced fan power consumption and easier winter humidification. See section *HVAC Design Criteria, Indoor Design Temperatures and Relative Humidity* of this chapter. Verify with users to determine if the air- conditioning system must be connected to emergency power system. These systems should 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.

5.8 Ventilation and Air Distribution



Air Flow Diagram, Atrium, Phoenix Courthouse

Pressurization. Except where natural ventilation is provided as a control strategy, buildings shall be designed to assure a positive pressure with respect to the outdoor environment. The central HVAC systems shall have an active means of measuring and maintaining this positive pressure relationship. The BAS shall alarm when the building pressurization drops below a 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 outside air flow rate required for pressurization. Minimum outside air flow rates shall be adjusted as necessary to assure building pressurization.

Building pressurization shall not be considered to have any effect on envelope heat transfer loads associated with air infiltration.

Special Ventilation Requirements

Toilets. Toilet areas must have segregated exhausts and should be negative in pressure relative to surrounding spaces.

Janitor/Housekeeping Closets. Janitor/Housekeeping closets must have segregated exhausts and should be negative in pressure to surrounding spaces.

Food Service Areas. Kitchen areas shall be negative in pressure relative to adjacent dining rooms, serving areas and corridors. Tempered make-up air shall be introduced at the kitchen hood and/or the area adjacent to the kitchen hood for at least 80 percent of exhaust air. Duct air velocity in the grease hood exhaust shall be no less than 7.5 to 9 m/s (1,500 to 1,800 FPM) to hold particulate in suspension. Dishwashing areas must be under negative pressure relative to the kitchen, and dishwashers shall be provided with their own exhaust hoods and duct systems, constructed of corrosion resistant material.

High Occupancy Areas. High occupancy areas, which also have largely variable occupancies, such as conference rooms, lecture theatres, etc., and are served by dedicated ventilation and air-handling systems, shall incorporate a demand controlled ventilation (DCV) system to minimize energy consumption, while maintaining appropriate levels of ventilation. The DCV system devices shall be located for ease of maintenance and shall provide appropriate operation of the ventilation system it is controlling.

5.9 Air Distribution Systems

Variable Air Volume (VAV) Systems

The baseline air-handling system is a simple VAV system providing cooling only. Any heating requirement (except freeze protection) shall be handled by a separate, dedicated perimeter system. The VAV supply fan shall be designed for the largest block load, not the sum of the individual peaks.

Perimeter Zones. The baseline system utilizes a dedicated hydronic heating system with convectors to offset heat losses through the building envelope in perimeter zones.

Volume Control. Particular attention shall be given to the volume control. VAV systems depend on air volume modulation to maintain the required ventilation rates and temperature set points, which makes terminal air volume control devices critical to the successful operation of the system and shall be provided. 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. Also, the minimum volume setting should equal the larger of the following:

(1) 30 percent of the peak supply volume;
(2) 0.002 m^3/s per m2 (0.4 cfm/ft2) of conditioned zone area; or
(3) minimum m^3/s (cfm) to satisfy ASHRAE Standard 62 ventilation requirements. VAV terminal units must never be shut down to zero when the system is operating. Outside air requirements shall be maintained in accordance with the Multiple Spaces Method, equation 6-1 of ASHRAE Standard 62 at all supply airflow conditions.

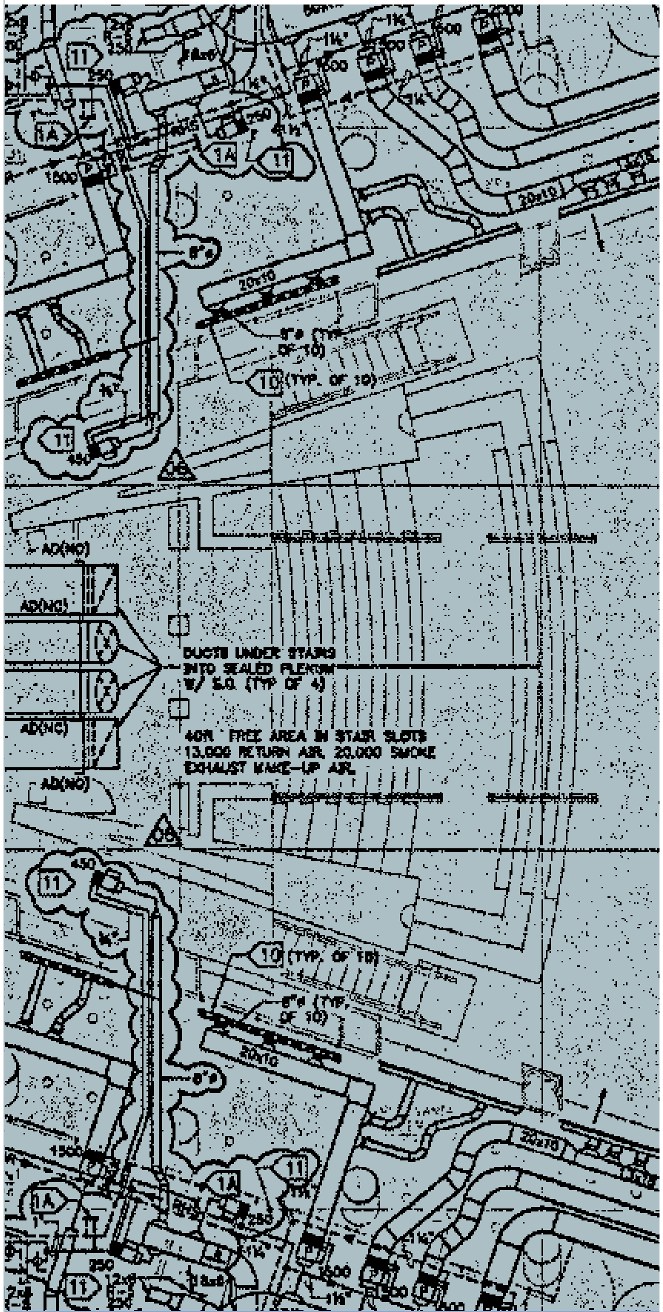
Terminals. VAV terminals shall be pressure-independent type units. Pressure-independent terminal units are more forgiving during the initial start up and testing of the HVAC system and modifications made to the system in the future.

VAV Box Description. 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. Terminals shall be shipped as complete assemblies requiring no field assembly.

All electrical components shall be UL listed and installed in accordance with the requirements of the National Electrical Code.

The terminal casing shall be minimum 22 gauge galvanized steel (20 gauge for fan-powered terminals), internally lined with non-porous, sealed liner which complies with UL 181 and NFPA 255. Insulation shall be 0.7 kg (1.5 lb.) density. Exposed insulation shall be non-fibrous or fiberglass insulation and shall be sealed from the airstream with a foil reinforced liner or solid metal lining.

Damper assemblies shall be heavy gauge steel with shaft rotating in self-lubricating bearings. Nylon bearings are not acceptable. Shafts shall be clearly marked on the end to indicate damper position (removable markings not acceptable). The damper shall incorporate a mechanical stop to prevent overstroking, and a synthetic seal to limit close-off leakage. Actuators shall be externally mounted for service access.



The Federal Triangle Building, Washington, D.C.

For fan-powered terminals the fan shall be constructed of steel and have a forward curved, dynamically balance wheel with direct drive motor. The motor shall be of energy efficient design with integral thermal overload protection and permanently lubricated bearings. Fan assembly shall include an anti-backward rotation device and isolation between motor and fan housing.

Fan-powered terminals shall utilize speed control to allow for continuous fan speed from maximum to minimum, as a means of setting the fan airflow. The speed control shall incorporate a minimum voltage stop to ensure the motor cannot operate in stall mode.

All terminals shall be provided with factory-mounted direct digital controls compatible and suitable for operation with the BAS.

Air Delivery Devices. Terminal ceiling diffusers or booted-plenum slots should be specifically designed for VAV air distribution. Booted plenum slots should not exceed 1.2 meters (4 feet) in length unless more than one source of supply is provided. “Dumping” action at reduced air volume and sound power levels at maximum m^3/s (cfm) delivery should be minimized. For VAV systems, the diffuser spacing selection should 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 should consider the excepted 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, good air mixing, and no objectionable drafts in the occupied space, typically 150 mm (6 inch) to 1830 mm (6 feet) 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.

Noise Control in VAV Systems. System sound levels need to be checked at maximum flow. Inlet guide vanes should be evaluated for noise in their most restricted position. Duct noise control should be achieved by controlling air velocity, by the use of sound attenuators, by the use of acoustically lined ductwork (only on courtroom return air transfer grilles) and by not oversizing terminal units. Terminal units should be selected so that design air volume is approximately three-quarters of the terminal box's maximum capacity. Volume dampers in terminal units should be located at least 1.8 m (6 feet) from the closest diffuser and the use of grille mounted balance dampers should be restricted except for those applications with accessibility problems.

Table 5-3 shows recommended low pressure duct velocities downstream from the VAV terminal unit based on noise generation as the controlling factor.

Table 5-3
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)

Air-Handling Units

Air-handling units shall be sized not to exceed 12.1 m^3/s (25,000 cfm) per air-handling unit. Casings and coils of air-handling units shall be sized so that the volume capacity can be increased in the future by 10 percent by replacing the fan. Speed control shall be achieved via variable speed drives.

Filtration. 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. Pre-filters shall be 30 percent to 35 percent efficient. Final filters should be 80 percent to 85 percent efficient for particles at 3 microns. Filter racks shall be designed to minimize the bypass of air around the filter media with a maximum bypass leakage of 0.5 percent.

Filters shall be sized at 2.5 m/s (500 FPM) maximum. Filter media shall be fabricated so that fibrous shedding does not exceed levels prescribed by ASHRAE 52. 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 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.

Humidification. 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 25 percent. Where humidification is necessary, atomized hot water, steam or ultrasound may be used and shall be generated by electronic or steam-to-steam generators. General heating boiler steam shall not be used for humidification. Where summer steam is required for humidification or sterilization, a separate summer steam generator shall be provided and sized for the summer load. Humidifiers shall be centered on the air stream to prevent stratification of the moist air. Where humidification is provided, vapor barriers shall be provided and the surface temperatures of walls and windows must be shown to not be lower than the dew point.

Supply and Return Air Fans. Vane-axial fans are efficient but are more costly than centrifugal fans. Centrifugal double-width double-inlet forward curved and airfoil fans are particularly popular for VAV systems. All fans shall bear the AMCA seal and performance shall be based on tests made in accordance with AMCA Standard 210.

Fans should be selected on the basis of horsepower as well as sound power level ratings at full load and at part load conditions. Since fan sound power level increases as an exponent of static pressure, it is essential that the total system static pressure be kept small.

Fan motors shall be sized so they do not run at overload anywhere on their operation curve. Fan operating characteristics must be checked for the entire range of flow conditions, particularly for forward curved fans. The fan and fan motor shall be internally mounted and isolated on a full-width isolator support frame using isolation springs. The fan discharge shall be connected to the fan using a flexible connection to insure vibration-free operation. Fan drives shall be selected for a 1.5 service factor and fan shafts should be selected to operate below the first critical speed. Thrust arresters should be designed for horizontal discharge fans operating at high static pressure.

Air-Side Economizer Cycle. An air-side economizer cycle reduces cooling costs when outdoor air temperatures are below a preset high temperature limit, usually 15 to 21°C (60°F to 70°F), depending on the humidity of the outside air.

During the life cycle cost analysis, the feasibility of either air- or water-side economizers shall be evaluated for facilities that would otherwise need mechanical refrigeration in cool weather. For water-side economizers see the *Cooling Systems, Special Cooling Applications* section of this chapter.

Enthalpy economizer controls are not recommended because they drift out of calibration easily and may cause energy use to increase. Economizer cycles can be used for humidified spaces, but because of the increased difficulty of maintaining space humidification and control, selection of humidification equipment must be evaluated to minimize operating costs.

If economizer cycles are used in conjunction with heat reclaim chillers, care must be taken in the controls design to avoid having one concept defeat the other. If an economizer cycle is used with the cold deck of a dual duct system, temperature set points may need to be adjusted downward.

Computer Room Air-Handling. In large computer installations (areas of 500 m^2 (5,000 ft^2)) it is recommended to segregate cooling of the sensible load

Table 5-4
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

(computer load) and control of the outside 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 outside 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.

Ductwork

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*.

Energy consumption, security and sound attenuation shall be major considerations in the routing, sizing and material selection for the air distribution ductwork.

Supply and Return Ductwork

Ductwork Pressure. Table 5-4 gives recommended maximum air velocities for ductwork up to 750 Pa (3 inches WG) and minimum velocities for ductwork of pressure ratings above 750 Pa (3 inches WG). 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 should 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 medium pressure classification as a minimum. Secondary air ductwork (runouts/branches from mains to terminal boxes and distribution devices) shall be low pressure classification as a minimum.

Pressure loss in ductwork shall be minimized. 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 m/s (2000 FPM).

Supply and return air ducts shall be designed and constructed to allow no more than 3 percent leakage of total airflow in systems up to 750 Pa (3 inches WG). In systems from 751 Pa (3.1 inches WG) through 2500 Pa (10.0 inches WG) ducts shall be designed and constructed to limit leakage to 0.5 percent of the total air flow.

Sizing of Ductwork. Supply and return ductwork shall be sized using the equal friction method. 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 shall be increased for revisions in future. Air flow diversity shall also be a sizing criterion. Full diversity can be taken at the air-handling unit and decreased the farther the ductwork is from the source until no air flow diversity is taken into account for the final portion of the system.

Ductwork Construction. Generally, ductwork shall be fabricated from galvanized sheet metal. 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. Generally, flex duct runs should not exceed 3 m (10 feet) nor contain more than two bends.

Joint sealing tape for all connections shall be of reinforced fiberglass backed material with field applied mastic. Pressure sensitive tape should not be used as the primary sealant.

Insulation. The insulation shall comply with 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 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.

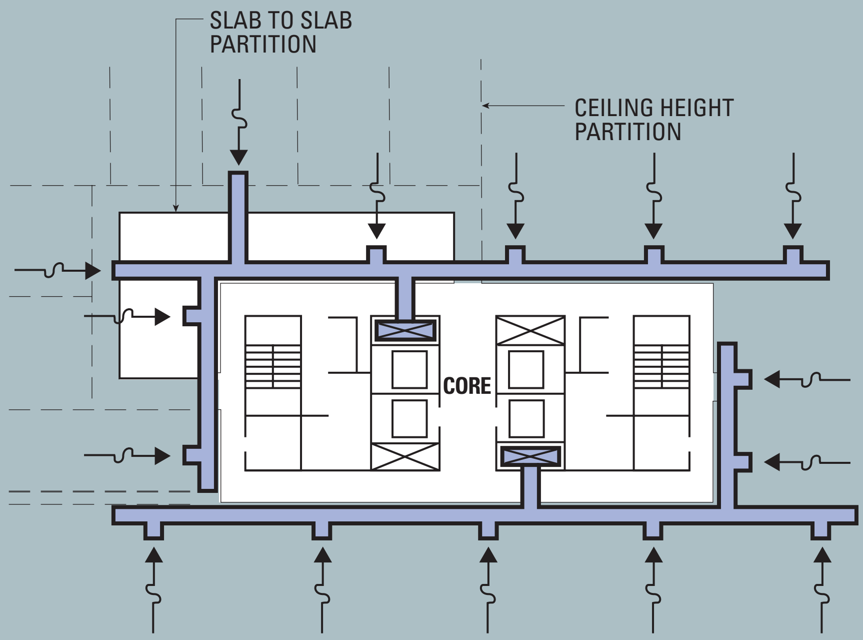
Return air and exhaust air distribution systems shall be insulated in accordance with ASHRAE Standard 90.1. The insulation of return air and exhaust air distribution systems need to be evaluated for each project and for each system to guard against condensation formation and heat gain/loss on a recirculating 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.

Internal duct lining shall only be used on courtroom return air transfer grilles.

Ceiling Plenum Supply. Ceiling plenum supply does not permit adequate control of supply air and shall not be used.

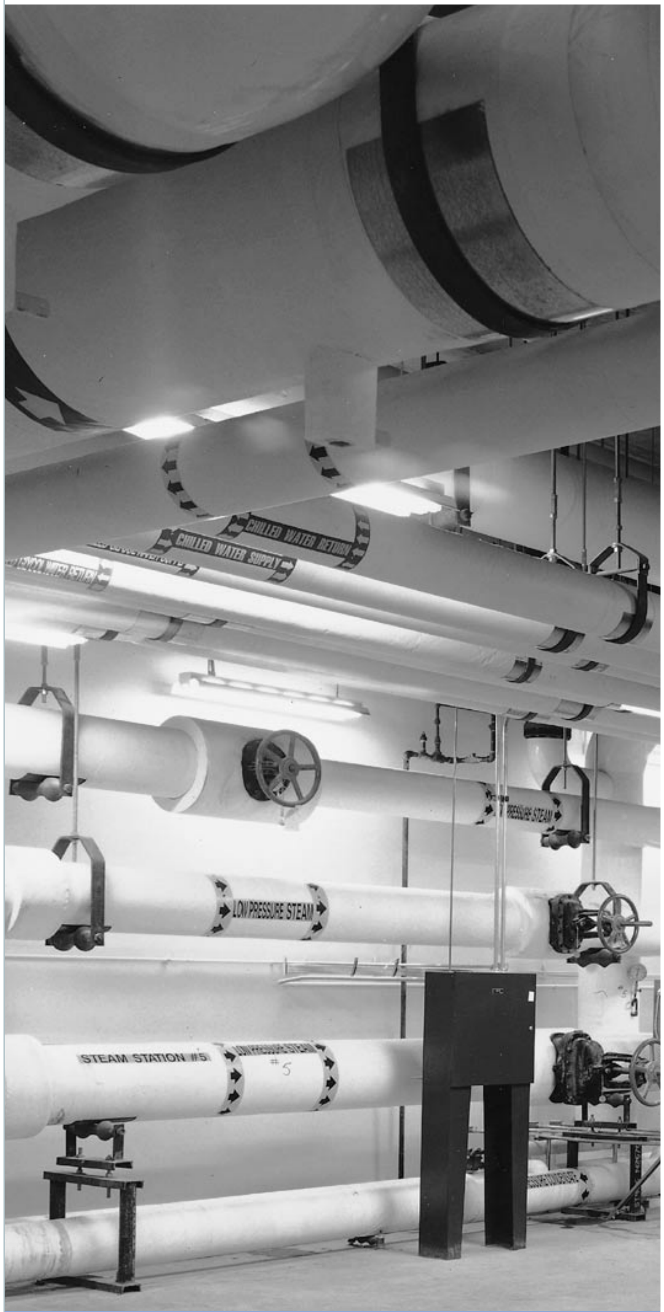
Raised Floor Plenum Supply. In computer rooms, underfoor plenum supplies are appropriate. As a general application in other areas (e.g. open offices), underfloor air distribution systems are appropriate. Where raised floor plenums are used for supply air distribution, the plenums shall be properly sealed to minimize leakage.

Figure 5-2 Ceiling Return Plenum with Minimal Return Ductwork



Plenum and Ducted Returns. 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 46 m (150 feet). No more than 2.3 m^3/s (5,000 cfm) should be collected at any one return grille. Figure 5-2 illustrates an example of an open ceiling plenum with a minimal amount of return air ductwork. All central multi-floor-type return air risers must be ducted.

Other, less flexible building spaces, such as permanent 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.



College Park, Maryland chilled water supply and return

5.10 Plumbing Systems

Water conservation shall be a requirement of all plumbing systems. Water saving plumbing fixtures are essential in this goal.

Domestic Water Supply Systems

Cold Water Service. Cold water service shall consist of a pressurized piping distribution system incorporating a separate supply line from the tap in the existing outside water main to the equipment area inside the building.

Water service shall be metered inside the building by meters furnished by the local department of public works. Remote reading of meters will be accomplished by special equipment over telephone lines. Irrigation systems must be sub-metered for deduct billing of the sewer system.

Internal distribution will consist of a piping system which will supply domestic cold water to all necessary plumbing fixtures, water heaters and all mechanical make-up water needs.

Distribution system shall include equipment that will maintain adequate pressure and flow in all parts of the system in accordance with GSA Facility Standards.

Hot Water Service. Hot water will be generated by heaters utilizing natural gas, electricity or steam as an 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.

Distribution system will consist of a piping system, which connects water heater or heaters to all plumbing fixtures as required. Circulation systems or temperature maintenance systems shall be included. Hot water shall be available at the fixture within 15 seconds of the time of operation.

Domestic Water Supply Equipment. Domestic water supply equipment shall include, but not be limited to the following equipment:

- Water heaters,
- Pressure booster systems,
- Pressure regulating valves,
- Circulating pumps,
- Backflow preventers,
- Balancing valves,
- Isolation valves,
- Hangers and supports, and
- Thermal insulation.

Sanitary Waste and Vent System

Waste Pipe and Fittings. A complete sanitary collection system shall be provided for all plumbing fixtures, floor drains and kitchen equipment designed in compliance with applicable codes and standards.

Piping shall be cast iron soil pipe with hub and spigot joints and fittings. Above ground piping may have no-hub joints and fittings.

Vent Piping and Fittings. System shall be the same as the waste piping above.

Floor Drains. Floor drains shall be provided in multi-toilet fixture restrooms, kitchen areas, mechanical equipment rooms, locations where condensate from equipment collects, and parking garages and ramps. Single fixture toilet rooms do not require floor drains.

In general, floor drains will be cast iron body type with 6 inch diameter nickel-bronze strainers for public toilets, kitchen areas and other public areas. Equipment room areas will require large diameter cast iron strainers and parking garages will require large diameter tractor grates. Drainage for ramps will require either trench drains or roadway inlets when exposed to rainfall. Trap primers shall be provided for all floor drains where drainage is not routinely expected from spillage, cleaning, or rainwater.

Sanitary Waste Equipment. Specific drains in kitchen areas shall discharge into a grease interceptor before connecting into the sanitary sewer. Coordination with the State health department and local authorities will determine which drains.

Floor drains and/or trench drains in garage locations are to discharge into sand/oil interceptors.

Automatic Sewage Ejectors. Sewage ejectors should only be used where gravity drainage is not possible. If they are required, only the lowest floors of the building should be connected to the sewage ejector; fixtures on upper floors should use gravity flow to the public sewer.

Sewage ejectors shall be non-clog, screenless duplex pumps, with each discharge not less than 100 mm (4 inches) in diameter. They shall be connected to the emergency power system.

Thermal Pipe Insulation. 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 condensate 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.

Rainwater Drainage System

Pipe and Fittings. Piping system shall be in compliance with local codes and sized upon local rainfall intensity.

Roof Drains. Roof drains shall be cast iron body type with high dome grates and membrane clamping rings, manufactured by any of the major foundries.

Each roof drain shall have a separate overflow drain located adjacent to it. Overflow drains will be the same drain as the roof drains except that a damming weir extension will be included.

Rainwater Drainage Equipment. Foundations drainage system with perforated drain tile collecting into a sump containing a pumping system as required by the applicable codes shall be provided.

Thermal Pipe Insulation. All piping exposed in plenums or above ceiling shall be insulated to prevent condensation from developing. All insulation materials and accessories shall comply with the fire and smoke hazard ratings indicated by ASTM-E84, NFPA 255 and UL 723.

Plumbing Fixtures

General. Provide all required plumbing fixtures including those that are indicated in the U.S. Courts Design Guides and all penal types. Fixtures shall be as manufactured by reputable companies who have a history of manufacturing. The number, type and style shall be approved by General Service Administration or their representatives.

Natural Gas Systems

Service Entrance. Gas piping entering the building must be protected from accidental damage by vehicles, foundation settlement or vibration. Where practical, the entrance should be above grade and provided with a self-tightening swing joint prior to entering the building.

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 and generators, shall be mechanically ventilated. Vertical shafts carrying gas piping shall be ventilated at top and bottom to prevent leaked gas from accumulating. Gas meters shall be located outside the building, avoiding leakage concerns and providing direct access to the local gas utility.

Diaphragms and regulators in gas piping must be vented to the outside.

Fuel Oil Systems

Fuel Oil Piping. Fuel oil piping system shall use at least Schedule 40 black steel or black iron piping. Fittings shall be of the same grade as the pipe material. Valves shall be bronze, steel or iron and may be screwed, welded, flanged or grooved. Double-wall piping with a leak detection system shall be used for buried fuel piping.

Underground Fuel Oil Tanks. Underground fuel oil storage tanks shall be of double wall, non-metallic construction or contained in lined vaults to prevent environmental contamination. Tanks shall be sized for sufficient capacity to provide 48 hours of heating operation under emergency conditions (72 hours for remote locations such as border stations). For underground tanks and piping a leak detection system, with monitors and alarms for both, is required. The installation must comply with local, State and Federal requirements, as well as EPA 40 CFR 280 and 281.

Fire Protection

Refer to Chapter 7: *Fire Protection Engineering*.

5.11 HVAC Pumping Systems

Hydronic, Closed Loop Systems

Closed piping systems are unaffected by static pressure, therefore, pumping is required only to overcome the dynamic friction losses. 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). This compensates 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.

Variable Flow Pumping. Variable flows occur when two-way control valves are used to modulate heat transfer. The components of a variable volume pumping system include pumps, distribution piping, control valves and terminal units, and will also include boilers and chillers unless a primary-secondary arrangement is used. All components of the system are subject to variable flow rates. It is important to provide a sufficient pressure differential across every circuit to allow design flow capacity at any time.

Flow may be varied by variable speed pumps or staged multiple pumps. Pumps should operate at no less than 75 percent efficiency for their performance curve. Variable flow pumping must be designed carefully. Package systems should be used, with pumps and controls supplied in the complete package having received factory testing prior to shipment.

Chillers and most boilers may experience flow-related heat exchange problems if flow is not maintained above a minimum rate. For this reason, separate, constant flow primary water pumps are recommended for variable volume pumping systems.

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.

Primary/secondary pumping arrangements allow increased system temperature design drops, decreased pumping horsepower and increased system control. 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 76 L/s (1,000 gpm)) and campus facilities.

5.12 Piping Systems

All piping systems should 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.)

Cathodic Protection. The need for metal protection for underground piping must be evaluated by a soils resistivity test. This is part of the Geotechnical Report. See Appendix A. Cathodic protection or another means of preventing pipe corrosion must be provided.

Piping Material. Table 5-5 cites which commercial standard should be used for piping material.

Isolation of Piping at Equipment. Isolation valves, shut-off valves, by-pass circuits and unions shall be provided as necessary 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.

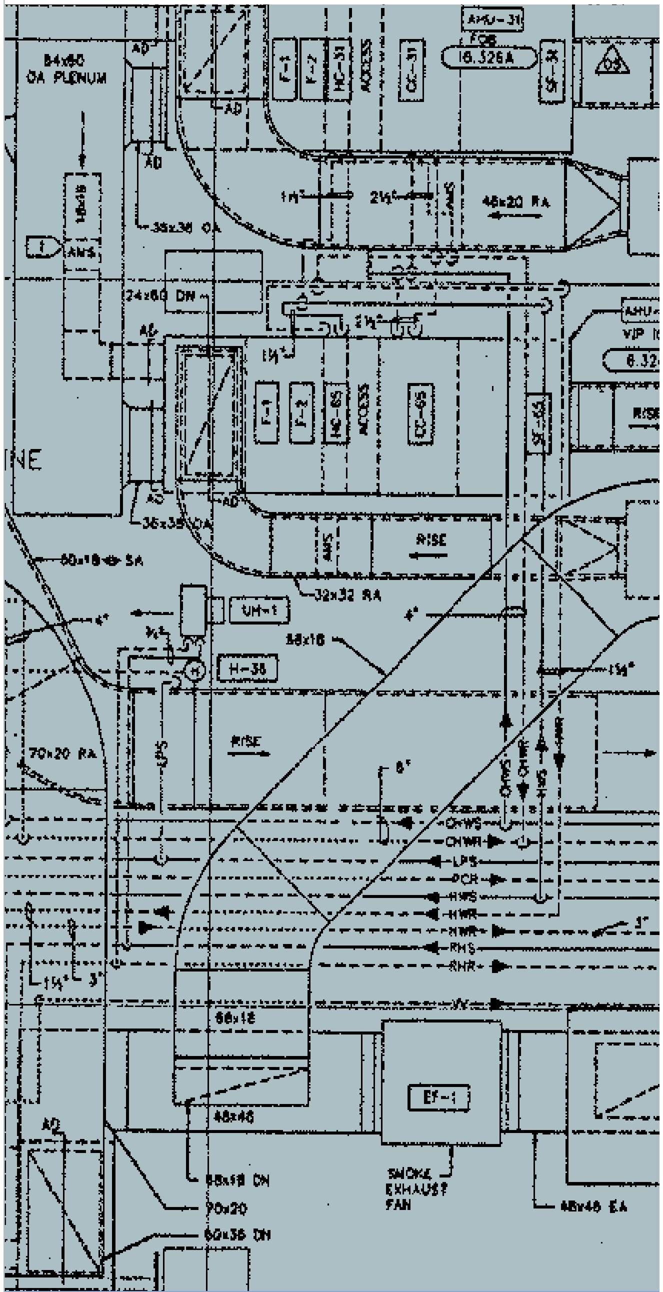
Provisions for Piping in Earthquake Zones. In Seismic Zones 2, 3 and 4, sleeves for pipes shall be at least 25 mm (1 inch) larger than the pipe, to allow for movement. Flexible couplings shall be provided at the bottom of pipe risers. Spreaders shall be used to separate adjacent pipes, unless the distance 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 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 type the system and direction of flow for piping systems or type and number for equipment. The identification system shall also tag all valves and other operable fittings. Gas piping and sprinkler lines must be identified as prescribed by NFPA.

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, those having design temperatures less than 18°C (65°F) or greater than 40°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 to whether piping is concealed or exposed. Chilled water piping systems shall be insulated with non-permeable insulation (of perm rating 0.00) such as cellular glass.

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.	035 kPa (150 psi) fittings. Standard weight pipe over 300 mm (12-in) diameter.
	Hot water	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	



Mechanical room part plan, The Federal Triangle Building, Washington, D.C.

5.13 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 ASHRAE *Applications Handbook, Sound and Vibration Control*.

Isolate all moving equipment in the building.

Mechanical Room Isolation. Floating isolation floors should be considered for major mechanical rooms located in penthouses or at intermediate levels in mid-rise and high-rise construction. See Chapter 3: *Architectural and Interior Design, Special Design Considerations, Acoustics, Design Criteria for Building Spaces, Class X Spaces*.

Mechanical Chases. Mechanical chases should be closed at top and bottom, as well as the entrance to the mechanical room. Any piping and ductwork should 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, except that shafts dedicated to gas piping must be ventilated.

Isolators. Isolators should be specified by type and by deflection, not by isolation efficiency. See ASHRAE *Guide for Selection of Vibration Isolators and Application Handbook* for types and minimum deflections. Specifications should be worded so that isolation performance becomes the responsibility of the equipment supplier.

Concrete Inertia Bases. Inertia bases should be provided for reciprocating and centrifugal chillers, air compressors, all pumps, axial fans above 300 RPM, and centrifugal fans above 37 kW (50 HP).

Ductwork. Reduce fan vibrations immediately outside 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.

Piping Hangers and Isolation. Isolation hangers should be used for all piping in mechanical rooms and adjacent spaces, up to a 15 m (50-foot) distance from vibrating equipment. The pipe hangers closest to the equipment should have the same deflection characteristics as the equipment isolators. Other hangers should be spring hangers with 20 mm (.75 inch) deflection.

Positioning hangers should be specified for all piping 200 mm (8 inches) and larger throughout the building. Spring and rubber isolators are recommended for piping 50 mm (2 inches) 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 should 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 should be designed into the piping before it reaches the riser.

Noise Transmission Attenuation. Attenuate noise transmission to and from courtrooms, judges' chambers, jury rooms, prisoner consulting rooms and from prisoner detention areas.

5.14 HVAC Control Systems

Automatic Temperature and Humidity Controls

A Direct Digital Control (DDC) system with host computer controlled monitoring and control shall be provided.

Controls. Pre-programmed stand-alone single or multiple loop controllers shall be used to control all HVAC and plumbing sub-systems.

Temperature Controls. 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 façade of the building with a different orientation.

The sequences controlling the heating and cooling to spaces shall minimize the magnitude to which they are provided simultaneously. A 2.5°C (5°F) deadband 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.

Temperature Reset Controls

Air Systems. Systems supplying heated or cooled air to multiple zones must include controls that automatically reset supply air temperature by representative building loads or by outside 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 by representative temperature changes responding to changes in building loads (including return water temperature) or by outside air temperature.

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 Damper Position (economizer) Supply Air Discharge Temp Return Air Temp Mixed Air Temp Supply Air Flow Rate Outside Air Flow Rate Return Air Flow Rate	**Refrigeration Equipment** Start/Stop Leave Water Temp Reset Demand Limiting Isolation Valve Position Leaving Water Temp Entering Water Temp kW Draw Flow	**Hot Water Boilers** Start/Stop Leaving Water Temp Reset Isolation Valve Position Leaving Water Temp Entering Water Temp Flow
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	**Pumps** Start/Stop Discharge Pressure Reset
Utilities Natural Gas – Consumption Electricity – Consumption & Demand Water – Consumption Fuel Oil – Quantity		

5.15 Building Automation Systems (BAS)

The primary reason for using a BAS is the anticipated lower operating cost over the life of the building. Programmable controllers monitor and 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 monitor systems such as HVAC, lighting, elevators, security controls and fire alarms. The BAS can be programmed to cycle and schedule equipment for preventive maintenance and maintain parts inventories. For optimal function, the BAS should be integrated with the basic building HVAC controls system.

A BAS is not required for every project and should be a part of the life cycle cost analysis. The size of the building, number of pieces of equipment, expected energy savings and availability of trained staff should all be considered before a decision is made. BAS' are mandatory and considered part of the baseline system on large facilities (above 9,300 gross square meters (100,000 gross square feet)), both new facilities and major modernizations.

Level of Integration. It is possible to combine controls for practically all building systems—HVAC, lighting, emergency power, and elevators—into a single-CPU operating unit. Since the advent of micro-computer BAS systems, there has been an attempt to integrate as many systems as possible to reduce hardware requirements. However, caution is advised when planning BAS systems with a high level of integration. The more integration, the more complex the system becomes and the more training is required for the operating staff. Also, reliability requirements for the different systems may vary.

Fire alarm systems, security systems and elevator systems shall not be integrated, that is controlled by a BAS. These systems should 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 Engineering, Electrical Requirements, Fire Alarm Systems*, and Chapter 8: *Security Design*.

BAS' shall utilize 'open' communication protocols, such as BACnet, ASHRAE Standard 135 – 1995, 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.

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.

Energy Conservation. The best targets for energy conservation in building systems are the HVAC system and the lighting system. 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 comfort set points.

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.

A number of programs are available to control building lighting. They include timers and sweeps for on/off control and photocell controlled switching for taking full advantage of daylight.

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 set points 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. Stand-alone control panels and terminal unit controllers can have text-based user interface panels which are hand-held or fixed.

Energy Measurement Instrumentation. The capability to allow building staff to measure energy consumption and monitor performance is critical to the overall success of the system. Electrical values, such as V, A, kW, KVAR, KVA, PF, kWh, KVAH, Frequency and Percent THD, shall be measured. See also Chapter 6: *Electrical Engineering, Site Distribution*, for separate metering of power consumption.

Ronald Reagan Building, Washington, D.C.

5.16 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 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 outside 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 outside 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.

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.

Water Use Meters. See *Plumbing Systems, Domestic Water Supply Systems.*

Indoor Air Quality Measurement. Vehicle garage exhaust fans shall generally be activated based upon carbon monoxide sensors within the garage. Carbon monoxide sensors shall also be located in upper floor areas where vertical shafts penetrate to vehicle garage areas.

5.17 Start-up, Testing, and Balancing Equipment and Systems

Start-Up. The A/E shall specify that factory representatives be present for startup of all major equipment, such as boilers, chillers 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 either Associated Air Balance Council (AABC) or National Environmental Balance Bureau (NEBB).

National Building Museum, Washington, D.C.

5.18 Alterations in Existing Buildings and Historic Structures

The goal of alteration projects is to meet the same standards described in this document for new projects. Equipment/systems at 20 years life or older 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 should 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 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 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 should be attempted.

In the second case, 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.

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 HBPP which identifies zones of architectural importance, specific character-defining elements that should be preserved, and standards to be employed. See Chapter 1: *General Requirements, General Design Philosophy, Historic Buildings*.

Modern standards for climate control developed for new construction may not be achievable or desirable for historic buildings. In each case, the lowest level of intervention needed to successfully accomplish the project should be selected. 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 should be followed for HVAC work in historic buildings:

- 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.
  - Add insulation where not visible and intrusive, such as attics or basements. Insulate walls only where it can be done without removal or covering original visible elements.
  - Add storm windows where they can be installed in a manner that will not detract from original visible elements.
  - Use new replicated thermal windows only where it is not economically feasible to repair existing windows.

- 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. Consider reuse of existing components when reuse will reduce architectural intrusion and achieve savings, without compromising overall performance and life cycle requirements. 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.

- Use a number of smaller units in lieu of a few large ones. Insure that room is available to maintain and replace equipment without damaging significant features to the greatest extent possible, selecting components that can be installed without dismantling window or door openings.

- Place new distribution systems out of sight whenever possible by using closets, shafts, attics and basements.

- Use custom rather than commercial standard products where elements are exposed in formal areas.

- Select temperature and humidity conditions that will not accelerate deterioration of building materials.

- Where equipment is near significant features, insure that leakage from pipes and HVAC units will not cause deterioration. Use deeper condensate drain pans, lined chases and leak detectors.

- Design HVAC systems to avoid impacting other systems and historic finishes, elements and spaces.

- Place exterior equipment where it is not visible. Be particularly careful with new chimneys or vents and condensers, towers, solar panels and air intakes and discharges. Recess equipment from the edge of the roof to minimize visibility of the equipment from grade. Alternatively, explore creating 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 façade.
  — Locate equipment with particular care for weight and vibration on older building materials. These materials may not accept the same stress as when the equipment is used with newer construction methods.
  — 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 outside. This is the area of highest natural illumination, and it can be used to reduce the need for artificial illumination, which will in turn reduce the size of HVAC systems. Original plaster ceilings in significant spaces such as lobbies and corridors should 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.
  — Locate pipes so that they do not damage or visually interfere with character-defining elements in historic structures such as windows, doors, columns, beams, arches, baseboards, wainscots, paneling, cornices, ornamental trim, decorative woodwork and other decorative treatments of floors, walls and ceilings.
  — **Vertical Distribution.** If new risers are required, they should preferably be located adjacent to existing shafts.
  — **Horizontal Distribution.** Many older buildings have high floor-to-floor heights, which permit an option to use an existing ceiling space.

- In buildings containing ornamental or inaccessible ceilings, piping and ductwork may 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 should also be considered in historic industrial buildings and open plan, tall ceiling, high window spaces suited to flexible grid/flexible density treatments.

Electrical Engineering

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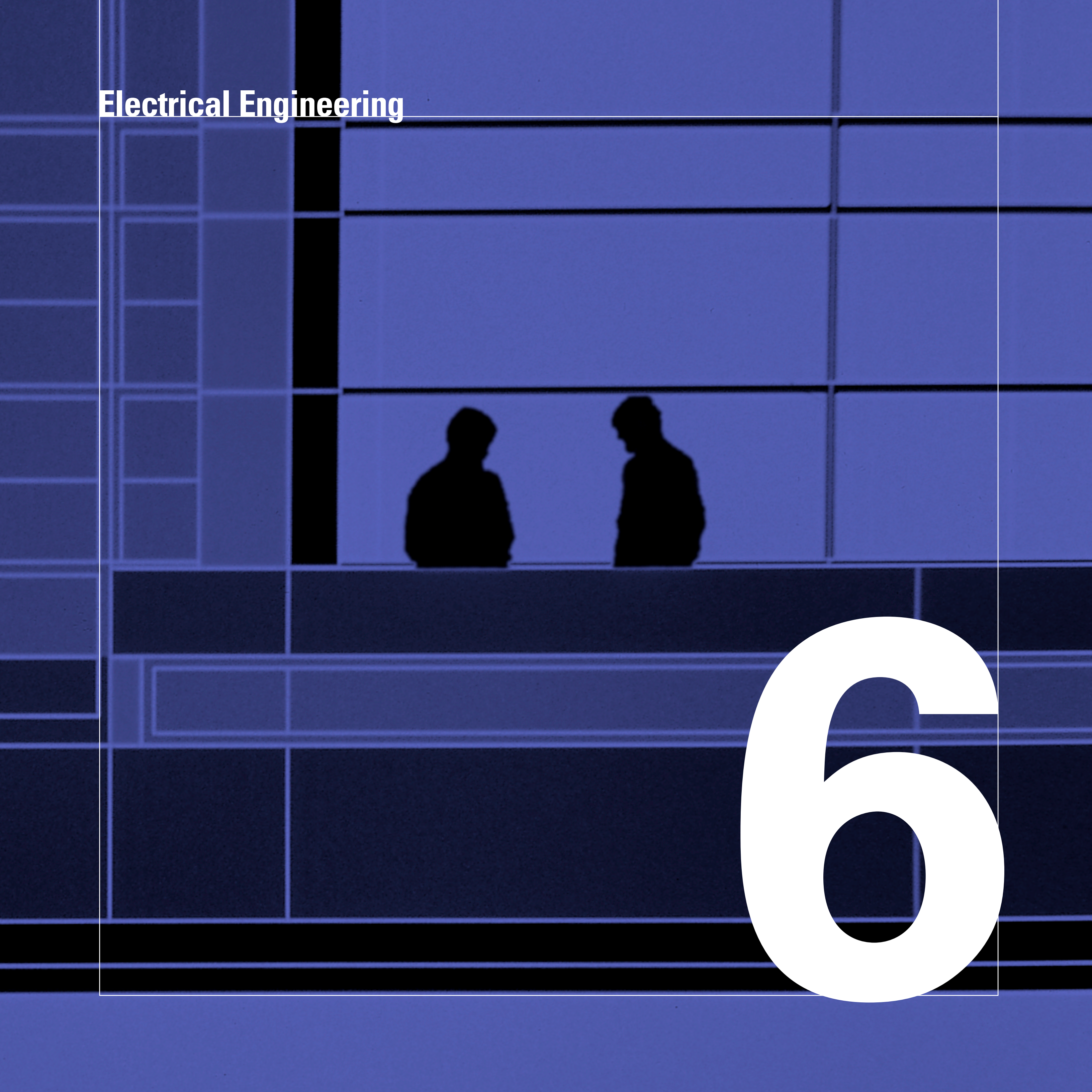

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6.1 General Approach

Electrical and communications systems in GSA buildings 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.

GSA owns and operates its buildings much longer than the private sector. Consequently, a higher level of durability is required for all systems, as is the ability to replace equipment during the life of the building.

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 should provide ample capacity for increased load concentrations in the future 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 should 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 trend toward intelligent buildings is gaining momentum in the Federal sector. 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 should be noted that the design of all communications 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 generally. Exceptions are the fire alarm and security systems, which shall function as stand-alone systems with a monitoring only interface to the BAS.

Architects and engineers should always make environmentally responsible choices regarding new building materials and the disposal of discarded products. Recycled material use needs to be maximized to the fullest extent practical within the project requirements. Architects and engineers should consider integrating renewable energy technologies such as photovoltaics and other solar applications, geothermal heat and wind into building systems.

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

Submission Requirements, Every project will have unique characteristics and requirements for submission and review. These shall be developed by the GSA Project Manager. The general submission requirements for each phase of project development are described in Appendix A.

Ronald Reagan Building, Washington, D.C.

6.2 Codes and Standards

Model codes and standards adopted by GSA are discussed in Chapter 1: *General Requirements, Codes and Standards, Building Codes*. All electrical and communications systems must meet or exceed the requirements of the National Electric Code (NEC).

Electrical Design Standards

The standards listed below are intended as guidelines for design only. They are mandatory only where referenced as such in the text of the chapter. The list is not meant to restrict engineers from using additional guides or standards as desired.

- Federal Information Processing Standard 175: *Federal Building Standard for Telecommunication Pathways and Spaces* (see also EIA/TIA Standard 568-A and related bulletins)
- Federal Information Processing Standard 174-1: *Federal Building Telecommunications Wiring Standard* (see also EIA/TIA Standard 569 and related bulletins)
- Federal Information Processing Standard 176: *Residential and Light Commercial Telecommunications Wiring Standard* (see also EIA/TIA Standard 570 and related bulletins)
- Federal Information Processing Standard 187: *The Administration Standard for Telecommunications Infrastructure of Federal Buildings* (see also EIA/TIA Standard 606 and related bulletins)
- Federal Information Processing Standard 195: *Federal Building Grounding and Bonding Requirements for Telecommunications* (see also EIA/TIA Standard 607 and related bulletins)

6.3 Placing Electrical Systems and Communications Systems in Buildings

In order to achieve system flexibility and thorough integration between building architecture and engineering systems, a concept for the power and telecommunications infrastructure that supports the distribution of electrical and communications systems must be established during the architectural schematic design. The locations of vertical backbone pathways, horizontal pathways, closets, equipment rooms and utility entrance facilities for electrical and communications distribution equipment must be established before the architectural concept is finalized.

Electrical Closets . The spacing of electrical and communications closets in buildings is described in Chapter 3: *Architectural and Interior Design, Building Planning, Placement of Core Elements and Distances*.

Communications Closets. Communications closets shall meet the requirements of FIBS Standard 175: *Federal Building Standard for Telecommunications Pathways and Spaces*. The location and size of communications closets are discussed in Chapter 3: *Architectural and Interior Design*.

Planning Grid, Floor Grid and Ceiling Grid. A common planning grid is to be used in all GSA buildings. Electrical and communications elements in floors and ceilings including lights, power, telephone and data are given precise locations within the planning grid. The relationship of this grid to wall placement, ceiling grids and location of mechanical and electrical elements is described in detail in Chapter 3: *Architectural and Interior Design, Building Planning, Planning Grid*.

Horizontal Distribution of Power and Communications. In new construction the building shall have raised access flooring. In buildings with access flooring, power circuits should be provided via conduit, modular wire distribution boxes and modular wire cable sets to flush floor receptacles. Communication cables can be laid exposed directly on the slab and grouped together in rows 3600 mm (12 feet) on center.

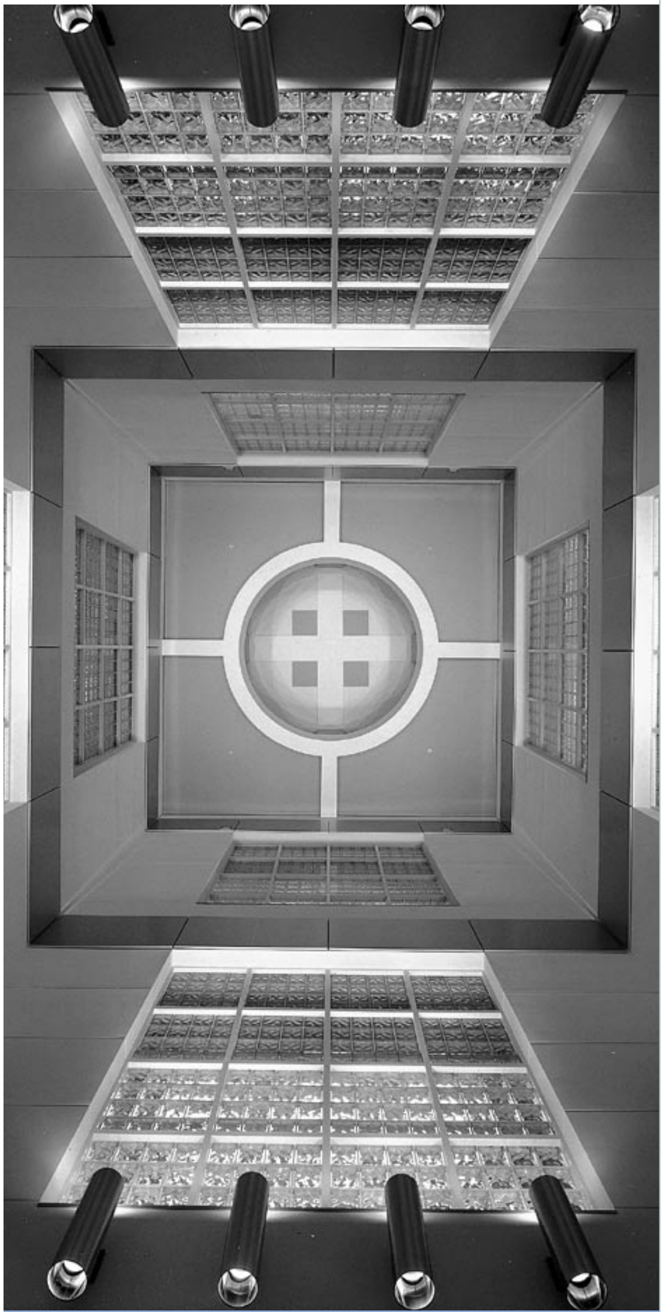
Power, data and telephone cables shall be grouped together in pathways that are separated into channels for each system. Independent channels are required in horizontal pathways for normal power, emergency power, mechanical, fire alarm, security, television and communications. The communications channel includes voice and data. Major zones within the facility should have horizontal distribution capacity for all seven categories described above. Horizontal pathways serving individual work stations must have at least three channels for power, voice and data. FIBS 175: *Federal Building Standard for Telecommunication Pathways and Spaces* provides detailed requirements for communications pathways, including requirements for underfloor ducts, access floor, conduit, cable trays and wireways, ceiling pathways and perimeter pathways. Provide at least 650 mm^2 (1 square inch) of horizontal capacity for power and communications to office areas for every 10 m^2 (100 square feet) of occupied area.

The placement of outlets in walls or in the partitions of systems furniture should be avoided because of the difficulty it creates for future reconfiguration of the office space. This is true for both closed office and open plan concepts. Light switches likewise should be located on columns and the walls of fixed core elements, to the maximum extent possible.

Flat conductors, poke-through and/or power poles shall not be used in new construction.

These criteria apply to all occupiable area or net usable space in a GSA building but not to public spaces or support spaces, which can be considered fixed elements and are not subject to frequent changes.

Vertical Distribution. Risers for normal power, emergency power and communications should be combined with other core elements to form compact groups and maximize usable floor space. The number and size of risers will depend on the systems chosen, but future flexibility should be an important criterion in the vertical layout as well. Electrical and communication closets shall be vertically stacked. Electrical closets shall have two capped 4-inch spare sleeves through the structural floor for future flexibility. Communications closets shall also have two capped spare sleeves in each closet. Vertical risers for normal power, emergency power, and communications should be aligned throughout the building to minimize conduit bends and additional cabling. Be aware of the requirements to locate fire alarm vertical risers remotely.



U.S. Courthouse, Kansas City, KS

6.4 General Design Criteria

Energy Conservation. Code requirements for energy conservation are detailed in Chapter 1: *General Requirements, Codes and Standards, Mandatory Design Standards, Energy Conservation Standards*. The largest factor in the energy consumption of a building is lighting. The overall efficiency of the lighting system depends both on the individual components and on the interaction of components in a system. A good controls strategy that eliminates lighting in unoccupied spaces and reduces it where daylighting is available can contribute significantly to energy conservation. The best way to institute such controls is through a Building Automation System (BAS). See section on *Lighting, Lighting Controls* in this chapter for further discussion. Designers should check with local power companies and include technologies that qualify for rebates.

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 should be closely coordinated with the architectural design. This includes colors and finishes of lights, outlets and switches.

Equipment Grounding Conductor. All low voltage power distribution systems should be supplemented with a separate, insulated equipment grounding conductor. Grounding for communication systems must follow the requirements in the Federal Information Processing Standard 195: *Federal Building Grounding and Bonding Requirements for Telecommunications* (see also EIA/TIA Standard 607 and related bulletins).

Lightning Protection. Lightning protection should be evaluated in accordance with NFPA 78. Buildings in the "moderate to severe" category of exposure and higher shall be equipped with a UL listed lightning protection system. The system should be carefully designed to ensure that static discharges are provided with an adequate path to ground. Surge arresters on the main electrical service should also be considered.

Cathodic Protection. The need for corrosion protection for conduits and for all other underground piping and buried metals on the project must be evaluated through soil resistivity and pH testing. Testing for soils resistivity is part of the Geotechnical Report. See Appendix A: *Submission Requirements*. Cathodic protection should be designed by a qualified specialist.

6.5 Electrical Load Analysis

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, of course, be satisfied.

Standards for Sizing Equipment and Systems

To ensure maximum flexibility for future systems changes, the electrical system must be sized as follows: panelboards for branch circuits must be sized with 50 percent spare ampacity, panelboards serving lighting only with 25 percent space switchboard ampacity, distribution panels with 35 percent spare ampacity and main switchgear with 25 percent spare ampacity. Spare overcurrent devices shall be provided as well as bus extension for installation of future protective devices.

Table 6-1
Minimum Connected Receptacle Load

	Minimum connected receptacle load	
Type of occupiable area	**Load per square meter**	**Load per square foot**
Normal systems		
Office/Workstation	14 VA	1.3 VA
Non-workstation areas such as public and storage	10 VA	1 VA
Core and Public areas	5 VA	0.5 VA
Electronic systems		
Office/Workstation	13 VA	1.2 VA
Computer rooms	700 VA	65 VA
NOTE: Normal and electronic equipment systems are as shown on Figure 6-6		

6.6 Utility Coordination and Site Considerations

Power Company Coordination. See Chapter 2: *Site Planning and Landscape Design, Site Utilities, Utilities Services.*

These data must be established prior to initial system design. Electrical load estimates must be prepared in conjunction with utility company discussions to establish the capacity of the new electrical services.

The service entrance location for commercial electrical power should be determined concurrently with the development of conceptual design. Space planning documents and standards for equipment furnished by utility companies should be incorporated into the concept design. Locations for transformers, vaults, meters and other utility items must be coordinated with the architectural design to avoid detracting from the building's appearance.

Site Considerations. The routing of site utilities and location of manholes should be determined early in the design process.

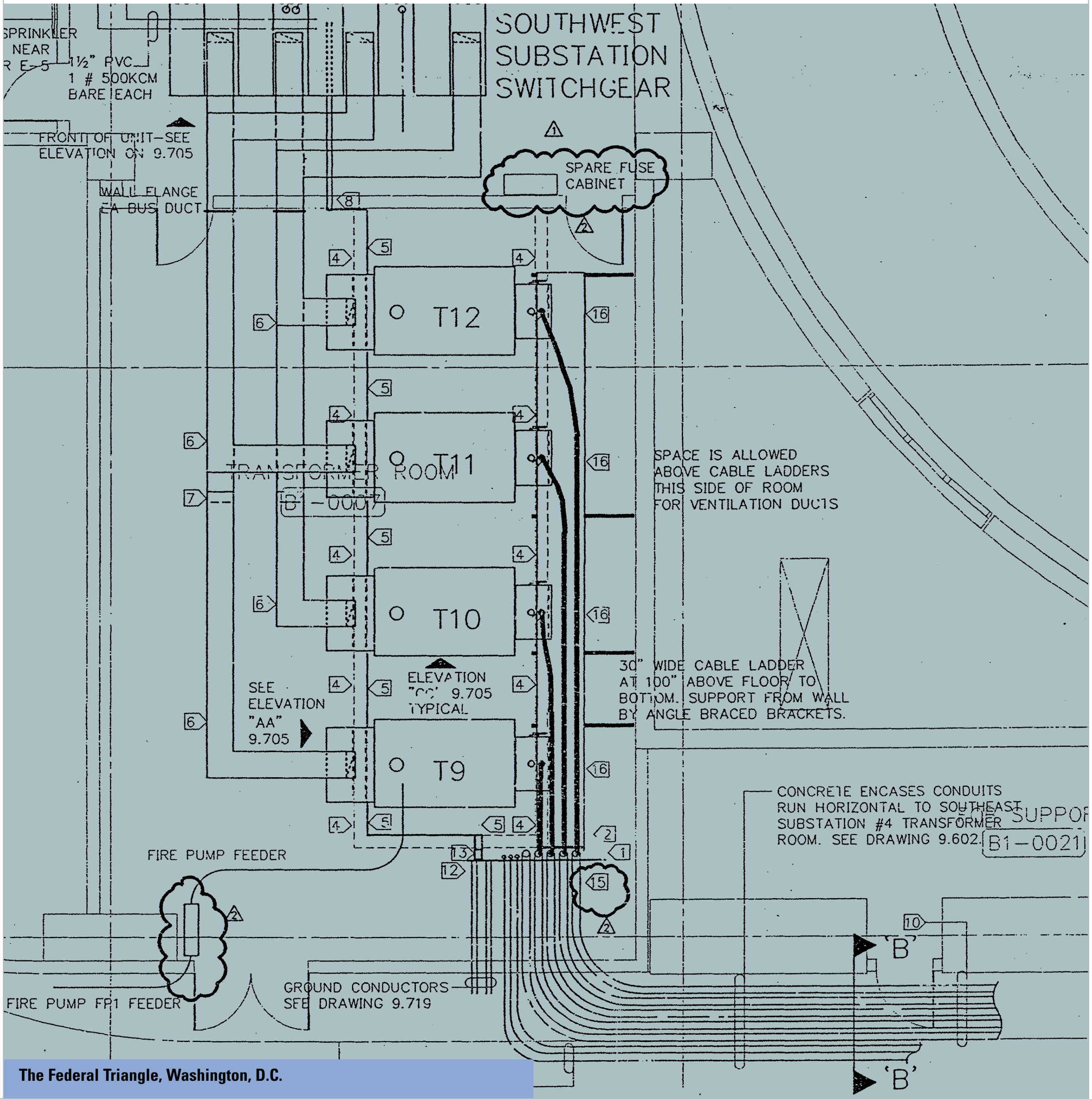
It is desirable to have the utility company furnish power at the main utilization voltage, i.e., 480/277V or 208/120V (for small buildings). GSA prefers that the utility company own and maintain the transformers.

In the case of large buildings or buildings with large footprints, it may be necessary to have more than one service. In large office buildings and in campus situations, it may also be necessary to distribute medium voltage power. If available, medium voltage, up to 15KV, should be used for primary power distribution to substations.

Communications Service Coordination. All communications systems within the building are designed, installed and operated under the management of the Office of the Chief Information Officer (I).

(I) contracts for service to GSA buildings. The engineers involved in the building design must coordinate their work with (I), and the telephone company having jurisdiction (not directly with the telephone company).

(I) will provide space requirements for telephone switch or PABX rooms and furnish information on any other design requirements.



The Federal Triangle, Washington, D.C.

6.7 Site Distribution

Exterior distribution systems must be either direct buried conduit or concrete encased conduit systems. Cable selection should 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) is appropriate for the distribution of branch circuits. Direct buried cable should not be used.

Concrete-Encased Ductbank. Concrete-encased ductbanks should 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.

Duct line routes should be selected to balance maximum flexibility with minimum cost and to avoid foundations of other buildings and other structures. Ducts should be provided with a cover of at least 600 mm (24 inches). Ductbanks under railroads should be reinforced. Ducts should slope 4 percent toward manholes. Changes in direction should 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 should be selected to balance maximum flexibility with minimum cost and to avoid foundations of other buildings and other structures. Ducts should be provided with a cover of at least 24 inches. Ductbanks under railroads should be reinforced. Ducts should slope 4 percent toward manholes. Changes in direction should be by sweeps with a radius of 25 feet or more. Stub-ups into electrical equipment may be installed with manufactured elbows.

Where it is necessary to run communication cables alongside power cables, two separate systems must be provided with separate manhole compartments. The same holds true for normal and emergency power cables. Ductbanks should 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)

Electrical and communication ducts should be kept clear of all other underground utilities, especially high temperature water or steam.

Duct Sizes. Ducts should be sized as required for the number and size of cables. Inner ducts must be provided inside communication ducts wherever fiber optic cables will be used. A sufficient number of spare ducts should be included for planned future expansion; in addition, a minimum of 25 percent spare ducts must be provided for unknown future expansion.

Manholes. Manholes should be spaced no farther than 150 m (500 feet) apart for straight runs. The distance between the service entrance and the first manhole should not exceed 30 m (100 feet). Double manholes should be used where electric power and communication lines follow the same route. Separate manholes should be provided for low and medium voltage systems. Manholes should 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. Manholes must have a minimum wall space of 1800 mm (6 feet) on all sides where splices are to be racked.

Stubs. Minimum of two spare stubs should 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 FTS.

Smaller manholes may be used for low voltage feeders (600V and below), branch circuits or communications circuits. They should 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 should be installed. Where more than two splices occur (600V feeders only), a 6 feet by 6 feet by 6 feet manhole may be more appropriate.

6.8 Primary Distribution

The selection of a primary distribution system, i.e., radial, loop, primary selective, secondary selective, network, etc., should be evaluated on a case by case basis, with consideration given first to safety, then to cost and reliability. Generally, radial or loop systems are preferred.

The primary distribution system design should be based on the estimated demand load plus 25 percent spare capacity.

Medium Voltage Switchgear. When required, medium voltage service switchgear may be provided with either air, vacuum or SF6 circuit breakers or fused air interrupter switches. Provide voltmeter, ammeter and watt-hour meter with demand register. Meters should be pulse-type for connection to the BAS. Providing a power monitoring and management system is an acceptable option.

Conductors. Conductors should be insulated with cross linked polyethylene (XLP) or ethylene propylene rubber (EPR). 133 percent insulation should be provided. Conductor size should not exceed 240 mm^2 (500 Kcmil).

Spot Network Transformers. In cases where reliability is an absolutely critical concern - the IRS office that processes refund checks, for example - network transformers should be considered. In large cities, where load densities are very high, utility companies may choose to supply power through network transformers. If so, these systems should be utility owned and maintained.

Double-ended Substations. If reliability is critical and spot networks cannot be provided by the utility, double-ended substations should be used. Transformers may be equipped with 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 it must not exceed the fan cooling rating. All double-ended substations should be equipped with two secondary main breakers and one tie breaker set up for open transition automatic transfer.

Transformers

Substation transformers must be dry-type with epoxy resin cast coils or silica oil filled type. Liquid filled transformers may be used outdoors. Substations should 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. Consider surge suppression on the secondary and/or downstream busses.

Transformers located in underground vaults must not be positioned directly adjacent to or beneath an exit way.

Where silica oil filled transformers are used, the design must comply with all spillage containment and electrical code requirements.

6.9 Secondary Distribution

Main Switchboards. 208V and/or 480V service switchboards as well as substation secondary switchboards should be provided with a single main service disconnect device. This main device should be molded case, insulated case, power air circuit breaker or fusible switch (where appropriate) individually mounted, draw-out type (as applicable). Insulated case and power air circuit breakers should be electrically operated.

The meter section should contain a voltmeter, ammeter and watt-hour meter with demand register. Meters should be pulse type for connection to the BAS. Providing a power monitoring and management system is an acceptable option.

Feeder devices of switchboards 2,000 AMPS and larger should be molded case, insulated case, power air circuit breakers or fusible switches where appropriate, individually mounted, draw-out type as applicable and electrically operated. Feeder devices of switchboards below 2,000 AMPS may be group-mounted, molded case circuit breakers or fusible switches.

Switchboards should be front and rear accessible. In smaller switchboards, front access only is acceptable if space is limited.

Grounding. All grounding systems must be carefully coordinated, especially in regard to: NEC grounding electrode systems; lightning protection; communications grounding; and computer room signal reference guide. Power distribution system grounding must be in accordance with Article 250 of the *National Electrical Code*. Also reference general design criteria (this chapter) for equipment grounding conductor. Grounding for communications systems must follow the requirements in the Federal Information Processing Standard 195: *Federal Building Grounding and Bonding Requirements for Telecommunications* (see also EIA/TIA Standard 607 and related bulletins).

Ground Sources. The ground source for the electrical power system must have a maximum resistance to ground of 5 ohms, except in small buildings i.e. less than 5000 m^2 (50,000 square feet) that have only minimal communications systems. Grounding systems for these buildings may have a resistance up to 10 ohms. The grounding design must be based on a soils resistivity test and ground resistivity calculations. Below-grade connections should be exothermically welded.

A wall-mounted, 6 mm by 50 mm (0.25-inch by 2-inch) copper ground bus should be provided in each electrical room. The ground bus should be located in the rear access aisle of the room and should extend at least 1 m (3 feet). It should be interconnected with the ground electrode and ground bus in the switchgear or switchboard.

Isolated Grounding Panels. Provide separate panels for computer loads to separate from general electrical loads in lieu of an IG system which is more complex and prone to mis-wiring.

Submetering. Electric power meters must be provided on the services to all spaces planned to be outleased, to all computer rooms and to the parking garage, if any.

Power Factor Correction. If the utility rate structure has a power factor penalty, non-PCB centralized automatic power factor capacitors should be connected at the main electrical service on the load side of the utility metering. Power factor capacitors should be designed to automatically correct a lagging power factor to a value that will avoid penalty charges. Switching circuits should be specifically designed to prevent electrical noise from entering the electrical power distribution system.

Motor Control Centers. Grouped motor controls should be used where more than six starters are required in an equipment room. Motor control center construction should be NEMA Class I, Type B with magnetic (or solid state if appropriate) starters and either circuit breakers or fuses. Minimum starter size should be size 1 in motor control centers. Each starter should have three overload relays. Control circuit voltage should be 120V connected ahead of each starter via control transformer as required.

Reduced voltage starters may be used for larger motors to reduce starting KVA.

In the design of motor control centers on emergency power, time delay relays should be considered to reduce starting KVA on the generator.

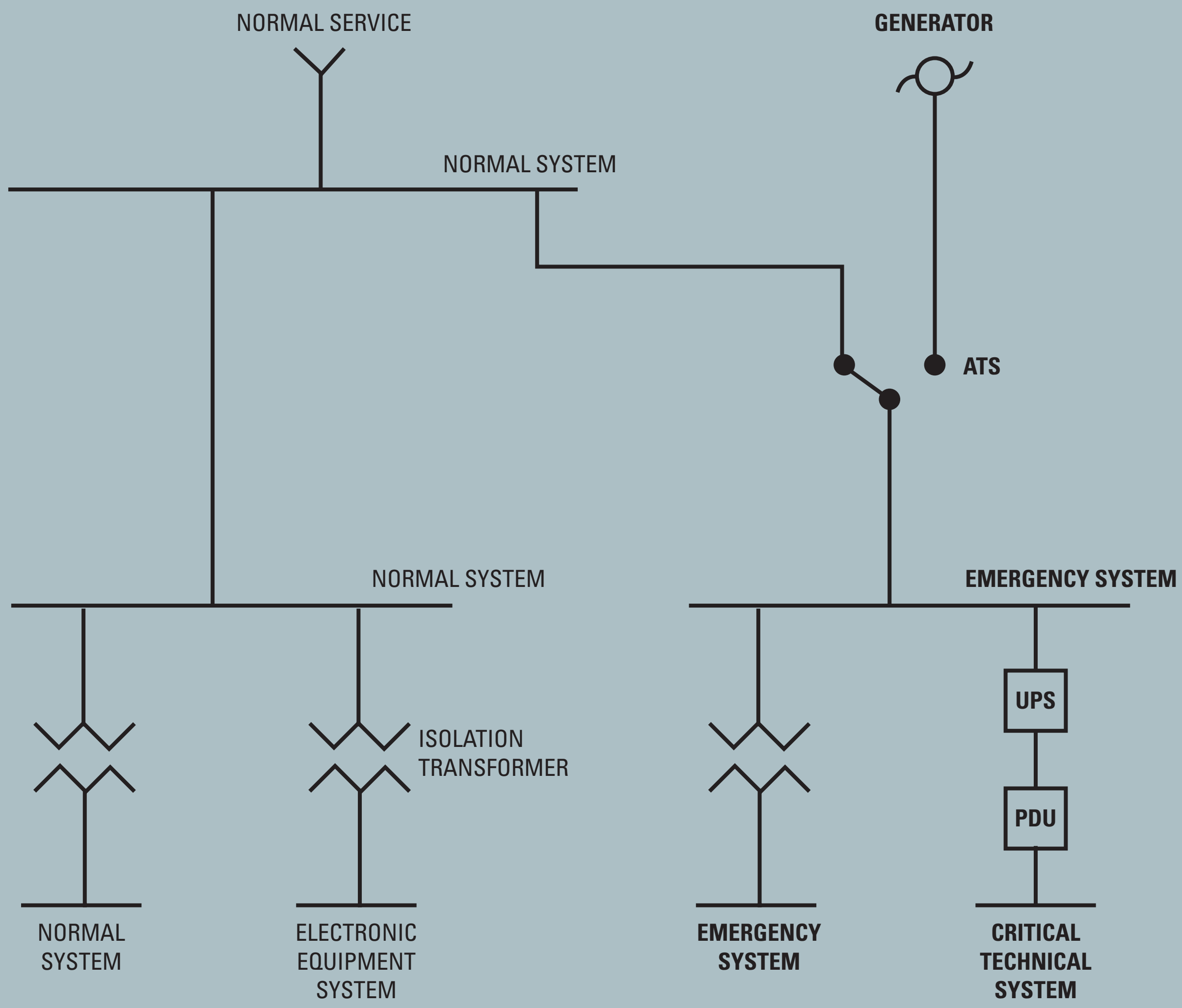
Elevator Power. Elevators should be powered from a shunt trip circuit breaker located in the elevator machine rooms. Electrical design standards in elevator standard ANSI/ASME A17.1 must be followed.

Secondary Distribution Systems

Secondary electrical power distribution systems in Federal buildings are classified as normal, emergency and uninterruptible. Normal power serves the general power and lighting loads in the building. Emergency power is distributed to life safety and critical loads. Uninterruptible power is required for critical loads, which cannot be interrupted.

In typical GSA office buildings it is recommended that 208/120V normal power be subdivided to isolate the office electronic equipment load. Figure 6-6 shows a typical power distribution scheme.

Figure 6.6 Typical Power Distribution Scheme



Bus Duct. Where plug-in bus duct is used, it should have an integral ground bus, sized at 50 percent of the phase bus to serve as the equipment grounding conductor.

Conductors. Aluminum or copper conductors are acceptable for motor windings, transformer windings, switchgear bussing, switchboard bussing and bus duct, where the conductor is purchased as part of the equipment. Aluminum conductors shall not be used for primary feeders, branch feeding or branch circuits.

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.

Lighting panelboards shall have minimum of three 20-amp 1-pole spare circuit breakers.

Receptacle panelboards should have minimum of six 20-amp 1-pole spare circuit breakers. For initial planning purposes, the number of receptacle circuits may be estimated by assuming 19 m^2 (200 square feet) per circuit.

All panelboards must be located in closets. In circumstances where horizontal runs would become excessive and another riser is not warranted, shallow closets, at least 600 mm (24inches) deep, may be used for additional panelboards.

Panelboards Serving Electronic Equipment. Electronic equipment panelboards serving personal computers, computer terminals or dedicated work stations should have an isolated ground bus. The service to the electronic panelboard should be supplied from an isolation transformer. Consideration shall be given to providing equipment with 200 percent neutrals. For initial planning purposes, the number of receptacle circuits may be estimated by assuming 19 m^2 (200 square feet) per circuit.

Feeders and branch circuits serving electronic load panels should be provided with isolated ground conductors.

6.10 Wiring Devices

In GSA buildings, general wiring devices must be specification grade. Emergency receptacles must be red. Isolated grounding receptacles must be orange. Special purpose receptacles must be brown. The color of standard receptacles and switches should be coordinated with the architectural color scheme; for example, white, not ivory, devices should be used if walls are white or light gray.

Building standard receptacle must be duplex, specification grade NEMA 5-20R. Special purpose receptacles should be provided as required. Device plates should 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 should be avoided 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 metal conduit or cable to underfloor distribution boxes. One distribution box per bay is recommended (see section *Placing Electrical Systems in Buildings, Horizontal Distribution of Power and Communications*, Figure 6-2 of this chapter). Flush-mounted access floor service boxes should be attached to the underfloor distribution boxes by means of a plug-in modular wiring system to facilitate easy relocation.

Number of Receptacles. For initial planning purposes, assume that office space uses systems furniture with a density of two work stations for every 9 m^2 (100 square feet). Electrical systems should be designed to allow two duplex outlets for electronic equipment power and two duplex outlets for normal power per work station.

Conference Rooms. Conference rooms shall be served in the same fashion as general office space.

Maintenance Shops. Maintenance shops require plugmold strips above work benches with outlets 450 mm (18 inches) on center.

Electrical and Communications Closets. Electrical closets require one emergency power receptacle. The communications closet 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 1.8m (6 foot) intervals around the walls and direct connection to the main building grounding system. If uninterruptible power is required in communications closets, it will be furnished as part of the communications system.

Main Mechanical and Electrical Rooms. Main mechanical and electrical equipment rooms shall each have one emergency power receptacle.

Exterior Mechanical Equipment. Provide one receptacle adjacent to mechanical equipment exterior to the building.

Toilet Rooms. Each toilet room shall have one GFI receptacle at the vanity or sink.

6.11 Emergency Power Systems

All facilities must have an emergency power system for life safety as required by code. It must be designed in accordance with NFPA 110, *Emergency and Standby Power Systems*. See Chapter 7 for additional requirements.

Batteries

Self contained battery units may be used for individual light fixtures in buildings where an emergency generator is not required for other systems.

Fire alarm and security systems must be provided with their own battery back-up.

Generator Systems

The system should 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.

Service Conditions. If the unit is to be installed outdoors, it should be provided with a suitable enclosure and have provisions to ensure reliable starting in cold weather. Starting aids such as jacket-water heaters can be specified to improve reliable starting capability in cold weather.

When installed at high altitudes or in higher-than-rated 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. Silencers are required for all generators. Acoustical treatment of the generator room shall be provided if necessary.

Generators should 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.

Radiators should be unit-mounted if possible. If ventilation is restricted in indoor applications, remote installation is acceptable. Heat recovery and load shedding should not be considered.

Capacity. The engine generator should be sized to approximately 110 percent of design load; ideally it should run at 50 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.

Emergency Power Loads. Emergency power should be provided for the following functions:

- Egress and exit lighting.
- Fire alarm system.
- Generator auxiliaries.
- Smoke control systems (if required by code)[1].
- Fire pump.
- Lighting[2].
- Telephone switch.
- Security systems.
- Mechanical control systems.
- Building Automation System.
- Elevators (one per bank)[1].
- Sump pumps.
- Sewage ejector pumps.
- Exhaust fans removing toxic, explosive or flammable fumes.
- Uninterruptible power systems serving computer rooms[1].
- Air conditioning systems for computer and UPS rooms[1].
- Exhaust fan in UPS battery rooms.
- Power and lighting for Fire Control Center and Security Control Center.
- Lighting for main electrical room, electrical closets, and communications closets.
- Air conditioning systems serving communications closets.

Notes:
1 Evaluate on a case by case basis.
2 As noted in the Section: *Lighting Criteria for Building Spaces* of this chapter.

Distribution System. The distribution system should be designed so that emergency and auxiliary power sources cannot backfeed energy into the de-energized normal voltage systems under normal, emergency or failure conditions.

Generator Derangement Alarms. Generator derangement alarms must be provided in the generator room. All malfunctions should be transmitted to the BAS. In buildings without BAS, a generator alarm annunciator should be located next to the fire alarm panel.

Automatic Transfer Switches. Automatic transfer switches serving motor loads should be dual motor-operated (adjustable time delay neutral position) or 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 may also have pre-transfer contacts to signal time delay relays in the emergency motor control centers.

In order to reduce possible nuisance tripping of ground fault relays, automatic transfer switches serving 3-phase, 4-wire loads should have 4-pole contacts with an overlapping neutral.

Automatic transfer switches should 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.

Load Bank. Generally, generators should be run with the actual load connected. In selected applications where critical loads cannot tolerate a momentary outage, load banks may be considered.

Paralleling. For computer centers and other critical facilities, generator paralleling should be considered.

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.

6.12 Uninterruptible Power Systems

In some facilities computer room back-up systems may be designed by the tenant agency. If this is the case, shell space and utility rough-ins should be provided. In facilities where uninterruptible power supply (UPS) systems are to be provided as part of the building construction, they should be designed as described in this section. All UPS systems are considered to be above standard for GSA space.

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 should be provided to allow for an orderly shut-down.

Electrical Service Size. A UPS system should be sized with 25 percent spare capacity.

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 should serve critical loads only. Non-critical loads should be served by separate distribution systems supplied from either the normal or electronic distribution system. Section *Site Distribution, Secondary Distribution, Secondary Distribution Systems* Figure 6-6 of this chapter shows the integration of UPS into the building power distribution system.

Emergency Electrical Power Source Requirements. When the UPS is running on emergency power, the current to recharge the UPS batteries should be limited. This limited battery charging load should be added when sizing the emergency generator.

If the UPS system is backed up by a generator to provide for continuous operation, then the generator must also provide power to all necessary auxiliary equipment, i.e., the lighting, ventilation, and air conditioning supplying the UPS and serving the critical technical area.

System Status and Control Panel. The UPS should include all instruments and controls for proper system operation. The system status panel should have an appropriate audio/visual alarm to alert operators of potential problems. It should include the following monitoring and alarm functions: system on, system bypassed, system fault, out of phase utility fault, closed generator circuit breaker. It should 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 should also be transmitted to the BAS.

UPS and Battery Room Requirements. Design the battery room in accordance with Article 480 of *National Electrical Code*. 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; 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. See Chapter 7 for additional requirements.

6.13 Computer Center Power Distribution

In some GSA buildings the power distribution system for computer centers will be designed by the tenant agency. In that case utility rough-in should be provided under the construction contract. If distribution is to be provided under the building contract, it should be designed according to the criteria in this section. Computer center power systems must comply with the Federal Information Processing Standard FIPS 94: *Guidelines on Electrical Power for ADP Installations*.

Power Distribution Units (PDU's). PDU's with internal or remote isolation transformers and output panelboards should be provided in all computer centers.

Non-linear Loads. Non-linear loads generate harmonic currents that are reflected into the neutral service conductors. Engineers should exercise caution when designing circuits and selecting equipment to serve non-linear loads, such as automated data processing equipment in computer centers. It is recommended to size neutrals at twice the size of the phase conductor. PDU's with internal or remote isolation transformers should also be derated for 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 should be provided. The design of the computer room grounding system should 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 which 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 should be run from the PDU isolation transformer to the nearest effective earth grounding electrode as defined in Article 250 of the NEC. All circuits serving Automated Data Processing (ADP) equipment from a PDU should have grounding conductors equal in size to the phase conductors.

High Frequency Power System Grounding. 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 strip directly on the structural floor below the raised access floor. Data processing equipment should 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.

U.S. Census Bureau, Bowie, MD

The following guidelines should 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.

Emergency Power Off (EPO) Systems. EPO pushbuttons should be provided in data processing centers at exits and at PDU's. Upon activation of push button or local fire alarm system, all power to the room and to the HVAC system for the room should be disconnected per *National Electric Code*, Article 645 and NFPA 75.

6.14 Lighting

Lighting should be designed to enhance both the overall building architecture as well as the effect of individual spaces within the building.

Interior Lighting

Consideration should be given to the options offered by direct lighting, indirect lighting, downlighting, uplighting and lighting from wall- or floor-mounted fixtures.

Illumination Levels. For lighting levels for interior spaces see the values indicated in Table 6-2. For those areas not listed in the table, the IES *Lighting Handbook* may be used as a guide.

In office areas with system furniture, assume that undercabinet task lighting is used and provide general illumination of about 300 Lux (30 footcandles) on the work surface. Ceiling lighting branch circuit capacity, however, should be sufficient to provide levels in Table 6-2 for occupancy changes.

Energy Efficient Design. Lighting design must comply with ASHRAE/IES 90.1 as modified by Table 6-3. Power allowances for normal system receptacles include task lighting as shown in Table 6-1. Lighting calculations should show the effect of both general and task lighting assuming that task lighting where it is used has compact fluorescent tubes.

Accessibility for Servicing. Careful consideration must be taken in the design of lighting systems regarding servicing of the fixtures and replacement of tubes or bulbs. This issue needs to be discussed with building operation staff to determine the dimensional limits of servicing equipment.

Light Sources. Generally, interior lighting should be fluorescent. Downlights should be compact fluorescent; high bay lighting should be high intensity discharge (HID) type. HID can also be an appropriate source for indirect lighting of high spaces. However, it should not be used in spaces where instantaneous control is important, such as conference rooms, auditoria or courtrooms.

Dimming can be accomplished with incandescent, fluorescent or HID fixtures, although HID and fluorescent dimmers should not be used where harmonics constitute a problem. Incandescent lighting should be used sparingly. It is appropriate where special architectural effects are desired.

General Lighting Fixture Criteria

Lighting Fixture Features. Lighting fixtures and associated fittings should always be of standard commercial design. Custom-designed fixtures should be avoided. They may only be used with express approval from GSA in cases where available standard units cannot fulfill the required function.

Offices and other areas using personal computers or other VDT systems should use indirect or deep-cell parabolic ceiling fixtures. If acrylic lenses or diffusers are used, they should be non-combustible.

Baseline Building Fixture. The fixture to be used for baseline cost comparisons for office space is a 600 mm (2-foot) by 1200 mm (4-foot) 3 lamp fixture utilizing T-8 or CFL lamps and electronic ballasts, deep cell parabolic diffuser, and white enamel reflector.

The number of fixture types and lamp types in the building must be minimized.

Table 6-2
Interior Illumination Levels (Average)

Area	Nominal Illumination Level in Lumens/Square Meter (lux)
Office Space	
Normal work station space, open or closed offices[1]	500
ADP Areas	500
Conference Rooms	300
Training Rooms	500
Internal Corridors	200
Auditoria	150-200
Public Areas	
Entrance Lobbies, Atria	200
Elevator Lobbies, Public Corridors	200
Ped. Tunnels and Bridges	200
Stairwells	200
Support Spaces	
Toilets	200
Staff Locker Rooms	200
Storage Rooms, Janitors' Closets	200
Electrical Rooms, Generator Rooms	200
Mechanical Rooms	200
Communications Rooms	200
Maintenance Shops	200
Loading Docks	200
Trash Rooms	200
Specialty Areas	
Dining Areas	150-200
Kitchens	500
Outleased Space	500
Physical Fitness Space	500
Child Care Centers	500
Structured Parking, General Space	50
Structured Parking, Intersections	100
Structured Parking, Entrances	500

[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.)

NOTE: To determine footcandles (fc), divide lux amount by 11.

Table 6-3
System Performance Unit Lighting Power Allowance Common Activity Areas

UPD Area/Activity	UPD W/m²	Wft²	Note
Auditoriums	15.0	1.4	c
Corridor	8.6	0.8	a
Classroom/Lecture Hall	19.4	1.8	
Elect/Mech Equipment Room			
General	7.5	0.7	a
Control Rooms	16.1	1.5	a
Food Service			
Fast Food/Cafeteria	8.6	0.8	
Leisure Dining	15.0	1.4	b
Bar/Lounge	14.0	1.3	b
Kitchen	15.0	1.4	
Recreation/Lounge	5.4	0.5	
Stairs			
Active Traffic	6.5	0.6	
Emergency Exit	4.3	0.4	
Toilet & Washroom	5.4	0.5	
Garage			
Auto & Pedestrian Circulation	2.7	0.25	
Parking Area	2.1	0.2	
Laboratories	23.7	2.2	
Library			
Audio Visual	11.8	1.1	
Stack Area	16.1	1.5	
Card File & Cataloging	8.6	0.8	
Reading Area	10.7	1.0	
Lobby (General)			
Reception & Waiting	5.9	0.55	
Elevator Lobbies	4.3	0.4	
Atrium (Multi-Story)			
First 3 Floors	4.3	0.4	
Each Additional Floor	1.6	0.15	
Locker Room & Shower	6.5	0.6	

UPD Area/Activity	UPD W/m²	Wft²	Note
Office			
Enclosed offices of less than 900 ft² and all open plan offices without partitions or with partitions lower than 4.5 ft. below ceiling			
Reading, Typing and Filing	14.0	1.3	d
Drafting	23.6	2.2	d
Accounting	19.4	1.8	d
Open plan offices, 900ft² or larger, with medium partitions 3.5 to 4.5 ft. below ceiling			
Reading, Typing and Filing	16.1	1.5	a
Drafting	28.0	2.6	a
Accounting	22.6	2.1	a
Open plan offices, 900ft² or larger, with large partitions higher than 3.5 ft. below ceiling			
Reading, Typing and Filing	18.3	1.7	a
Drafting	32.3	3.0	a
Accounting	25.8	2.4	a
Common Activity Areas			
Conference/Meeting Room	14.0	1.3	c
Computer/Office Equipment	22.6	2.1	
Filing, Inactive	10.7	1.0	
Mail Room	19.4	1.8	
Shop (Non-Industrial)			
Machinery	26.9	2.5	
Electrical/Electronic	26.9	2.5	
Painting	17.2	1.6	
Carpentry	24.7	2.3	
Welding	12.9	1.2	
Storage and Warehouse			
Inactive Storage	2.1	0.2	
Active Storage, Bulky	3.2	0.3	
Active Storage, Fine	9.7	0.9	
Material Handling	10.7	1.0	
Unlisted Spaces	2.1	0.2	

Notes:

a Area factor of 1.0 shall be used for these spaces.

b Base UPD includes lighting required for clean-up purpose.

c A 1.5 adjustment factor is applicable for multi-function spaces.

d Minimum of 90% of all work stations shall be enclosed with partitions of the height prescribed.

Fixture Ballasts. Ballasts should have a sound rating of "A" for 430 MA lamps, "B" for 800 MA lamps and "C" for 1500 MA lamps. Electronic ballasts should be used wherever possible.

Exit Signs. Exit signs shall be of the LED type and meet the requirements of NFPA 101.

Lighting Criteria for Building Spaces

Office Lighting. Office lighting is generally fluorescent lighting. A lighting layout with a fairly even level of general illumination is desirable. Modular (plug-in) wiring for fluorescent lighting fixtures should be used for office areas to facilitate changes. In open office areas with systems furniture partitions, the coefficient of utilization must be reduced to account for the light obstruction and absorption of the partitions.

Design for glare, contrast, visual comfort and color rendering and correction must be in compliance with recommendations contained in the Illuminating Engineering Society of North America (IES) *Lighting Handbook*.

Task lighting will be used in situations, such as areas of systems furniture, where the general lighting level would be insufficient for the specific functions required.

ADP Areas. Generally, ADP areas should have the same lighting as offices. If the area contains special work stations for computer graphics, dimmable fluorescent lighting may be required. If a large ADP area is segregated into areas of high and low personnel activity, switching design should provide for separate control of lights in high- and low-activity areas of the space.

Conference Rooms and Training Rooms. These spaces should have a combination of fluorescent and dimmable incandescent lighting.

Lobbies, Atria, Tunnels and Public Corridors

Special lighting design concepts are encouraged in these spaces. The lighting design should be an integral part of the architecture. Wall fixtures or combination wall and ceiling fixtures may be considered in corridors and tunnels to help break the monotony of a long, plain space. As stated previously, careful consideration must be taken in the design of lighting systems regarding servicing of fixtures and replacement of lamps.

Mechanical and Electrical Spaces

Lighting in equipment rooms or closets needs to be provided by industrial-type fluorescent fixtures. Care should be taken to locate light fixtures so that lighting is not obstructed by tall or suspended pieces of equipment.

Dining Areas and Serveries

Ample daylight is the illumination of choice in dining areas, assisted by fluorescent fixtures. Limited compact fluorescent lighting for accents is acceptable if comparable architectural effect to incandescent lighting can be achieved.

Character-Defining Spaces in Historic Structures. Spaces that contribute to the character of a historic structure, as identified the HBPP, should be lighted in a manner that enhances their historic and architectural character. Maintenance and rehabilitation of historic lighting fixtures should be considered, and may be required in the HBPP. Care should be taken to avoid placing fixtures, switches, conduit, or other electrical facilities through character-defining architectural elements.

Structured Parking. Fixtures for parking areas may be fluorescent strip fixtures with wire guards or diffusers. Care must be taken in locating fixtures to maintain the required vehicle clearance. Enclosed fluorescent or HID fixtures should be considered for above-grade parking structures.

High Bay Lighting... Lighting in shop, supply, or warehouse areas with ceilings above 4900 mm (16 feet) should be color-improved high-pressure sodium. In areas where color rendition is known to be of particular importance, metal halide should be used.

Supplemental Emergency Lighting. Partial emergency powered lighting must also be provided in main mechanical, electrical and communications equipment rooms; UPS, battery and ADP rooms; security control centers; fire control centers; the room where the Building Automation System is located; adjacent to exits; and stairwells. Where CCTV cameras are used for security systems, emergency lighting should be provided at the task area.

Lighting Controls

All lighting must be provided with manual, automatic, or programmable microprocessor lighting controls. The application of these controls and the controlled zones will depend on a number of space factors: frequency of use, available daylighting, normal and extended work hours and the use of open or closed office plans. All of these factors must be considered when establishing zones, zone controls and appropriate lighting control.

Lighting Configuration Benefits. An appropriate lighting configuration can benefit the Government; it reduces operating costs by permitting limited operation after working hours, takes advantage of natural light during the daytime working hours and facilitates the subdivision of spaces.

Enclosed Space Lighting Controls. Enclosed space lighting controls may include switches, occupancy sensors, daylight sensors, light level sensors or micro-processors. The lights can be zoned by space or multiple spaces. If microprocessor controls are used to turn off the lights, a local means of override should be provided in every office to continue operations when required.

The following design guidance is provided for enclosed areas:

- Photoelectric sensors that reduce lighting levels in response to daylighting are recommended for small closed spaces with glazing.
- Occupancy sensors should be considered for small closed spaces without glazing.
- Microprocessor control, programmable controller or central computer control are recommended for multiple closed spaces or large zones.
- Touchtone telephone or manual override controls should be provided if microprocessor, programmable controller or central computer control is provided.

Open Space Lighting Controls. Open space lighting controls may include switches, light level sensors for spaces adjacent to glazing and microprocessor controls for zones within the space. If microprocessor controls are used to turn off the lights, a local means of override should be provided to continue operations when required.

Large open space should be subdivided into zones of approximately 100 m^2 (1,000 square feet) or one bay. The following guidelines are provided for open plan spaces:

- Controls should be located on core area walls, on permanent corridor walls or on columns
- Remote control schemes and reductions from a programmable controller, microprocessor, and/or central computer should be considered.

Occupancy Sensor Lighting Controls. Infrared, ultrasonic, or passive dual sensors should be considered for small, enclosed office spaces, corridors (if adequate lighting is provided by emergency system) and toilet areas. Each occupancy sensor should control no more than one enclosed space/area. Each occupancy sensor should be marked by a label identifying the panel and circuit number. Occupancy sensors should not be used in open office areas or spaces housing heat producing equipment.

Ambient Light Sensor Controls. Photoelectric sensors should be considered for fixtures adjacent to glazed areas and for parking structures.

Exterior Lighting

Exterior luminaires must comply with local zoning laws. Lighting levels for exterior spaces should be the values indicated by the IES Lighting Handbook. Flood lighting should only be provided if specified in the building program. Exterior lighting of a historic structure should be designed to blend with and support the new architectural characteristics that contribute to the structure's character.

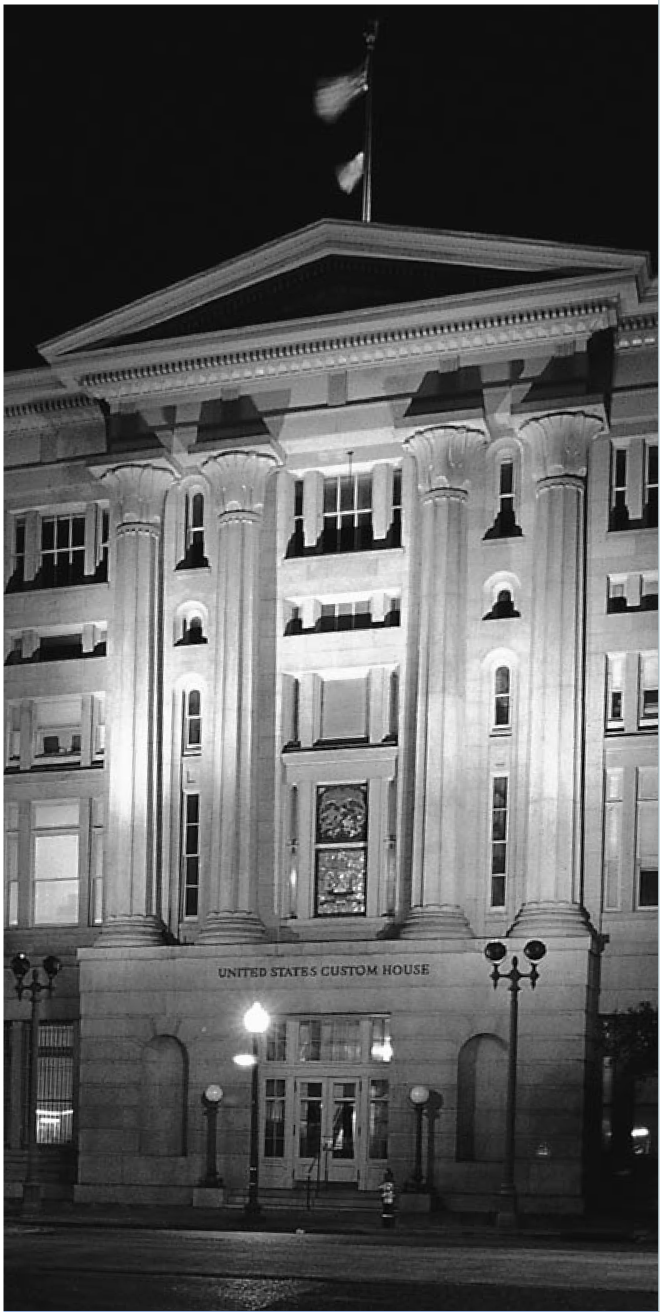
Parking and Roadway Lighting. Parking and roadway lighting should be an HID source and should not exceed a 10 to 1 maximum to minimum ratio and a 4 to 1 average to minimum ratio.

Parking lots should be designed with high-efficiency, pole-mounted luminaires. High- pressure sodium lamps are preferred but consideration should be given to existing site illumination and the local environment. Emergency power is not required for parking lot lighting.

Entrances. Lighting fixtures should be provided at all entrances and exits of major structures.

Loading Docks. Exterior door lighting should be provided at loading docks. Fixtures for illumination of the interior of trailers should be provided at each truck position.

Controls. Exterior lighting circuits should be controlled by photocell and a time clock controller to include both all-night and part-night lighting circuits.



U.S. Custom House, New Orleans, LA

6.15 Raceway System for Communications

Communications systems for all GSA buildings will meet the requirements of FIBS Standard 175: *Federal Building Standard for Telecommunications Pathways and Spaces.* Communications systems for all GSA buildings will be designed by FTS and installed by FTS or the tenant. Only the raceway system is part of the building design and construction. It consists of manholes, ductbanks, entrance rooms and vaults, communications equipment room(s), closets, and the sleeves, ducts, conduits, raceways and outlets that comprise the horizontal pathways, backbone pathways and workstation outlets of the technology infrastructure.

Bonding for communication system must comply Federal Information Processing Standard 195: *Federal Building Grounding and Bonding Requirements for Telecommunications* (see also EIA/TIA Standard 607 and related bulletins).

Since FTS will manage the design of the communications systems, all criteria for routing and types of raceways must be obtained from FTS.

Communications Equipment or Frame Room. A communications equipment or frame room should be provided in every building. It must be sized to accommodate voice and data distribution and transmission equipment and support equipment with adequate equipment access clearances. FTS will provide detailed information on the communications equipment. A 5 ohm (maximum) signal ground and an emergency power receptacle should be provided in the room. The electrical service should be sized to accommodate the largest commercial switch of the type designated by FTS. The room should be shielded from radio and noise interferences. (See Chapter 3: *Architectural and Interior Design, Space Planning, Mechanical and Electrical Rooms* for additional information on frame room requirements.)

Communications Closets. Communications closets shall meet the requirements of FIBS Standard 175: *Federal Building Standard for Telecommunications Pathways and Spaces*. See Chapter 3: *Architectural and Interior Design, Communications Closets* for additional information on communications closets. Communications and electrical closets should be located adjacent to each other. Communications closets must be stacked vertically. Communications closets should be sized to accommodate telephone terminal boards and broadband and narrow-band data communications equipment, including cross-connects, lightwave terminal cabinets, and equipment racks with patch panels and concentrators. Telecommunications closets will contain the mechanical terminations for that portion of the horizontal wiring system and portion of the backbone wiring system for the building area served by the closet. It may also contain the main or intermediate cross-connect for the backbone wiring system. The telecommunications closet may also provide the demarcation point or interbuilding entrance facility. Closets will have the capability for continuous HVAC service, and be equipped with fire protection per Chapter 7.

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. See section on *Placing Electrical Systems in Buildings, Horizontal Distribution of Power and Communications* in this chapter.

Above Ceiling Delivery. Communications distribution in ceilings should be avoided and only used where no other alternative exists. Where necessary, communications cabling above ceilings must be run in cable tray and/or conduit.

Communications Outlets. Telephone and data outlets are to be located by FTS; layout information will be provided to A/E's.

Administration of Communications Infrastructure. Long-term use of the communications infrastructure requires administration of the systems including placing identification on all elements, keeping records and drawings on all elements, and task order information on work performed on all infrastructure elements. The administration system must maintain information on horizontal and backbone pathways, equipment rooms and closet spaces, cables, termination hardware, termination positions, splices, grounding system and bonding conductors. The information should be compatible with other building management and facility maintenance systems employed at the site.

6.16 Layout of Main Electrical Rooms

Separate electrical rooms may be provided for medium voltage and low voltage switchgear assemblies.

Vertical Clearances. Main electrical equipment rooms generally should have a clear height to the underside of the structure for compliance with requirements of the NEC. Where maintenance or equipment replacement requires the lifting of heavy parts, hoists should be installed.

Horizontal Clearances. Electrical equipment rooms should be planned with clear circulation aisles and adequate access to all equipment. Layout should be neat, and the equipment rooms should be easy to clean. Horizontal clearances should comply with requirements set forth by the NEC.

Lighting. Lighting in equipment rooms should be laid out so as not to interfere with equipment. Switched emergency lighting must be provided in main electrical rooms.

Housekeeping Pads. Housekeeping pads should be at least 75 mm (3 inches) larger than the mounted equipment on all sides.

Operation and Maintenance Manuals. Documentation on all building systems should be provided for the guidance of the building engineering staff. This 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.

The building staff should be provided with the following:

- Record drawings and specifications.
- Operating manuals with a schematic diagram, sequence of operation and system operating criteria for each system installed.
- Maintenance manuals with complete information for all major components in the facility.

Posted Instructions. Posted operating instructions are required for manually operated electrical systems. They should consist of simplified instructions and diagrams of equipment, controls and operation of the systems, including selector switches, main-tie-main transfers, ATS by-pass, UPS by-pass, etc.

Instructions should be framed and posted adjacent to the major equipment of the system.

6.17 Alterations in Existing Buildings and Historic Structures

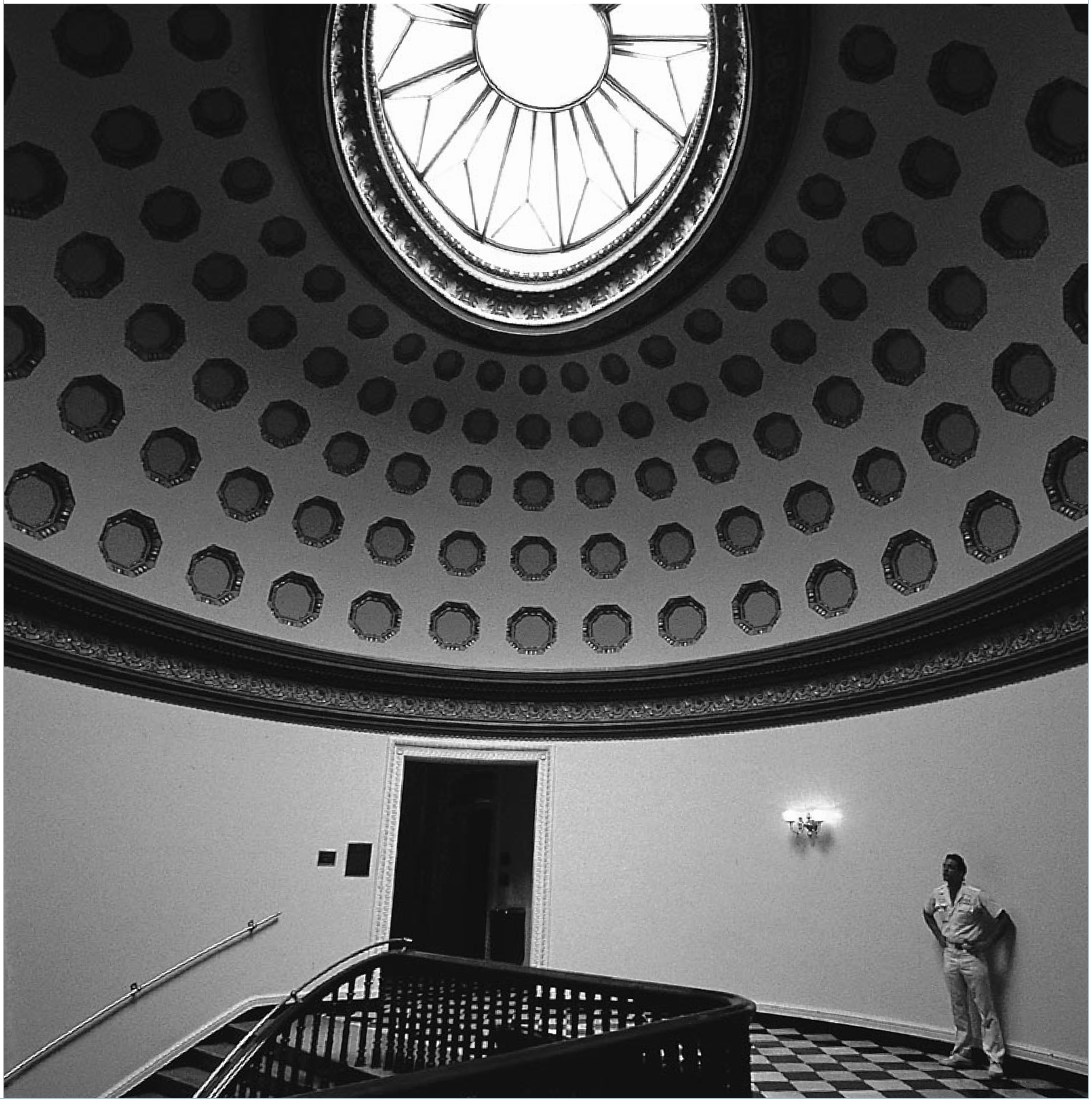
The goal of GSA's alteration projects is to approximate as well as possible the facilities standards described in this book for new projects. Renovation designs must satisfy the immediate occupancy needs but should also anticipate additional future changes. Remodeling should make building systems more flexible.

Alteration projects can occur at three basic scales: refurbishing 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 new requirements within the parameters and constraints of the existing systems. The smaller the area in comparison to the overall building, the less changes to existing systems should be attempted.

In the second case, the engineer has the opportunity to design major upgrades into the electrical and communications systems. The electrical and communications 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.

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. See Chapter 1: *General Requirements, Applicability of the Facilities Standards, Types of Facilities, Historic Buildings.*

The electrical systems in historic buildings often differ greatly from today's design and construction standards, and frequently these systems need to be upgraded substantially or completely rebuilt or replaced. The end result should be a building whose lighting and other electrical facilities support its modern use while retaining its historic and architectural character. Historic light fixtures, hardware and other period features should be retained and any supplementation shall be inconspicuous to avoid detracting from existing historic building ornamental spaces.

The end user requirements are an important part of the programming information for alteration projects. Close interaction between designers and users is essential during the programming and conceptual design phase to meet the users' needs without excessive construction costs. The general policies and standards that an administrator would give designers are usually not specific enough.

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

See Chapter 3: *Architectural and Interior Design, Alterations in Existing Buildings and Historic Structures.*

Placing Electrical and Communications Systems in Renovated Buildings

Even more than in new construction, the optimal placement of engineering systems in the building structure is a crucial element in the success of the alteration. Vertical and horizontal distribution of utilities must be integrated into the architectural concept from the outset.

Chapter 3: *Architectural and Interior Design, Alterations in Existing Buildings and Historic Structures, Placing Mechanical and Electrical Systems in Renovated Buildings* describes some of the strategies available for placement of power, lighting and communications systems.

Vertical Distribution. If new risers are required, they should preferably be located in or adjacent to existing closets. Where there is lack of space, communications risers and electrical risers can perhaps be combined.

Horizontal Distribution. Raised access flooring is highly recommended for large modernization projects. Most of the criteria established for raised flooring earlier in this chapter would apply, except that module sizes may have to be varied to fit existing conditions.

In buildings where raised access flooring is not feasible, horizontal electrical and communications distribution may be located in the ceiling. Fortunately, many older buildings have high floor-to-floor heights, which permit an expansion of the existing ceiling space. Vertical zoning of this space between various engineering systems is critical. The zoning should be established according to the principles described earlier in this chapter or according to existing ceiling zones.

In buildings with decorative or inaccessible ceilings, electrical raceways for power and communications lines can be located along walls, or be incorporated into the design of a molding or a special chase between window sills and floor. Raceways should have some additional space for future changes to the electrical and communications systems.

In buildings with fairly close spacing of columns or masonry walls, it may be possible to locate all receptacles, phone and data outlets in furred wall space. The furring should be treated as an architectural feature in historic buildings. If bay sizes are too large for this solution, systems furniture with built-in electrical service is an alternative. Power poles are also an option as long as they are integrated into the architectural design. Poke-through and flat cable should be avoided.

Building Service

If new switchgear is provided, consider sizing it according to the loads provided in the section *Electrical Load Analysis*, Table 6-1, of this chapter even if less than the entire building is being remodeled at the time.

Secondary Power Distribution

New panelboards should be added as required with ample spare capacity. See section *Electrical Load Analysis, Standards for Sizing Equipment and Systems* in this chapter. In both large and small remodeling projects, panelboards serving electronic loads should be served from an isolation transformer and sized with consideration given to harmonic currents.

Computer Center Power

Non-linear computer loads should be isolated from normal power. Ensure that the size of the supply transformer for non-linear loads is rated and protected on the basis of input and output current. Provide circuit breakers with true RMS overload protection on the supply and load sides of the transformer and increase the size of the neutral to twice the size of the phase conductor.

Lighting

General Renovations. For small remodeling projects, existing lighting systems should be matched for uniformity and ease of maintenance. In total building modernizations, the guidelines established in the section *Lighting* of this chapter should be followed.

In structures with ornamental or inaccessible ceilings, indirect lighting offers many possibilities. Fixtures may be located in wall coves or at the top of low columns or partitions.

Historic Structures. In historic buildings, the quality of the fixtures and the quality of the light are integral to the architectural integrity of the building. The character of many old buildings has been compromised by poor lighting designs. Designers are encouraged to seek imaginative solutions to achieve required light output while preserving the essential visual characteristics of historic lighting, such as variable light levels, highlighting of architectural features, light source color, reflected patterns, and the surface reflectivity of historic materials.

Many historic buildings have beautiful plaster ceilings that do not permit use of lay-in fixtures. Indirect lighting from coves, combined with task lighting, can be a good alternative. Wall sconces are another alternative, particularly in corridors. In public spaces, chandeliers or other decorative fixtures may need to be restored or duplicated.

These fixtures may be retro-fitted with compact fluorescent lamps, reflectors, and other light sources to increase light output and energy efficiency. Use of halide lamps as the sole light source in historic fixtures is discouraged because of differential color shifting that occurs as lamps age.

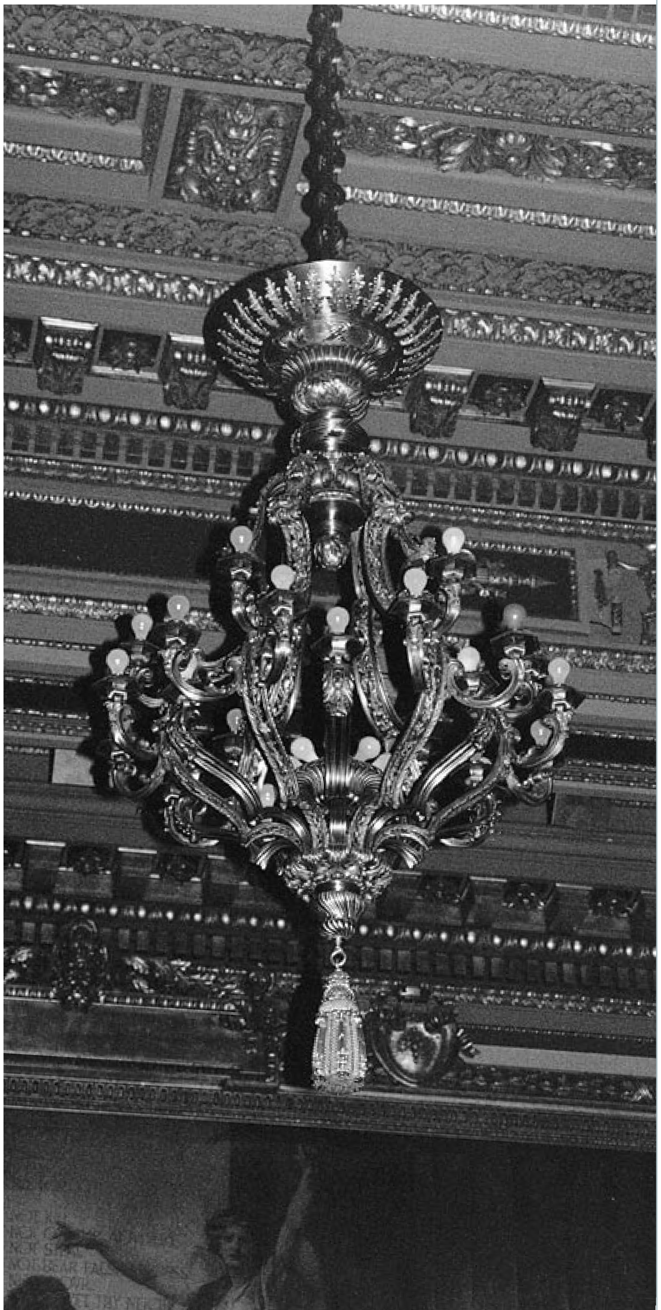
Reproduction historic lights for significant spaces such as courtrooms may be fitted with multiple light sources and separate switches to allow for multiple light levels. Select lamps providing color rendition as close as possible to that of original lighting. In historically significant spaces requiring increased light levels, apply the following order of preference:

1. Retrofit historic lights with energy efficient ballasts/lamps

2. Add discretely designed supplementary lighting, preferably reflected light, to avoid competing with period lighting.

In historically significant spaces, supplementing of ceiling-mounted lights with wall mounted sconces, indirect lights mounted on furniture, or freestanding lamps is preferable to installing additional ceiling mounted fixtures.

The light source is another important concern. Typically, the existing source is incandescent. Where feasible, the light fixture should be changed to a fluorescent source, with color rendition as close as possible to that of the incandescent light.



Metzenbaum Courthouse, Cleveland, OH

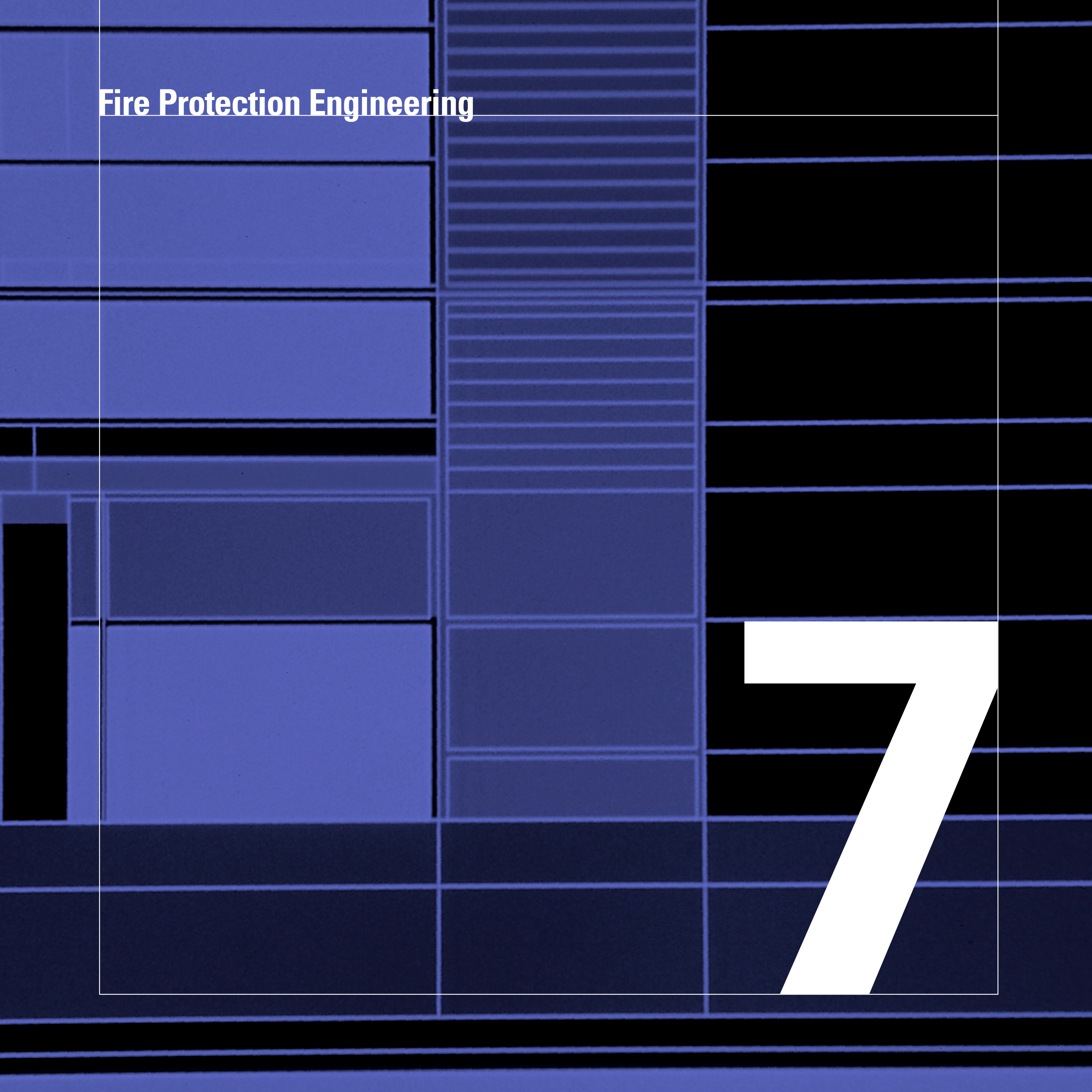
Communications Distribution

Communications systems are always designed by FTS, and they will, therefore, furnish raceway systems criteria for alteration projects.

Telephone. Generally, older buildings have telephone closets and wiring. For small alterations, the telephone system should probably just be extended to meet new requirements. For major building modernizations, a new distribution system for phone and data should be installed, as described in the section *Raceway System for Communications* of this chapter.

Data. Data wiring is generally non-existent in older buildings. An above-ceiling cable tray should be included in even the smallest projects to facilitate computer networking.

In total building renovations, vertical and horizontal data and telephone distribution should be provided. If there is no existing underfloor system, consider a cable tray loop in the ceiling of the permanent circulation corridors.



Fire Protection Engineering

7

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7.16 Historic Structures

7.1 General Approach

Introduction

GSA's approach in the construction of new facilities and renovation projects is to design facilities that incorporate efficient, cost-effective fire protection and detection systems that are effective in detecting and extinguishing or controlling a fire event. 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 and maintain client agency mission continuity) to the Federal Government and taxpayer.

General

Scope. This chapter provides the technical fire protection requirements and design criteria for GSA facilities to meet the goals identified above. The majority of the fire protection 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 of 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 requirements are primarily directed to the construction of new facilities and renovation projects.

For all projects involving fire protection engineering 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 need.

Deviations from established requirements are allowed when the Design Team's registered fire protection engineer performs an assessment that analyzes the risks. The GSA regional fire protection engineer shall review the technical documentation to determine that the proposed alternative design is deemed equivalent or superior to the intent of the prescribed requirements of this chapter. Refer to Chapter 1 for additional information.

7.2 Fire Safety During Construction and Renovations

General. Fire safety during construction and renovations shall comply with the requirements of the National Model Building Code, the National Model Fire Code, and 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. For example, the provision of a 24 hour fire watch by qualified individuals may provide an equivalent level of fire protection during system disruption.

Old Post Office Building renovation, Washington, D.C.

7.3 Building Construction

Types of Construction. For each construction type, design fire resistive ratings of structural members in accordance with the requirements of the National Model Building Code.

Panel and Curtain Walls. All panel and curtain walls shall meet the requirements for nonbearing walls in the type of construction involved and shall be securely anchored to the building so as to prevent failure of the anchors during fire.

Fire Stopping. Fire stopping shall be provided in all openings between exterior walls (including panel, curtain, and spandrel walls) and floor slabs, and openings in floors and shaft enclosures, to form an effective fire and smoke barrier between stories.

Fireproofing

All fireproofing (cementitious or fiber) used shall be specified to meet the following requirements:

Sprayed-on Fireproofing.
- *Deflection:* No cracking, spalling or delamination. Test method ASTM E 759.
- *Impact on Bonding:* No cracking, spalling or delamination. Test method ASTM E 760.
- *Corrosion Resistance:* No corrosion. Test method ASTM E 937.
- *Air Erosion:* Maximum weight loss of 0.27 g/m2 (0.025 grams per square foot) in 24 hours. Test method ASTM E 859.
- *Burning Characteristics:* Maximum flame spread rating of 10 for concealed fireproofing, 5 for exposed fireproofing, and smoke development rating of 0. Test method ASTM E 84.

Concealed Sprayed-on Fireproofing.
- *Density:* The greater of 240 kg/m3 (15 pounds per cubic foot) or the density required to attain the required fire resistance rating. Test method ASTM E 605.
- *Thickness:* The greater of 10 mm (0.375 inches) or the thickness required for the fire resistive design. Test method ASTM E 605.
- *Bond Strength:* 1030 kPa (150 PSI). Test method ASTM E 736.
- *Compressive Strength:* 35 kPa (5.21 PSI). Test method ASTM E 761.

Exposed Fireproofing. Fireproofing shall not be exposed to the outside environment unless there are no viable options. However, if this must occur, precautions must be made to protect fireproofing from light, moisture, rain, sleet and snow, and damage from other sources.

Spokane Federal Building/U.S. Post Office

7.4 Interior Finishes

The interior finish requirements for walls, ceilings, floors, draperies, curtains, and movable partitions shall meet the requirements of the National Model Building Code.

Special Requirements. The requirements below supersede the requirements of the National Model Building Code:

- Adhesives and other materials used for the installation of carpets shall be limited to those having a flash point of 140 degrees F or higher.
- All other materials composed of combustible substances, such as wood (e.g., plywood, 600 mm by 1200 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).

7.5 Occupancy Classifications

General. Occupancy classifications shall meet the requirements of the National Model Building Code.

Spokane Federal Building

7.6 Means of Egress

General. The egress requirements in NFPA 101 shall be used in lieu of the egress requirements in the National Model Building Code. In 1999, NFPA 101B, Code for Means of Egress for Buildings and Structures, was developed with the intent that it be used as part of a national model building code. (The requirements contained in NFPA 101B have been derived from NFPA 101, Life Safety Code.) In an effort to make this a user-friendly document, GSA would offer the project team the opportunity to use the requirements in NFPA 101B in lieu of the egress requirements of NFPA 101, Life Safety Code.

Special Requirements.:

- In buildings that are fully sprinklered, 1-hour fire rated corridors shall not be required.
- In buildings that are fully sprinklered, enclosure of the elevator lobbies shall not be required.
- Interlocking (scissor) stairs that occupy a single (communicating) stair shaft shall count as only one exit stair. A minimum of two exit stairs is 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. Fire escapes, as defined in NFPA 101, shall not be considered approved exits.

Stairway Pressurization. In fully sprinklered new construction having occupied floors located more than 75 feet above the level of exit discharge or more than 30 feet below the level of exit discharge, exit stairways shall be pressurized in accordance with the requirements of the National Model Building Code.

7.7 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 NFPA 13 and the National Model Building Code.

Fire Pump Design. When a fire pump is necessary to supplement fire flow and pressure, size it to comply with NFPA 13, 14, and 20.

Special Requirements. The requirements below supersede the fire pump requirements of NFPA 13, 14, and 20:

- The fire pump shall be sized only for the sprinkler system requirements. The local responding fire department will provide the necessary flow and pressure for manual fire fighting operations (i.e., hose stations).
- 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 of NFPA 20.

Fire Pump Operations. A fire pump shall start automatically at 69 kPa (10 psi) below jockey pump start pressure. Fire pumps shall be designed for manual or automatic shut down. Manual shut down of the fire pump will ensure that the pump does not shut down prematurely before controlling the fire.

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.

Jockey Pump. A jockey 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 1 gpm, whichever is larger.

7.8 Water Based Fire Extinguisher Systems

Automatic Sprinkler System Installation

Automatic sprinklers systems shall be installed throughout all new construction projects and in all major renovation projects in accordance with the requirements of NFPA 13, the National Model Building Code, and the appropriate GSA sprinkler system specification.

Special Requirements: The requirements below supersede the requirements of NFPA 13 and the National Model Building Code:

- Automatic sprinklers shall be installed in all new construction projects and in all renovation projects. This includes elevator machine rooms, boiler rooms, mechanical equipment rooms, walk-in freezers and cold rooms, essential electronic facilities, electrical closets, telephone closets, emergency generator rooms, uninterruptible power service and battery rooms, electrical switchgear rooms, transformer vaults, telephone exchange (PABX) rooms, etc.
- 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

Sprinkler systems shall be hydraulically calculated in accordance with the requirements specified in NFPA 13.

Special Requirements. The requirements below supersede the design requirements of 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.
- In rooms containing movable/mobile shelving (high density storage) the sprinkler design shall be Ordinary Hazard (Group 2) using quick response sprinklers.

Seismic Protection. Seismic protection shall be installed where required by the National Model Building Code.

Types of Sprinklers

Quick response sprinklers (QRS) shall be installed in all new construction and renovation projects in accordance with the requirements specified in NFPA 13.

Special Requirements. The requirements below supersede the requirements of NFPA 13:

- All sprinklers installed in any new construction or renovation projects shall be both Underwriters Laboratories Inc. (UL) listed and Factory Mutual Engineering and Research Corporation (FM) approved.
- Sprinklers equipped with “O-ring” water seals shall not be utilized in any new construction or renovation projects.
- All sprinkler escutcheons installed in any new construction or renovation projects shall be both Underwriters Laboratories Inc. (UL) listed and Factory Mutual Engineering and Research Corporation (FM) approved.

- 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.
- Flow control (On-off) sprinklers shall not be installed in any new construction or renovation projects.
- QRS institutional sprinklers shall be installed in U.S. Marshal's Service areas of confinement in any new construction or renovation projects.

Sprinkler Piping System

Sprinkler piping, fittings, control valves, check valves, and drain assemblies shall meet the requirements of NFPA 13.

Special Requirements. The requirements below supersede the requirements of NFPA 13:

- Black steel piping and/or copper tubing shall be used for all sprinkler piping. Chlorinated polyvinyl chloride (CPVC) sprinkler piping shall be allowed to be installed only when approved by the GSA regional fire protection engineer.
- Steel pipe sizes 2 inches and smaller shall be Schedule 40 and shall be threaded.
- Steel pipe sizes larger than 2 inches shall be minimum Schedule 10. Piping less than Schedule 40 shall be roll grooved.
- Threadable lightwall pipe shall not be used.
- Piping having a corrosion resistant ratio less than 1 shall not be used.
- Plain-end fittings shall not be used.

Special Sprinkler System Requirements

Sprinklers In Spaces Housing Electrical Equipment.

- All elevator machine rooms 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.
- 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.
- All essential electronic facilities 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 less than 7 feet above the floor and in electrical rooms and electrical closets shall be equipped with sprinkler guards to provide protection against accidental damage.

Places of Confinement.

- Institutional sidewall sprinklers shall be installed in the corridor outside each of the prisoner detention cells.
- Sprinklers shall be located such that the spray pattern of the sprinklers penetrates through the bars of the cell.
- Sprinklers shall not be installed inside individual prisoner detention cells.

7.9 Non-Water Based Fire Extinguishing Systems

Wet Chemical Extinguishing Systems. Wet chemical extinguishing systems shall be installed in all commercial cooking equipment installations, and installed in accordance with NFPA 17A.

Dry Chemical Extinguishing Systems. Dry chemical extinguishing systems shall not be installed in any commercial cooking equipment installations.

Clean Agent Extinguishing Systems. Clean agent extinguishing systems shall not be installed in any new construction or renovation projects.

7.10 Standpipes and Fire Department Hose Outlets

Standpipes. Standpipes shall be installed in buildings where required by the National Model Building Code.

Special Requirements. The requirements below supersede the requirements of the National Model Building Code:

- All standpipes shall be connected to the fire protection water supply, be permanently pressurized, and be installed in accordance with 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 2-1/2 inch fire department hose outlets. Each outlet shall be located in the stair shaft and have a removable 1-1/2 inch adapter and cap. Threads and valves shall be compatible with the local fire department requirements.

7.11 Portable Fire Extinguishers and Cabinets

Portable fire extinguishers and cabinets shall be installed in accordance with the requirements of the National Model Building Code.

Special Requirements. The requirements below supersede the requirements of the National Model Building Code:

- 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, special hazard areas, etc.

7.12 Fire Protection for Storage Facilities

General Storage. The storage arrangements and protection of a general storage facility shall meet the requirements of NFPA 13 and NFPA 231.

Rack Storage. The storage arrangements and protection of a rack storage facility shall meet the requirements of NFPA 13, NFPA 231 and NFPA 231C.

Record Storage. The storage arrangements and protection of a record storage facility shall meet the requirements of NFPA 13 and NFPA 232.

Archive and Record Center. The storage arrangements and protection of an archive and record center shall meet the requirements of 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 requirements below supersede the requirements of NFPA 232.

- Smoke detectors shall be installed throughout archival storage areas in accordance with the requirements of NFPA 72.

Vincent E. McKelvey Federal Building, Menlo Park, CA

Track Files. A track file uses a single aisle to give access to an otherwise solid group of open-shelf files. Access is gained by moving shelf units on rollers along a track until the proper unit is exposed.

- 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 2400 mm (8 feet) high, and a minimum clearance of 460 mm (18 inches) shall be maintained between the top of the shelving and the ceiling.
- The sprinkler density shall be 12.2 (L/min)/ m^2 (0.3 gpm/sq ft) over 139 m^2 (1500 sq ft). Sprinkler spacing shall be 9.3 m^2 (100 ft2) maximum.
- Clearance between units shall be a minimum 2 inches when filing system is in the closed position. To accomplish this mount bumpers on the face of each unit.
- The back cover of stationary end files shall be solid sheet metal.

Flammable and Combustible Liquid Storage. The storage arrangements and protection of a flammable and combustible liquid storage area shall meet the requirements of NFPA 30 and the applicable Factory Mutual Data Sheets.

7.13 Special Fire Protection Requirements

Essential Electronic Facilities

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 NFPA 75 and the appropriate GSA computer room fire alarm system specification.

Special Requirements. The requirements below supersede the requirements of 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. 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 smoke detectors within a single protected area shall disconnect power to the computer equipment and to the HVAC system after a pre-set time delay.

Elevator Systems

Elevator systems shall be designed and installed in accordance with ANSI/ASME Standard A17.1.

Sprinkler Protection. Each elevator machine room shall be provided with a wet-pipe sprinkler system using standard response sprinklers.

Power Disconnect. Activation of the dedicated elevator machine room water flow switch shall simultaneously disconnect all power to the elevator equipment within the elevator machine room and notify the fire alarm system of the condition and the location of the waterflow.

Smoke Detectors. Smoke detectors for elevator recall shall be installed in each elevator lobby and each elevator machine room.

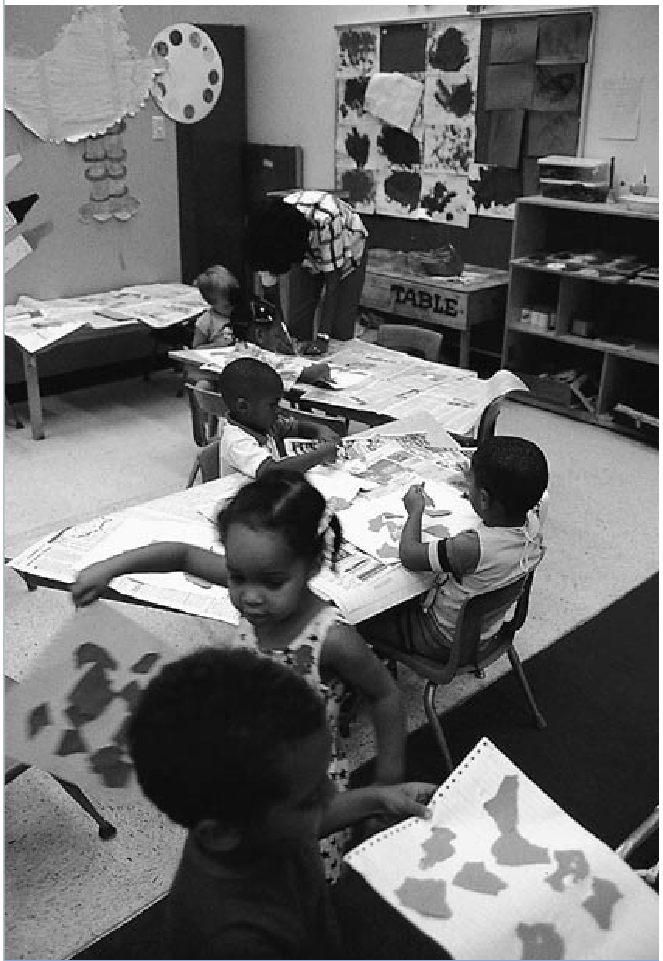
EPA Headquarters

Atrium Smoke Removal System

An atrium smoke removal system shall be designed and installed in accordance with the requirements of the National Model Building Code and NFPA 92B.

Smoke Control Systems

Smoke control systems shall be designed and installed in accordance with the National Model Building Code and NFPA 92A.



Child Care Center

Fire Protection Requirements for Cooling Towers

Cooling towers shall be in accordance with NFPA 214.

Special Requirements. The requirements below supersede the requirements of NFPA 214.

- Cooling towers over 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 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.

Child Care Centers

For special fire protection requirements for Child Care Centers see the GSA document *Child Care Center Design Guide* (PBS-P140).

Courthouses

For special fire protection requirements for Courthouses see the document *U.S. Courts Design Guide.*

Border Stations

For special fire protection requirements for Border Stations see the document *U.S. Border Station Design Guide.*


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

Laboratories

Laboratories shall meet the design requirements in NFPA 45 and the National Model Building Code.

Special Requirements. The requirements below supersede the requirements of 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 (not photo labs, unless they utilize large quantities of flammable liquids) 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.

7.14 Emergency Power, Lighting and Exit Signage

Emergency and Standby Power Systems. Emergency and standby power shall be installed and meet the performance requirements of NFPA 70, NFPA 110, and NFPA 111.

Emergency Lighting. Emergency lighting shall be installed and meet the performance requirements of NFPA 101.

Exit Signage: Exit signage shall be installed and meet the performance requirements of NFPA 101.

7.15 Fire Alarm Systems

Fire Alarm System Installation

New and replacement fire alarm systems shall be installed in accordance with the requirements of NFPA 72, the National Model Building Code, and the appropriate GSA fire alarm system specification.

Special Requirements: The design requirements below supersede the requirements of NFPA 72 and the National Model Building Code:

- All new and replacement fire alarm systems shall be addressable systems as defined in NFPA 72.
- 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.
- Each fire alarm system shall be provided with a hardwired mini-computer 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 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 3/4 inch, that utilizes compression type fittings and couplings.

Manual Fire Alarm Stations

Manual fire alarm stations shall be installed in accordance with the requirements of NFPA 72 and the National Model Building Code.

Special Requirements. The design requirements below supersede the requirements of NFPA 72 and the National Model Building Code:

- Manual fire alarm stations shall be double-action and installed in every facility in accordance with the spacing and location requirements in NFPA 72.

Waterflow

Waterflow switch(es) shall be installed in accordance with the requirements of NFPA 13, NFPA 72 and the National Model Building Code.

Special Requirements. The design requirements below supersede the requirements of NFPA 72 and the National Model Building Code:

- Waterflow switch(es) shall be installed at each floor or fire area protected by sprinkler systems.

Smoke Detectors

Smoke detectors shall be installed in accordance with the requirements of NFPA 72, NFPA 90A, and the National Model Building Code.

Special Requirements. The design requirements below supersede the requirements of NFPA 72, NFPA 90A, and the National Model Building Code:

- Smoke detectors shall not be installed in each of the following rooms: fire command center, mechanical equipment, electrical closet, telephone closet, emergency generator room, uninterruptible power service and battery rooms, or similar rooms.

- Appropriate type smoke detection shall be installed in each of the following rooms: electrical switch gear, transformer vaults and telephone exchanges (PABX).

Audible Notification Appliances

Placement and spacing of audible notification appliances shall be in accordance with the requirements of NFPA 72.

Special Requirements. The design requirements below supersede the requirements of 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 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.
- Where voice communication systems are provided, fire alarm speakers shall be installed in elevator cabs 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 cabs.

Visible Notification Appliances

Placement and spacing of visible notification appliances shall be in accordance with the requirements of NFPA 72.

Special Requirements. The design requirements below supersede the requirements of NFPA 72:

- Visual notification appliances shall only be installed in projects that involve the installation of a new fire alarm system.
- Visual notification appliances shall only be required to be installed in public and common areas. For the purposes of this requirement, visual 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 to accommodate additional visual notification appliances being added to accommodate employees who are deaf or have hearing impairments.
- Visual 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 slow whoop tone for three (3) cycles followed by the automatic voice messages which shall be repeated until the control panel is reset (i.e., slow whoop - slow whoop - slow whoop, - voice message; slow whoop - slow whoop - slow whoop - voice message; etc.).

The automatic voice messages shall be broadcast through the fire alarm speakers on the appropriate floors, but not in stairs or elevator cabs.

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 visual alarm indicating 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 visual alarm indicating 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, 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 control panel. When using the microphone, live messages shall be broadcast through speakers in stairs, in elevator cabs, and throughout a selected floor or floors. All stairwell speakers shall have a dedicated zone activation switch. All elevator speakers shall have a dedicated 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."

Graphic Annunciator

All fire alarm systems shall have at least one graphic annunciator located at the entrance to the building that the fire department enters.

Survivability

At least two vertical risers shall be installed as remote as possible from each other. The second riser shall be separated from the first riser by at least a one-hour fire rated enclosure, not common to both risers.

Where a building has two or three exit stairways, any single impairment of the notification appliance systems (i.e., audible and visible) shall not affect more than one-half of any floor. Where a building has four or more exit stairways, any single impairment of the notification appliance systems (i.e., audible and visible) shall not affect more than one-quarter of any floor.

A minimum of two (2) distinct fire alarm audible appliance circuits and a minimum of two (2) distinct visible appliance circuits shall be provided on each floor.

Adjacent fire alarm audible appliances shall be on separate circuits.

Fire Command Center

The fire command center shall be provided in a location approved by the local fire department.

The equipment and contents of the fire command center shall meet the requirements of the National Model Building Code.

The fire command center shall be enclosed by 1-hour fire resistant construction. Appropriate lighting, ventilation, and emergency lighting shall be provided.

Edward T. Gignoux U.S. Courthouse, Portland, ME

7.16 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, and performance based codes to resolve conflicts between prescriptive code requirements and preservation goals. In addition, the 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 judgement 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.

Fir Protection Alternatives for Consideration. Listed below are fire protection alternatives for the Design Team's fire protection engineer to consider when designing a project:

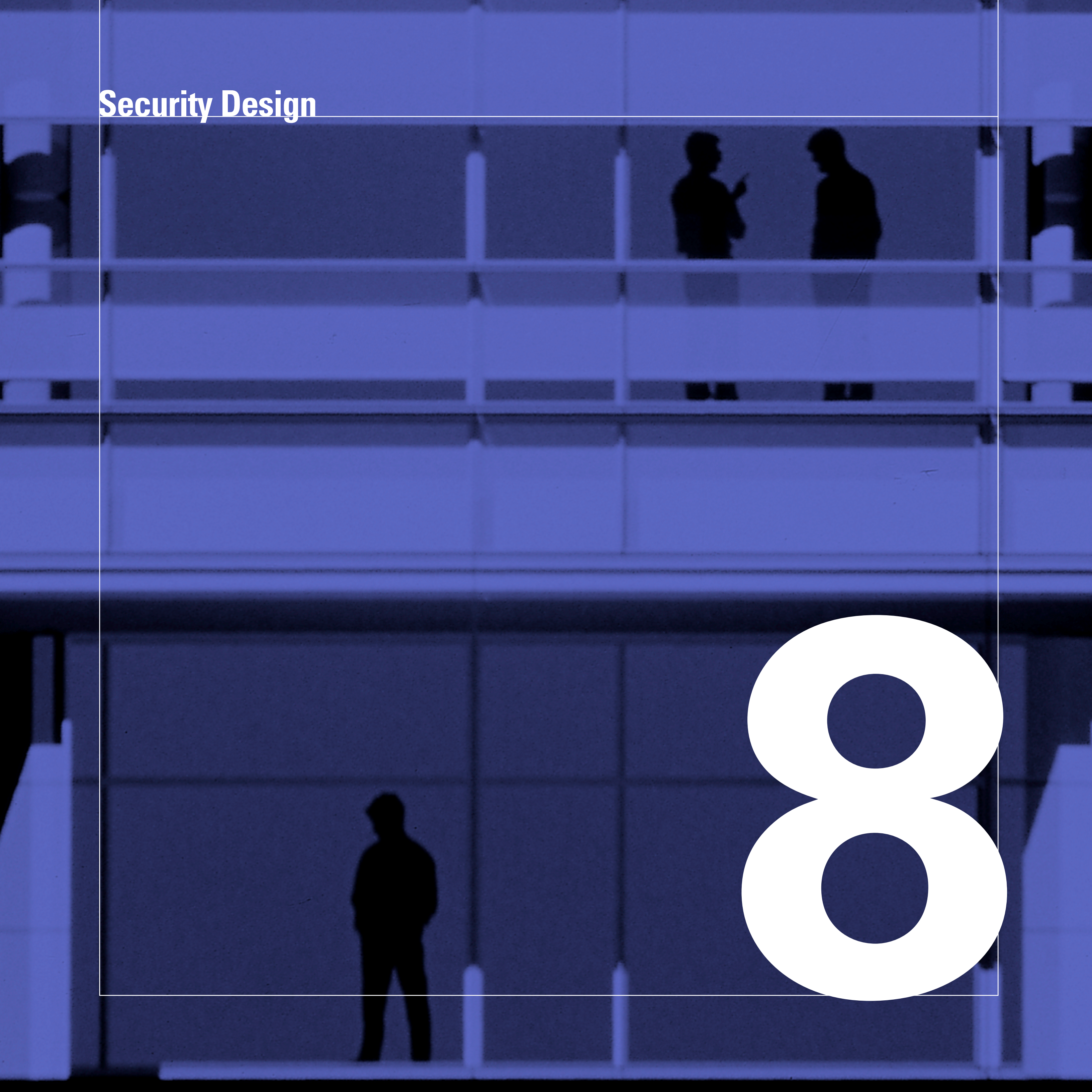
- New stair enclosures in historic buildings should be designed to minimize visual impact on significant spaces, including historic lobbies and corridors. Cross-corridor doors should be designed to provide maximum height and width clearance and avoid visually truncating the corridor. Oversized hold-open 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 carefully 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

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8.1 Planning and Cost

Planning

Security must be an integral part of building and site planning, starting at the earliest phase and continuing throughout the process. A multidisciplinary team will determine the appropriate design criteria for each project, based on a facility-specific risk assessment and an analysis of all available information on security considerations, constraints, and tenant needs.

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. All security/egress issues shall be discussed with both GSA regional fire protection engineer and physical security specialists.

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).

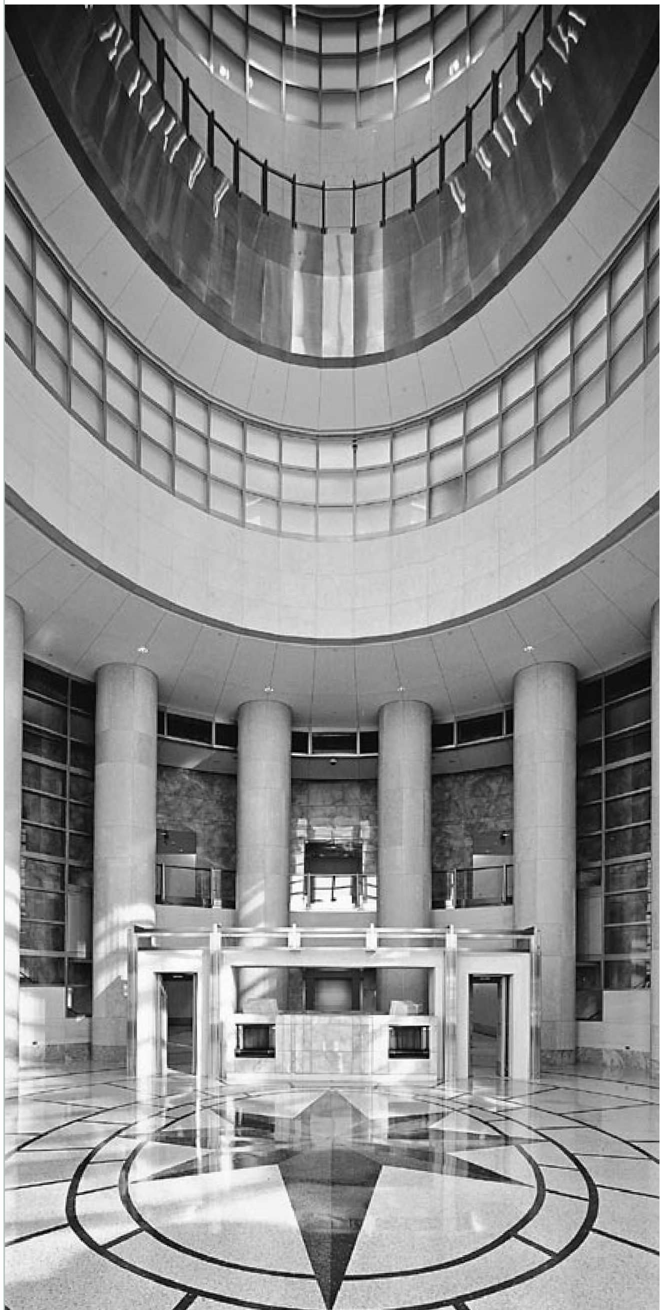
Capability to Increase or Decrease Security. Designs should include the ability to increase security in response to a heightened threat, as well as to reduce security if changes in risk warrant it.

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.



Thomas Eagleton Courthouse, St. Louis, MO

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 should be an output of a project-specific risk assessment. After the initial risk assessment has been conducted, a plan should outline security requirements for specific building systems. To facilitate funding, cost control, and risk management, agencies should 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 countermeasures 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 1946-98, may be used to manage cost risk.

Economic Analysis. A guide for selecting economic methods to evaluate investments in buildings and building systems can be found in ASTM E 1185-93. Two such economic practices are ASTM E 917-93 to measure life-cycle costs, and ASTM E 1074-93 to measure net economic benefits. ASTM E 1765-95 provides a way to evaluate both qualitative and quantitative aspects of security in a single model.

Security's life-cycle cost objective should be to minimize the total cost of building ownership while simultaneously improving a building's efficiency. Total costs include all costs incurred by the owner and users of a building. While great emphasis is often placed on meeting initial budget, scope, and schedule, these are only a small fraction of a building's total life-cycle costs. Operations is a critical area where improved effectiveness and productivity can have the greatest impact upon cost, performance, and mission accomplishments. Serious consideration of life-cycle costs during the initial project stages can greatly reduce total life-cycle costs.

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.

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 Parking Zone and Landscaping* below, and Chapter 9). See Chapter 2: *Site Planning and Landscape Design*, for fire department fire apparatus access requirements.

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. 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.

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 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.

Loading Docks and Shipping and Receiving Areas. Loading docks and receiving and shipping areas should be separated by at least 50 feet in any direction from utility rooms, utility mains, and service entrances including electrical, telephone/data, fire detection/alarm systems, fire suppression water mains, cooling and heating mains, etc. Loading docks should be located so that vehicles will not be driven into or parked under the building. If this is not possible, the service shall be hardened for blast.

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.

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 NFPA 101 and limit roof access to authorized personnel.

Warren B. Rudman Courthouse, Concord, NH

Sam Gibbons U.S. Courthouse, Tampa, FL

8.3 New Construction

Progressive Collapse[1]**.** 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. 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 model building codes 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 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.

Design up to specified load. Window systems design (glazing, frames, anchorage to supporting walls, etc.) on the exterior facade should be balanced to mitigate the hazardous effects of flying glazing following an explosive event. The walls, anchorage, and window framing should fully develop the capacity of the glazing material selected.

The designer may use a combination of methods such as government produced and sponsored computer programs (e.g., WINLAC, GLASTOP, SAFEVU, and BLASTOP/WINGUARD) coupled with test data and recognized dynamic structural analysis techniques to show that the glazing either survives the specified threats

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.

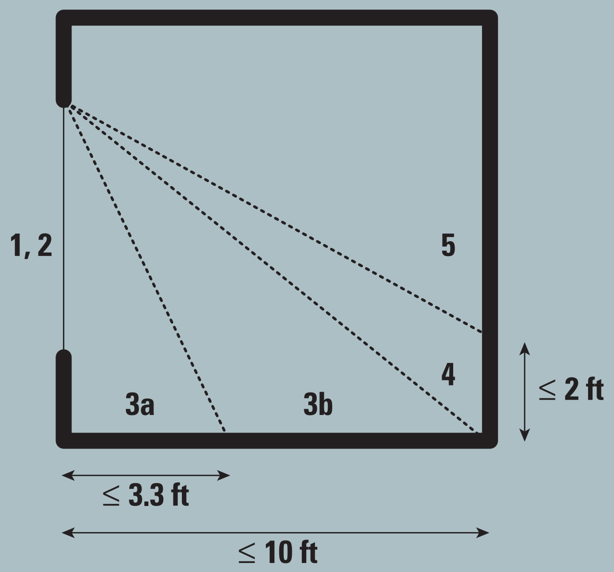
or the post damage performance of the glazing protects the occupants in accordance with the conditions specified here (Table 8-1). When using such methods, the designer may consider a breakage probability no higher than 750 breaks per 1000 when calculating loads to frames and anchorage.

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.
- 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

Robert C. Byrd Courthouse, Charlston, WV 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.

8.4 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.

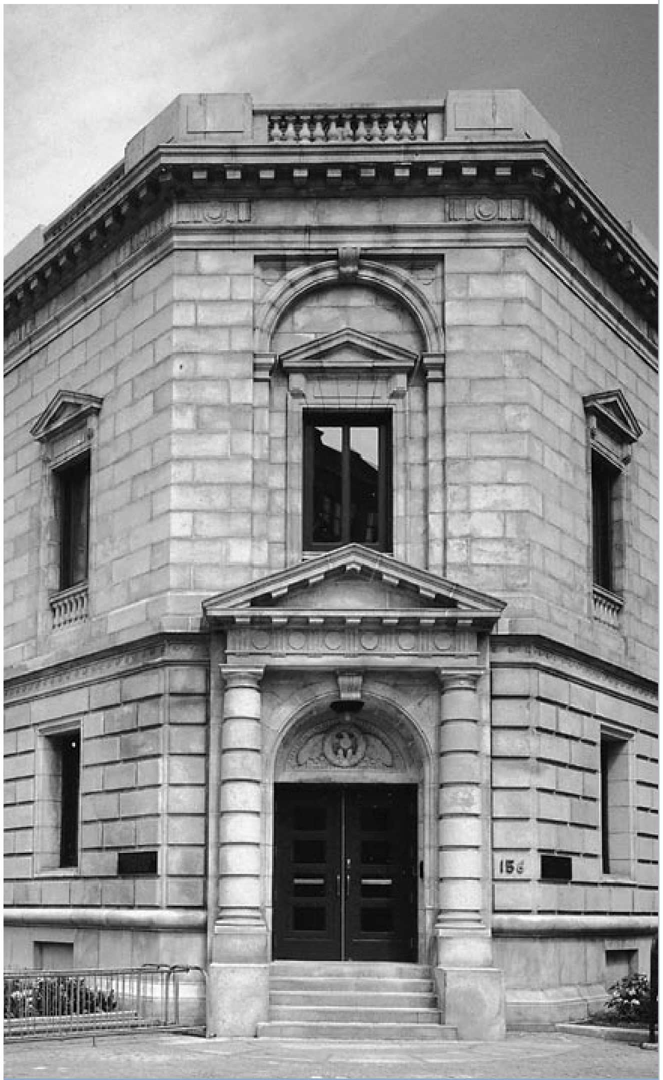
Protection Levels. Risk assessments based on the new construction criteria shall be performed on existing structures to examine the feasibility of upgrading the facility. The results, including at a minimum recommendations and cost, shall be documented in a written report before submission for project funding.

Progressive Collapse. Existing buildings will not be retrofitted to prevent progressive collapse unless they are undergoing a structural renovation, such as a seismic upgrade.

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.

8.5 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

8.6 Structural 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 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.


U.S. Census Bureau, Bowie, MD

- 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.

- 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).

8.7 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).

Smoke Control (Removal) Systems

Smoke Evacuation. 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 designer 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 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 designer 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.

8.8 Electrical Engineering

Philadelphia Veterans Center

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.

Empty Conduits. Empty conduits and power outlets can be provided for possible future installation of security control equipment.

8.9 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.

See Chapter 7 for additional information.

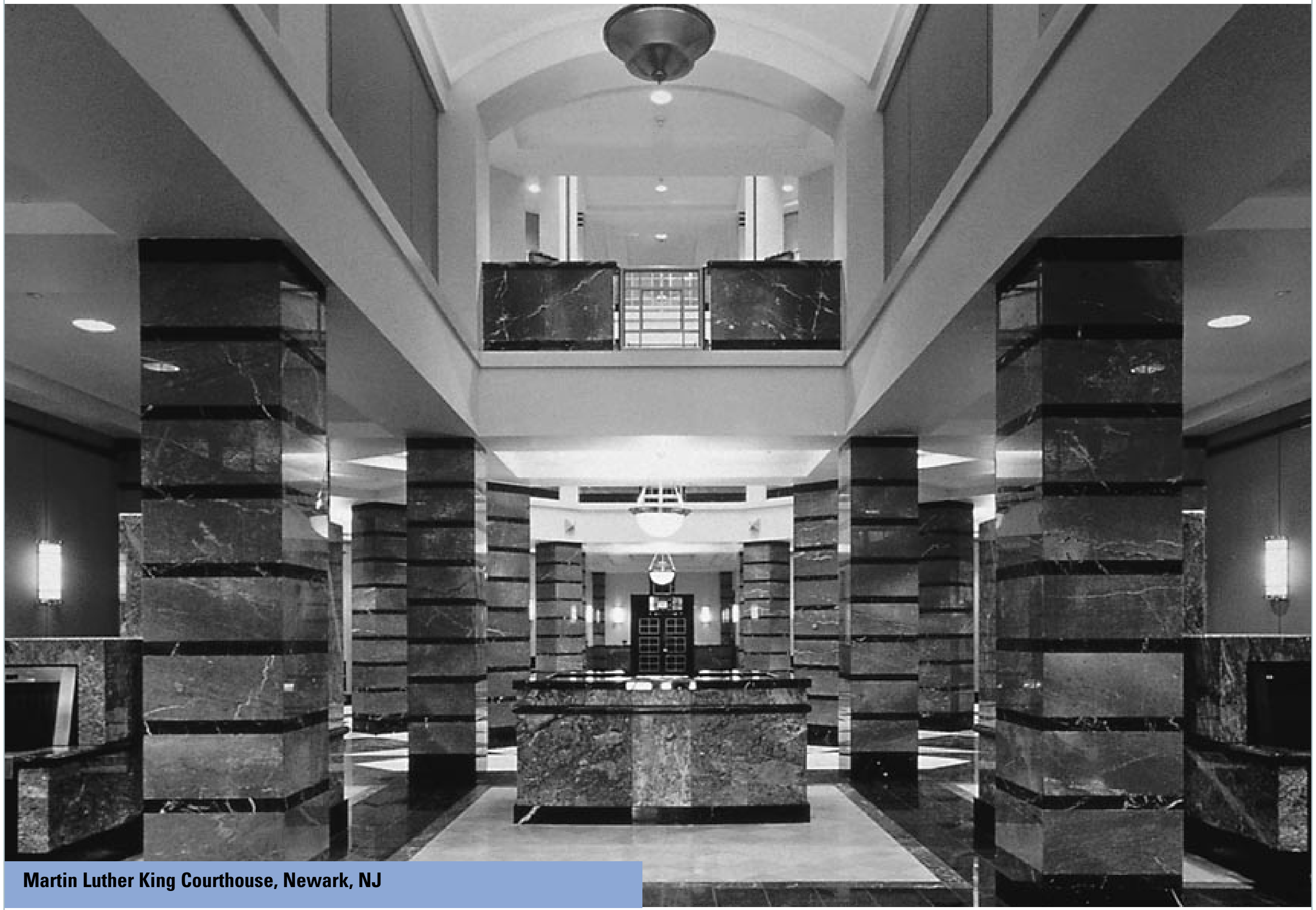
Active System

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.

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. The pumps should be located apart from each other.

Egress Door Locks. All security locking arrangements on doors used for egress must comply with requirements of NFPA 101, Life Safety Code.

8.10 Electronic Security



Martin Luther King Courthouse, Newark, NJ

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.

8.11 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 Table8-3.

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.

Table 8-3
Maintained Illumination Levels (Footcandles)[2]

Horizontal illumination at pavement, minimum	Low	Low/Med.	Medium	Higher
Covered parking areas	1.25	1.50	1.75	2.00
Roof and surface parking areas	0.25	0.50	0.75	1.00
Stairwells, elevator lobbies	2.5	3.5	4.5	5.5
Uniformity ratio (average: minimum)	4:1	4:1	4:1	4:1
Uniformity ratio (maximum: minimum)	20:1	20:1	20:1	20:1
Vertical illumination 5 feet above pavement, minimum	**Low**	**Low/Med.**	**Medium**	**Higher**
Covered parking areas	0.625	0.75	0.875	1
Roof and surface parking areas	0.125	0.25	0.375	0.5
Stairwells, elevator lobbies	1.25	1.75	2.25	2.75

Emergency Communications. Emergency intercom/duress buttons or assistance stations should be placed on structure columns, fences, other posts, and/or free-standing 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.

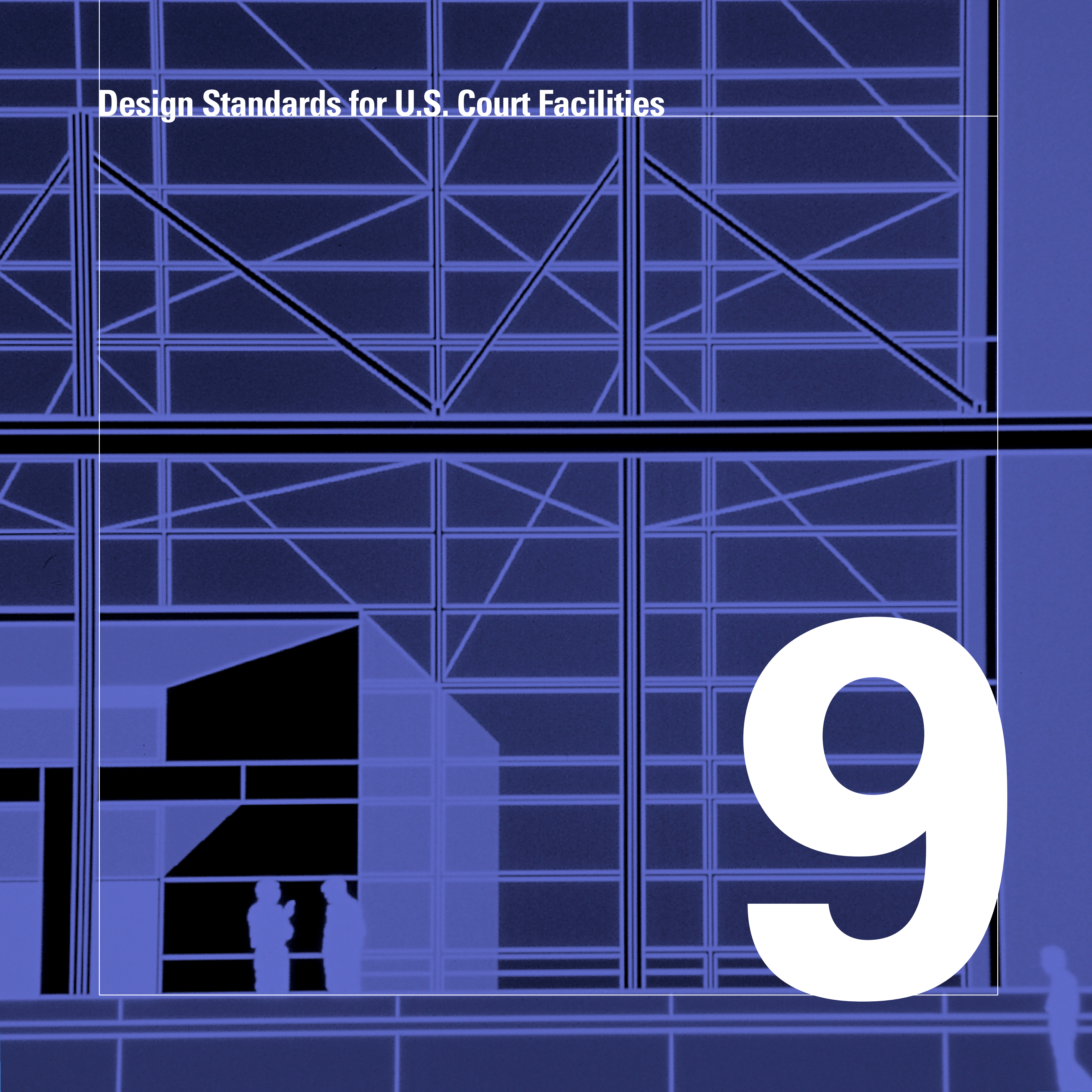
8.12 Submission Requirements

Every project will have unique characteristics and requirements for submission and review. These shall be developed by the GSA Project Manager.

The general submission requirements for each phase of project development are described in Appendix A.

[1] Design to mitigate progressive collapse is an independent analysis to determine a system's ability to resist structural collapse upon the loss of a major structural element. It is not a part of traditional blast analysis. It is possible, however, that a blast may be the cause of the removal of structural members. ASCE 7-95 describes progressive collapse and offers additional guidelines.

[2] From Chrest, Anthony P., Smith, Mary S., and Bhuyan, Sam. Parking Structures: Planning, Design, Construction, Maintenance and Repair, 2nd edition. Chapman and Hall. (1996).



Design Standards for U.S. Court Facilities

9

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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.

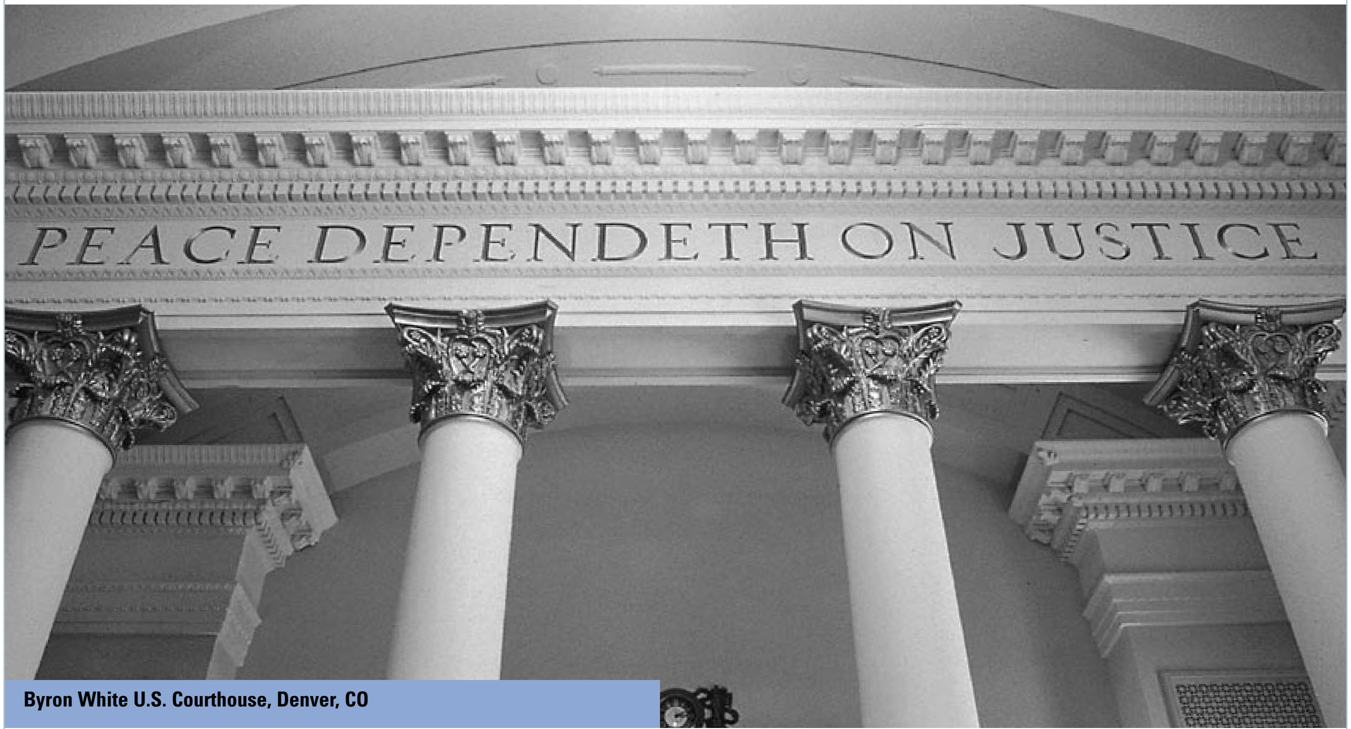
The USCDG makes reference to technical information related to performance criteria in order to help illustrate the rationale for the design requirements and to establish the standard for level of quality.

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 the first 10 years of this plan from the start of design.

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 should comply with the requirements of *Uniform Federal Accessibility Standards* (UFAS) and the *Americans with Disabilities Act of 1990* (ADA). The more stringent requirement between UFAS and ADA will be adopted as part of design criteria. Please refer to Chapter 1 of P100.2: *General Requirements, Codes and Standards*, plus Appendix 1.A. for information on general compliance issues and measures in Federal building planning and design.

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.

In all areas of a building used by the public, *Title II of the ADA* requires a totally accessible interior path from point of entry to all public services. The design elements affected by this requirement consist of:

- 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. Since 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. GSA and the U.S. Courts prefer the use of permanent lifts instead of ramps because they take less room, can be integrated into the design of the room, and are not tripping hazards. (Lifts are allowed by both UFAS and ADA.)

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 highlight instances where policy or preferences developed by GSA, in conjunction with the Judicial Conference of the United States, differ from UFAS or the ADA. If an ADA standard takes priority or must be considered in addition to UFAS, it is noted accordingly by the designation (ADA). 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 UFAS and ADA.
Litigant Table	Height clearance at table(s) and circulation space.
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. Ramp or lift to provide access. (Adjacent space is required for an interpreter.)
Judge's Bench	Comply with space and maneuvering requirements of ADA. Adaptable for future inclusion of ramp or lift. (Electrical service, space, and floor depression to be included in the initial design for lift.)
Courtroom Clerk	Adaptable for future accommodation. (Raised level for clerk's position may be served by a movable ramp.)
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 publicly accessible route. Refer to UFAS/ADA for number of wheelchair accommodating spaces. ADA 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 stone, brick, precast concrete, or other materials of substantial architectural character. 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 High-Medium level of the Interagency Security Construction 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 conditioned air, 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.

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, sprinkler heads, and components of other systems such as speakers and fire alarms.

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 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 and office furniture systems must meet a variety of needs, and selection of these systems must consider function, cost, availability, and aesthetic criteria. The selection and design of fixed and 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, to include lecterns, council tables for courtrooms, and grand jury spaces.

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.

Fixed Components

Table 9-2 outlines the basic fixed furniture elements that are provided for all Courts related functions.

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 Chairs
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-RSSPSSM for related furniture.

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.

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 initial or future use of suspended 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 current 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, at the courtrooms, 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.)

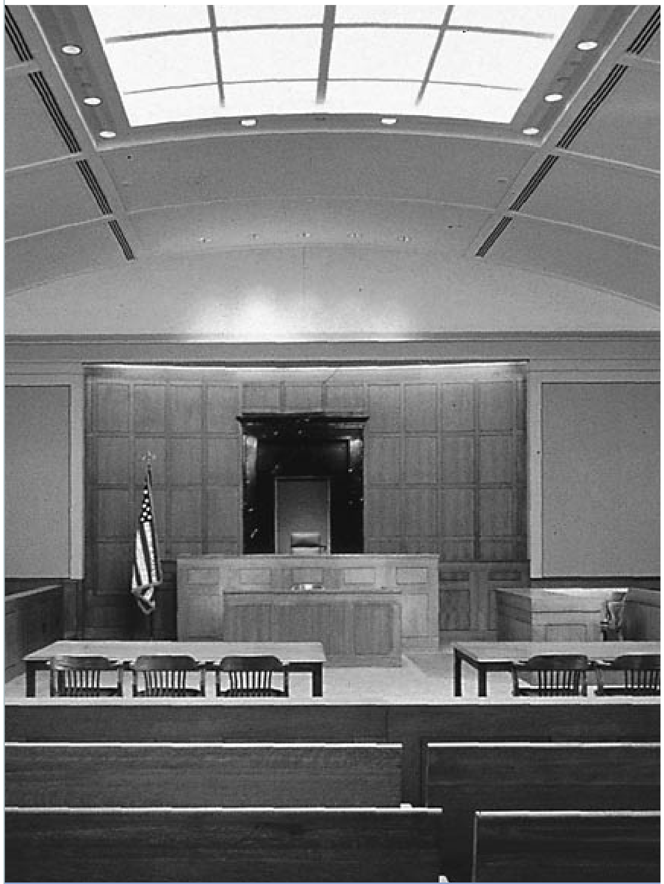
Jury Facilities

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 lined with 2 inches (50 mm) of acoustical absorption material for a length of at least 12 feet (3700 mm) 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

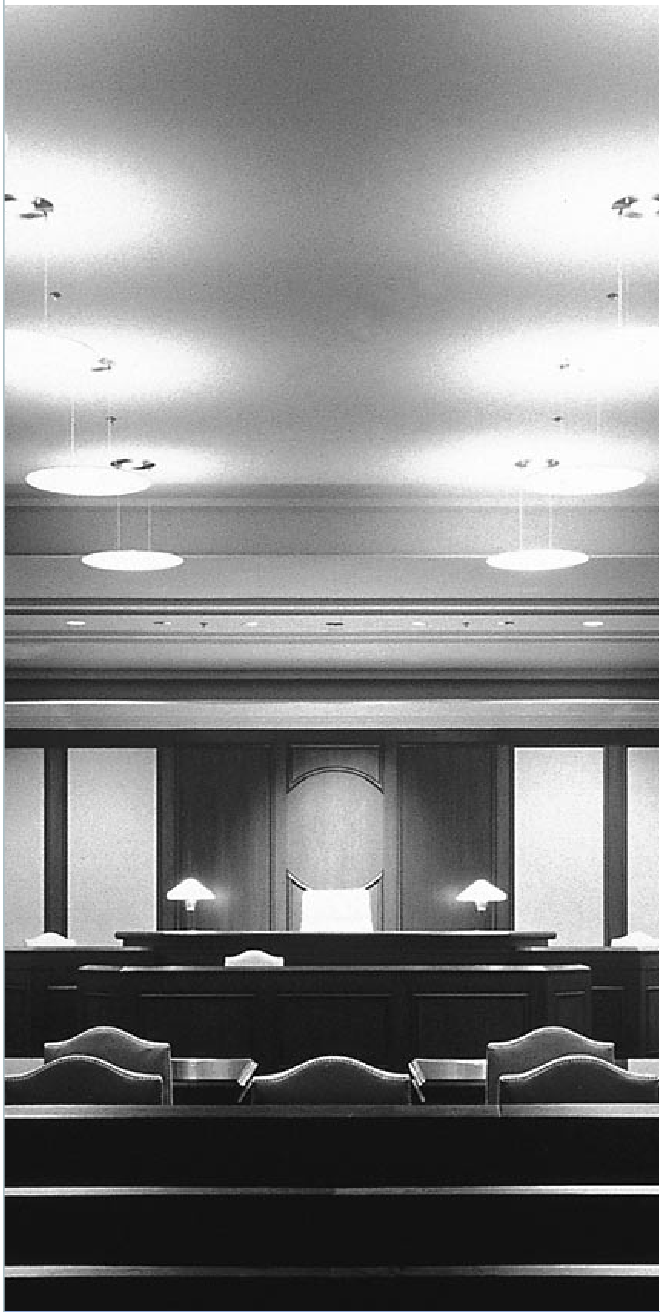
Information technology systems are not the largest source of heat within the office spaces but may be the largest sources in particular areas. Information technology systems will be the most uncertain source of heat flows during design phases, therefore the HVAC system should be planned with capacity 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 Requirements at Detention Areas

Refer to USMS-RSSPSSM and Chapter 7 for sprinkler and fire alarm requirements in detention areas.

All security systems, including those that control egress at the USMS detention area, will be connected to emergency power and meet the requirements of NFPA 101.



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 harmonies or spikes) desk circuits should be protected by excluding "dirty" loads (such as large photocopiers and vacuum cleaners).

On-Floor Electrical Distribution

On-floor electrical distribution in U.S. Court facilities will be accommodated through an integrated system of power, lighting, electronic, and control wiring. Many 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. (Codes presently do not allow normal and emergency power in the same conduit.)

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.

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 Systems in U.S. Court Facilities

All audio/visual design and technical requirements are indicated in the Administrative Office of the United States Courts (AOUSC) Publication: *Courtroom Technology Manual*.

9.8 Security Design

Agency Responsibilities

Courthouse security is the joint responsibility of the judiciary, GSA 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 High-Medium buildings); the Department of Justice's (DOJ) *Vulnerability Assessment of Federal Facilities* (Level IV buildings); and the USCDG. 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.

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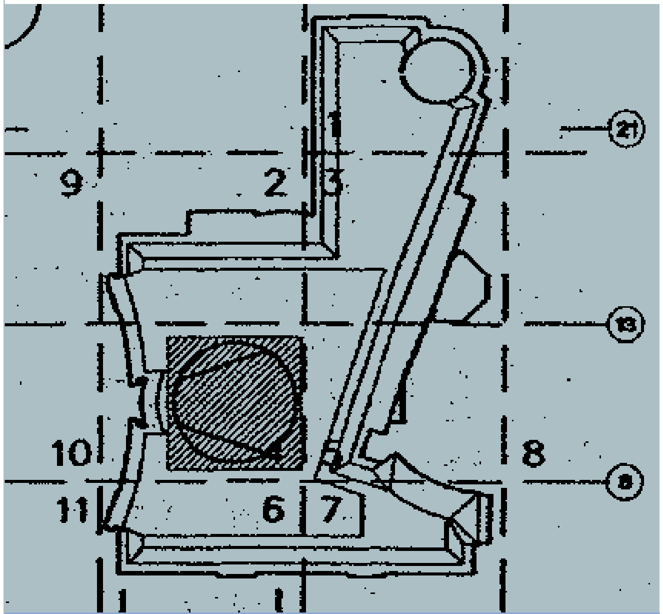


Ronald Reagan Building, Washington, D.C.

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). The following are related sheet sizes:

(A)	8.5" x 11"	220 mm x 280 mm
(B)	11" x 17"	280 mm x 430 mm
(C)	17" x 22"	430 mm x 560 mm
(D)	22" x 34"	560 mm x 860 mm
(E)	34" x 44"	860 mm x 1120 mm

Drawing Lettering. Lettering on drawings must be legible when drawings are reduced to half size and when they are microfilmed. This applies to concept and design development drawings as well as construction documents.

Drawing Scale. All drawings will be produced with metric drawing scales which are always expressed in non-dimensional ratios. Scales should also be illustrated graphically on the drawings. Scale of drawings should be appropriate for high resolution and legibility to include half-size reduced copies.

There are nine preferred base scales: 1:1 (full size), 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, 1:1000. Three others have limited usage: 1:2 (half size), 1:25, 1:250. Floor plans should be drawn at 1:100 (close to 1/8-inch scale).

CAD Standards. The National CAD/CIFM Standards should be obtained via the internet at www.gsa.gov/pbs/cifm/cifm_resources/standards.htm or by contacting the PBS CAD Center at (202) 501-9094, Fax: (202) 208-7147. 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 building plans, drawings and specifications prepared for construction or renovation, either in electronic or paper formats, must have imprinted on each page of the construction drawings or plans, "**PROPERTY OF UNITED STATES GOVERNMENT - FOR OFFICIAL USE ONLY**" in a minimum of 14 point bold type.

The following paragraph will be noted on the cover page of the construction drawings set and on the cove page of the specifications:

> "**PROPERTY OF THE UNITED STATES GOVERNMENT. COPYING, DISSEMINATION, OR DISTRIBUTION OF THESE DRAWINGS, PLANS OR SPECIFICATIONS TO UNAUTHORIZED PERSONS IS PROHIBITED.**" 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.

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.

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.

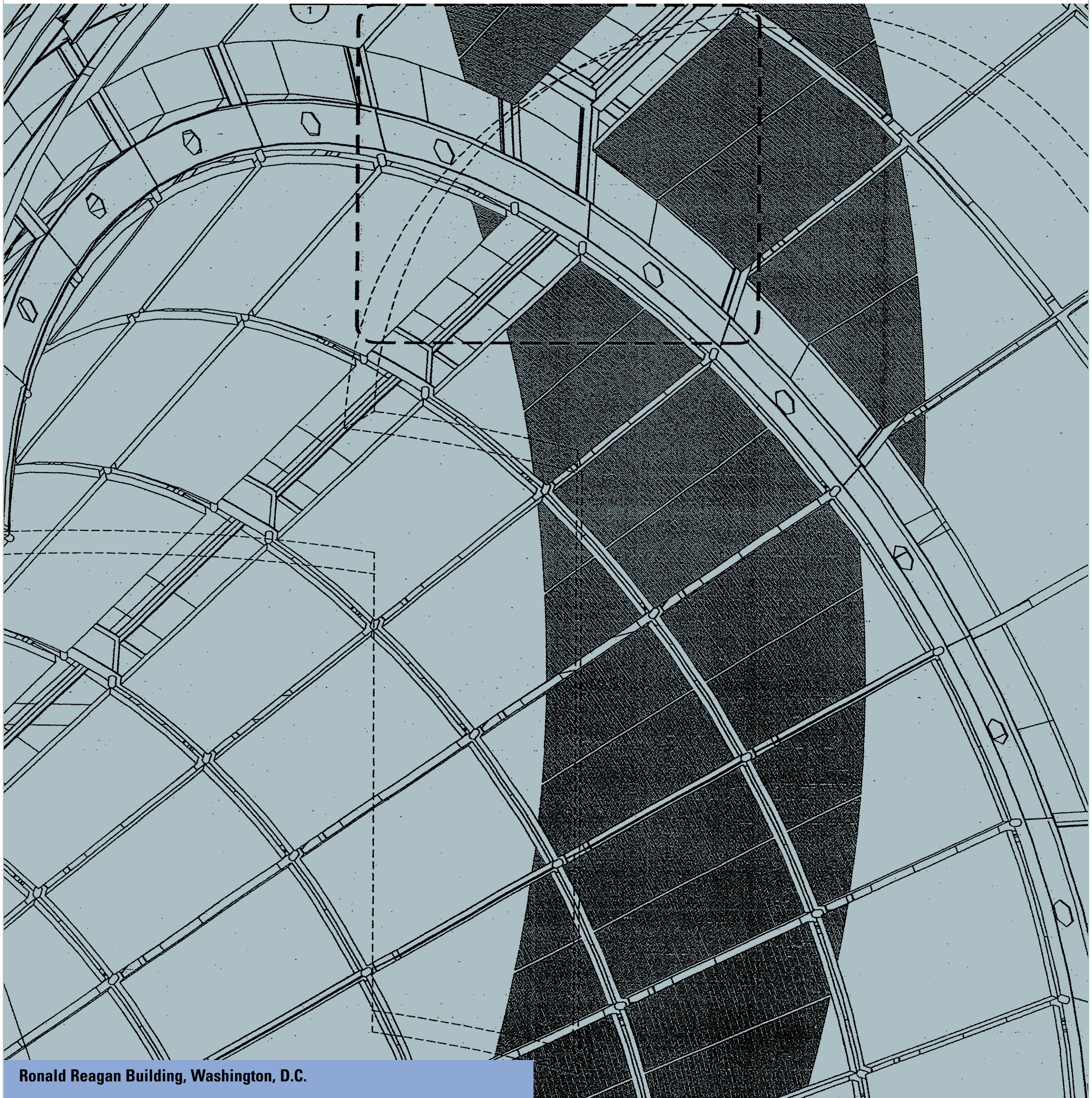
Calculations. Manual and/or computer based calculations should accompany narratives where required to support technical analysis. Each set of calculations should start with a summary sheet, which shows all assumptions, references applicable codes and standards, and lists the conclusions. Calculations 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.

Cost Estimates

Cost estimates must be provided at various stages of the design process and must comply with the GSA document *Project Estimating Requirements*.

In addition to the designer's estimate, GSA will have independent estimates performed at approximately 30, 60, and 90 percent design completion to compare with the A/E estimate.



Ronald Reagan Building, Washington, D.C.

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.

Figure A-1 Functional Objectives Matrix

SYSTEMS		Productivity	Sustainability	Security	Seismic	Fire Safety	Accessibility	Historic Preservation	Maintainable
		FUNCTIONAL OBJECTIVES							
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	**Partitions/Doors**	2	2	3	2	3	3	3	2
	Access Floors	3	1	1	2	2	1	1	1
Interior Finishes	**Walls**	3	2	1	1	2	1	1	2
	Floors	3	3	1	1	2	1	1	3
	Ceiling	3	3	1	2	2	1	1	3
Conveying		2	1	1	2	2	3	1	3
Plumbing		1	3	1	2	2	3	1	3
HVAC	**Central Plant**	3	3	1	2	1	1	1	3
	Distribution	3	3	1	2	3	1	1	3
Fire Protection		1	1	2	3	3	1	1	1
Electrical	**Service/Distribution**	2	1	2	3	2	1	1	1
	Lighting	3	3	3	2	2	1	1	3
Equipment		1	1	3	1	2	1	1	2
Furnishings		3	3	1	1	2	3	1	2
Special Construction		1	2	1	2	2	1	1	2
Demolition	**Building Elements**	3	3	1	1	1	1	3	1
	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
	Utilities	1	1	1	3	2	1	1	2
Trans. Sitework		2	3	1	2	1	3	1	2

Figure A-2 Sustainability Matrix

SYSTEMS		Energy	Water	Materials	In. Env. Qual.	Site & Trans.	O & M
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

PRINCIPLES / OBJECTIVES

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. 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

Figure A-3 Design Process and Related Submission Requirements for New Construction and Modernization

PHASES	ACTIVITIES	SUBMISSIONS
CONCEPTS		
• Review Space Directive • Integrate Expectations into Major Systems and Features	PROGRAM REVIEW DESIGN CHARRETTE PRELIMINARY CONCEPTS (3 or more) VALUE ENGINEERING (Systems Level) COMMISSIONER'S APPROVAL FINAL CONCEPTS	• Massing Models (New Construction Only) • Narrative to Include Proposed Building Systems • Rendering/Photos • Concept Level: Drawings, Narratives/Studies, Calculations, Cost Estimates • Space Program Statement/ Reconciliation
DESIGN DEVELOPMENT		
• System/Feature Analyses for Selection • Final Selection of All Building Systems • Inter-System Coordination	PROGRAM REVIEW VALUE ENGINEERING (Analysis Stage) PRODUCTION STAGE PROJECT DIRECTIVE MEETING	• Architectural Background Drawings Complete • Design Development Level: Drawings, Narratives/Studies, Calculations, Cost Estimates • Concurrence on Narrative for All Building Design Characteristics & Systems • Space Program Reconciliation
CONSTRUCTION DOCUMENTS		
• Presentation of Design in a Format Suitable to Parties Unfamiliar with the Site	PROGRAM REVIEW 75% COMPLETE 100% COMPLETE REVISED 100% POST DESIGN SERVICES	• Progress Drawings • Draft Specifications • Narrative Update • Current Calculations • Final: Drawings, Specifications, Narratives, Calculations, Cost Estimate • Incorporation of Review Comments • Space Program Reconciliation

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 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.

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.

5. Code statement.
   - Building classification, occupancy group(s), fire-resistance requirements and general egress requirements that relate to the site and occupancy use. Specific code requirements of each concept will not be required.

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 Energy Goals.

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.

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.
   - Indicate how major mechanical and electrical equipment can be removed/replaced.

2. Elevations of major building façades, showing:
   - Fenestration.
   - Exterior materials.
   - Cast shadows.

3. 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.

4. 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.

2. Description of final concept, explaining:
   - Expansion potential.
   - Building floor efficiency.
   - Conveying systems design (elevators, escalators).
   - Energy usage goals.
   - Treatment of historic zones, if applicable.
   - Operations and maintenance goals (exterior and interior window washing, relamping, etc.).

3. Vertical transportation analysis (elevators and escalators).

4. Code statement.
   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.
   - Building classification, occupancy group(s), fire-resistance requirements, construction type, occupant load calculations and egress requirements for the Final Concept.
   - A code/criteria analysis should be prepared that documents an investigation of various 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.

Structural

Drawings.

1. Plans, showing:
   - Framing plans of the proposed structural system showing column locations; bay sizes; and location of expansion or seismic joints.

Narrative.

1. Identification of unusual local code requirements.

2. Code compliance statement.
   - Name of model building code followed.
   - Building classification.
   - Identification of seismic zone, wind speed, etc.
   - Identification of special requirements, such as highrise.

3. For new buildings located in moderate and high risk seismic areas only:
   - Statement certifying that the structural engineer has reviewed the building configuration for seismic adequacy, and that criteria outlined in Chapter 4, *Structural Engineering, Building Configuration in Earthquake Zones*, of this document, have been met. This statement must be signed by the structural engineer and the architect.

Mechanical

Drawings.

1. Plans showing equipment spaces for mechanical equipment.

Narrative.

1. Description of at least two potential HVAC systems and a baseline system.
   - Unless otherwise described within design programming requirements, the baseline system to be used is that within Chapter 5 of this standard.

2. Proposed special features of plumbing system.

3. Code compliance statement.

Fire Protection

Fire submission requirements may be met in one of two ways, either as a separate Fire Protection section (as outlined in this document) or integrated into the construction documents as Architectural, Plumbing, Mechanical, Electrical etc. However, if integrated into the documents the A/E must provide a summary sheet identifying where the following is discussed.

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 statement.
   - Identification of special requirements, such as high rise, atrium, grand stairways, etc.

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 (latest approved version) and will meet GSA's energy goal requirement.

2. Green building (sustainable) design concepts—LEEDS 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 the concept stage estimate stated in GSA document *Project Estimating Requirements*.

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. 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.
   - 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 recyclable materials.

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 composed of actual material samples and color coded plans and sections of major spaces showing their use.

Drawings.

1. Building floor plans, showing:
   – Spaces individually delineated and labeled.
   – Enlarged layouts of special spaces.
   – Dimensions.
   – Planning module.

2. 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. One longitudinal and one transverse section, showing:
   – Floor-to-floor dimensions.
   – Stairs and elevators.
   – Typical ceiling heights.
   – General roof construction.

5. 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.

6. Proposed room finish schedule, showing:
   - Floors, bases, walls and ceilings.
   - (Finish schedule may be bound into narrative.)

7. Perspective sketches, renderings and/or presentation model, if included in the project scope.

8. Proposed site furniture, showing:
   - Site furniture cut sheets or photos
   - Proposed locations.

9. Diagrams illustrating the ability to access, service and replace mechanical/electrical equipment showing the pathway with necessary clearance.

10. Location of accessible pathways and services for the physically disabled.

11. Placement of Art-in-Architecture elements.

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).

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 column bay in width. It should also include 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, 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 final boring logs (if part of scope of work).
   - See Appendix A.5 for specific requirements.

7. Geologic Hazard Report, when required in seismic zones 2A, 2B, 3 and 4.
   - 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

Calculations.

HVAC.

1. Block loads for heating and refrigeration.

2. Heat and air balance calculations.

3. HVAC calculations for walls, roofs, rooms and spaces to size AHU's piping and duct systems.

4. Energy analysis.
   – Projections for the annual energy consumption of the building, taking into account architectural wall and roof design, and preliminary lighting design.

5. Life Cycle Cost Analysis
   – Comparative analyses of alternatives defined in concept submissions.
   – Additional analyses as required to optimize equipment selections, heat recovery/storage, and control/zoning options.

Plumbing.

1. Water supply calculations.
   – Include pressure for domestic hot and cold water.

2. Roof drainage calculations.

3. Plumbing fixture count analysis.

4. Sanitary waste pipe sizing calculations.

Narrative.

HVAC.

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 Chapter 5.

2. Description of the HVAC systems studied.
   – The general features, configuration, and functional advantages and disadvantages of each system should be compared qualitatively. In addition, a description of how the other building systems and their components integrate with the HVAC, such as windows, lighting, and building orientation.

3. Description of recommended HVAC system.
   – Include cost and other considerations.

4. Energy source study (for new buildings only, except border stations).
   – An evaluation of the most economical primary energy source over the life of the building. This is a separate study from the Life Cycle Cost Analysis for the HVAC systems.

5. Recommendations for HVAC systems for special spaces.
   – Automated data processing rooms, auditoria, conference rooms, kitchens and other special spaces identified in the building program.

6. 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.

Plumbing.

1. Proposed plumbing system.
   – Include lists of typical fixtures.

2. Evaluation of alternate sources for preheating of domestic water (solar or heat recovery).

Drawings.

1. Site plan.
   - Proposed inverts of sewers, storm water pipes and gas lines at the building service entrance.

HVAC.

1. Floor plans.
   - Proposed building zoning and major duct runs. Sketch layouts of mechanical rooms, showing locations of major equipment, including size variations by different manufacturers.

2. Systems schematics and flow diagrams.

Plumbing.

1. Floor plans.
   - Proposed building zoning and major piping runs.
   - Locations of proposed plumbing fixtures and equipment.

2. Systems schematics and flow diagrams.

Fire Protection

Fire submission requirements may be met in one of two ways, either as a separate Fire Protection section (as outlined in this document) or integrated into the construction documents as Architectural, Plumbing, Mechanical, Electrical etc. However, if integrated into the documents the A/E must provide a summary sheet identifying where the following is discussed.

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.

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.

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.

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.

Design Development Cost Estimate

A cost estimate must be provided. It should comply with the requirements for the design development estimate stated in GSA document *Project Estimating Requirements*.

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 (latest approved version) 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. Code criteria should be reviewed by each discipline to the degree of detail necessary to assure that tasks accomplished meet code requirements.

Site Planning and Landscape Design

Code Criteria. 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. 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.

Site Design Review Checklist.
This checklist is intended to provide an inter-disciplinary coordination review.

- ☐ Piping and other utility locations and inverts at building penetrations coordinated with mechanical drawings.
- ☐ Electrical service coordinated with electrical drawings.
- ☐ Interference of utilities with underground electrical runs checked.
- ☐ Interference between planting and utilities checked.
- ☐ Elevations of entrances coordinated with architectural drawings.
- ☐ Required reinforcement shown for all free standing and retaining walls.
- ☐ Connections to foundation drainage coordinated.
- ☐ Sub-surface drainage shown.
- ☐ Location of underground storage tanks shown.
- ☐ Construction of underground storage tanks detailed.

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, 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.

Architectural Review Checklist.
This checklist enumerates some of interfaces between architectural and engineering disciplines that require close coordination.

- ☐ Interference with structural framing members coordinated.
- ☐ Locations and details of below-grade and other waterproofing shown, and coordinated with structural drawings.
- ☐ Anchorage of exterior wall elements shown.
- ☐ Expansion and/or seismic joints shown and detailed.
- ☐ Adequate clearances to install, service, repair and replace mechanical and electrical equipment. (Verify all space requirements are incorporated into the floor plans.)
- ☐ Rooftop mechanical equipment shown.
- ☐ Adequate clearances under rooftop mechanical and electrical equipment to facilitate maintenance, repair and replacement of the roofing system.
- ☐ Location of roof drains and floor drains coordinated with mechanical drawings.

- ☐ Air diffusers and registers coordinated with mechanical drawings.
- ☐ Louver sizes and locations coordinated with mechanical drawings.
- ☐ Light fixture types and locations coordinated with mechanical and electrical drawings.
- ☐ Wall and roof sections coordinated with heat loss calculations.
- ☐ Adequate envelope design details to ensure thermal/air/moisture control.
- ☐ For pressurized plenum raised flooring, assure effective barrier to prevent air passage to exterior walls.
- ☐ Acoustical wall treatments shown in mechanical rooms (if applicable).
- ☐ Location of access panels in plaster ceilings and soffits coordinated with mechanical drawings.
- ☐ Plumbing fixture mounting heights coordinated with mechanical drawings.
- ☐ Coordination of architectural elements with exposed structural members.
- ☐ Location of air supply and ducted exhaust systems.
- ☐ Security light fixtures required and locations coordinated with electrical drawings.

Structural

Drawings.

1. Demolition plans.

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 must be shown on drawings. Live load reduction, if used, must be indicated.
   - Basic wind speed, importance factor, exposure, effective velocity pressure and wind load must be indicated.
   - Seismic design criteria, such as earthquake zone, and response factors 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 anchorage of building system equipment and 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
   - Blast analysis.

Structural Review Checklist.

- ☐ Floor elevations shown on drawings.
- ☐ Camber requirements shown on drawings.
- ☐ Beam and girder connections detailed.
- ☐ Clearances for bolts and fasteners shown (steel and wood construction).
- ☐ Fire resistance of structural members indicated.
- ☐ Beam reactions shown for moment connections.
- ☐ Equipment, piping and ductwork supports detailed (may be shown on structural, mechanical or electrical drawings, as applicable).
- ☐ Hoists shown in major mechanical rooms (if required).
- ☐ Interference with piping and ductwork coordinated.
- ☐ Interference with electrical ducts and conduit coordinated.
- ☐ Anchorage of architectural, mechanical or electrical systems and components.
- ☐ Roof drains coordinated with architectural and mechanical drawings.
- ☐ Subdrainage and foundations coordinated with mechanical drawings/piping.
- ☐ Waterproofing of foundation walls, retaining walls and other structural elements coordinated with architectural drawings.

Mechanical

Drawings. Systems must be fully drawn and sized to permit accurate bidding and construction.

HVAC.

1. Demolition plans.
   – Show for modernizations, if required.

2. HVAC piping layouts.
   – 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.

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(s).
   – Diagram to show control signal interface, complete with sequence of operation.

5. Layout of equipment rooms showing all mechanical equipment. (The layout shall indicate the space allocated for maintenance and removal.)

6. Mechanical details.

7. Complete equipment schedules.

8. HVAC duct riser diagram.

9. Schematic flow diagrams.

Plumbing.

1. Demolition plans.
   – Show for modernizations, 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.

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.
   – Roof drainage calculations.
   – Sanitary waste sizing calculations.

3. Generator calculations.
   – Sizing of fuel storage and distribution and vibration isolation.

Mechanical Review Checklist.

- □ Interference with structural framing members coordinated.
- □ Equipment pad locations coordinated with structural drawings.
- □ Adequate clearances to service and replace mechanical equipment.
- □ Hoist (or other means of equipment replacement) coordinated with structural drawings.
- □ Motors and special power needs coordinated with electrical drawings.
- □ Location of roof drains and floor drains coordinated with architectural and structural drawings.
- □ Air diffusers and registers coordinated with architectural drawings and electrical lighting plans.
- □ Location of supply and exhaust systems coordinated with security barriers, detection devices and other related concerns.
- □ Louver sizes and locations coordinated with architectural drawings.
- □ Inverts of piping coordinated with civil drawings.
- □ Supports and bracing for major piping, ductwork and equipment coordinated with structural drawings.
- □ Penetrations through rated wall/floor/roof assemblies detailed and specified.
- □ BAS system specified, including software and point schedules. (Use an open communication protocol system like BACnet.)
- □ Start up and testing requirements specified.

Special Checklist for VAV Systems.

- □ Minimum amount of outside air to be admitted during occupied hours shown on drawings; also minimum ventilation supplied at lowest setting of VAV box.
- □ Fan schedule for both supply and return fans, showing minimum and maximum airflow rates and total pressure at minimum flow, maximum sound power level and blade frequency increment at peak air flow.
- □ VAV terminal units to be specified indicating maximum and minimum air flow rates minimum static pressure required, maximum static pressure permitted and noise ratings at maximum air flow.
- □ Supply air outlets specified by face and neck sizes, ADPI performance for maximum and minimum airflow.
- □ Controller pressure setting and sensor location shown, including reference pressure location. For multiple sensors all locations must be shown. Also show pressure setting for high limit of supply fan.
- □ Maximum and minimum air flow rates shown for air flow measuring stations. Air flow measuring stations located.
- □ All required control instruments shown and located.

Fire Protection

Fire submission requirements may be met in one of two ways, either as a separate Fire Protection section (as outlined in this document) or integrated into the construction documents as Architectural, Plumbing, Mechanical, Electrical etc. However, if integrated into the documents the A/E must provide a summary sheet identifying where the following is discussed.

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.

Fire Protection Review Checklist.

Building Construction

☐ Verify details for fire walls and smoke partitions.

☐ Verify Underwriters Laboratories or U.S. Gypsum Association design numbers with fire walls, smoke partitions, and partitions.

☐ Verify firestopping for penetrations in fire rated walls and floors meet Code requirements.

☐ Verify structural components are fire rated (if applicable).

☐ Verify fireproofing meets Code requirements (if applicable).

☐ Verify proper building separation for exposure protection.

☐ Verify interior finish meets Code requirements.

Life Safety

☐ Verify the number of exits based on occupant load.

☐ Verify exits discharge outside.

☐ Verify travel distance to exits.

☐ Verify remoteness of exits.

☐ Verify common path of travel limits meet Code requirements.

☐ Verify door swings meet Code requirements.

☐ Verify stair details.

☐ Verify horizontal exit details.

☐ Verify exit signs meet Code requirements.

☐ Verify emergency lighting meet Code requirements.

☐ Verify each occupancy classification meets specific exiting requirements.

☐ Verify the type, size, and location of each portable fire extinguisher.

Water Supply

- ☐ Verify water supply is adequate to meet design density.
- ☐ Verify detail of anchorage of underground fire protection water supply line.
- ☐ Verify location of valve box and cover plate on buried gate valve.
- ☐ Verify fire pump calculations justify the size of the fire pump and jockey pump.
- ☐ Verify riser diagram for fire pump meets Code requirements.
- ☐ Verify detail of fire pump configuration.
- ☐ Verify sensing lines for both the fire pump and jockey pump are indicated on the details.
- ☐ Verify all piping for fire pump is identified on the drawings.
- ☐ Verify the location of the test header.
- ☐ Verify the location of both controllers.
- ☐ Verify the power feeds to the fire pump and jockey pump are identified on the drawings.

Water Based Fire Extinguishing Systems

- ☐ Verify specifications contain information stating the static and residual pressures are available at a measured flow rate.
- ☐ Verify the sprinkler riser is sized properly on the riser diagrams.
- ☐ Verify that sprinkler piping is not shown on the construction contract drawings. Only the interior fire main piping shall be shown, in addition to the location of obstructions, structural components, construction of walls, floors, and ceilings.
- ☐ Verify the location and size of underground or standpipe water supplies.
- ☐ Verify the location and arrangement of all waterflow and tamper switches.
- ☐ Verify the location of the riser and all points where it penetrates a floor.
- ☐ Verify the location of the fire department connection.
- ☐ Verify the location of all control valves and alarm valves.
- ☐ Verify all areas of the building have sprinkler protection.
- ☐ Verify accuracy of symbol list.
- ☐ Verify all floor control valves and sectional valves have drains.
- ☐ Verify inspector's test valve arrangements.
- ☐ Verify wall and ceiling construction is indicated, as well as ceiling height.

Non-Water Based Fire Extinguisher Systems

- ☐ Verify kitchen equipment is protected by a wet chemical system, monitored by fire alarm system.
- ☐ Verify power and gas shut down for kitchen equipment meet Code requirements.

Fire Alarm System

- ☐ Verify location of all audible notification appliances on the drawings and riser diagram meet Code requirements.
- ☐ Verify audible notification appliances are identified in stairways and elevator cabs.
- ☐ Verify location of all visible notification appliances on the drawings and riser diagram meet Code requirements.
- ☐ Verify accuracy of fire alarm riser diagram.
- ☐ Verify that at least two vertical fire alarm risers are installed remote as possible from each other. Verify that the second riser is separated from the first riser by at least a one-hour fire rated enclosure, not common to both risers.
- ☐ Verify location and construction requirements of fire command center.
- ☐ Verify location of graphic annunciator panel.
- ☐ Verify fire alarm system wiring is solid copper.
- ☐ Verify location of all manual fire alarm stations meet Code requirements.
- ☐ Verify smoke detectors are installed in each elevator lobby and elevator machine room to initiate elevator recall.
- ☐ Verify locations of all area smoke detectors on the drawings and riser diagram meet Code requirements.
- ☐ Verify locations of all fire fighter telephone stations and telephone jacks on the drawings and riser diagram meet Code requirements.
- ☐ Verify locations of all duct smoke detectors on the drawings and riser diagram meet Code requirements.
- ☐ Verify accuracy of fire alarm system input/output matrix.
- ☐ Verify accuracy of symbol list.
- ☐ Verify accuracy of final smoke control calculations where applicable (e.g., atrium, etc.).
- ☐ Verify accuracy of final stairway pressurization calculations where applicable.
- ☐ Verify accuracy of interface of fire alarm system and Building Automation System.
- ☐ Verify accuracy of interface of fire alarm system and the building security systems.

Miscellaneous

- ☐ Verify that the locations of the fire dampers meet Code requirements.
- ☐ Verify that the location of smoke dampers meet Code requirements.
- ☐ Verify that the elevator systems meet Code requirements.
- ☐ Verify that sprinklered elevator machine rooms are provided with a means to automatically disconnect power.

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.

Electrical Review Checklist.

- ☐ Interference between major conduit and structural framing members coordinated.
- ☐ Adequate clearances to install and service electrical equipment.
- ☐ Light fixture locations and types coordinated with architectural drawings and interior design.
- ☐ Screens for exterior generators and transformers coordinated with architectural drawings.
- ☐ Penetrations through rated wall/floor/roof assemblies detailed and specified.
- ☐ Normal or emergency power supplied for all mechanical and fire safety equipment.
- ☐ Supports and bracing for major conduits and equipment coordinated with structural drawings.

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 final working drawing stage estimate stated in the GSA document, *Project Estimating Requirements*.

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, and warranty schedules. This manual must also diagram the following: 1) cabling 2) fire safety sprinkler system 3) exterior grounds sprinkler system. The manual must be reviewed and certified complete before submission to the Facilities Manager.

GSA Design Awards Submission.

All prospectus level projects shall be submitted of 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 11-1/2 inch three-ring binder that is no more than 1-1/2 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.

Figure A-4 Design Process and Related Submission Requirements for Renovation

PHASES	ACTIVITIES	SUBMISSIONS
CONCEPTS		
• **Review Space Directive** • **Study** Adjacencies Circulation Aesthetics • **Systems/Features that Integrate Delivery of Expectations**	**PROGRAM REVIEW** **DESIGN CHARRETTE** **CONCEPT (1 or more)** **VALUE ENGINEERING (Systems Level)**	• **Drawings** • **Narratives** • **Rendering/Photos** • **Proposed Systems** • **Cost Estimate**
DESIGN DEVELOPMENT		
• **System/Feature Analysis for Selection** • **30% Complete Documentation** • **Final Selection of All Building Systems**	**PROGRAM REVIEW** **VALUE ENGINEERING (Analysis Stage)**	• **Drawings** • **Narratives** • **Calculations** • **Cost Estimate**
FINAL CONSTRUCTION DOCUMENTS		
• **Presentation of Design in a Format Suitable to Parties Unfamiliar with the Site**	**PROGRAM REVIEW** **75% COMPLETE** **100% COMPLETE** **REVISED 100%** **POST DESIGN SERVICES**	• **Progress Drawings** • **Draft Specifications** • **Narrative Update** • **Current Calculations** • **Final:** Drawings Specifications Narratives Calculations Cost Estimate • **Incorporation of Review Comments**

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.

Structural

A structural narrative only needs to be submitted if a structural upgrade is part of the scope of work.

Narrative.

1. Description of existing 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 Submission requirements may be met in one of two ways, either as a separate Fire Protection section (as outlined in this document) or integrated into the construction documents as Architectural, Plumbing, Mechanical, Electrical etc. However, if integrated into the documents, the A/E must provide a summary sheet identifying where each of the following requirements is met.

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 stated for the Concept Stage Estimate in GSA document *Project Estimating Requirements*.

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.

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.

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 final boring logs (if part of scope of work).
   – See separate section in this book for specific requirements.

5. Geologic Hazard Report, when required in zones 2A, 2B, 3 and 4.

Drawings.

1. Demolition plans.

2. Preliminary framing plans and key details.
   – Include column locations, bay sizes and location of expansion or 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 Submission requirements may be met in one of two ways, either as a separate Fire Protection section (as outlined in this document) or integrated into the construction documents as Architectural, Plumbing, Mechanical, Electrical etc. However, if integrated into the documents, the A/E must provide a summary sheet identifying where each of the following requirements is met.

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.

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 m^2 (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 stated in GSA document *Project Estimating Requirements*.

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.

Site Design Review Checklist.

- ☐ Piping and other utility locations and inverts at building penetrations coordinated with mechanical and electrical drawings.
- ☐ Interference of utilities with underground electrical runs checked.
- ☐ Interference between planting and utilities checked.
- ☐ Elevations of entrances coordinated with architectural drawings.
- ☐ Required reinforcement shown for all free standing and retaining walls.
- ☐ Connections to foundation drainage coordinated.
- ☐ Sub-surface drainage shown.
- ☐ Location of underground storage tanks shown.
- ☐ Construction of underground storage tanks detailed.

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.

Architectural Review Checklist.
This checklist enumerates some of interfaces between architectural and engineering disciplines which require close coordination.

- ☐ Interference with structural framing members coordinated.
- ☐ Location of below-grade waterproofing shown.
- ☐ Anchorage of exterior wall elements shown.
- ☐ Expansion and/or seismic joints shown and detailed.
- ☐ Adequate clearances to install, service and replace mechanical and electrical equipment.
- ☐ Rooftop mechanical equipment shown.
- ☐ Location of roof drains and floor drains coordinated with mechanical drawings.
- ☐ Air diffusers and registers coordinated with mechanical drawings.
- ☐ Louver sizes and locations coordinated with mechanical drawings.
- ☐ Light fixture types and locations coordinated with mechanical and electrical drawings.
- ☐ Wall and roof sections coordinated with heat loss calculations.
- ☐ Adequate envelope design details to ensure thermal/air/moisture control.
- ☐ Acoustical wall treatments shown in mechanical rooms (if applicable).

Structural

Drawings.

1. Demolition plans.

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 must be shown on drawings. Live load reduction, if used, must be indicated. (Indicate if live load reductions are used on columns – do not use live load reductions on horizontal framing members – and identify code used. State when live loads have not been used, and when and where they are used.)
   – Basic wind speed, importance factor, exposure, effective velocity pressure and wind load must be indicated.
   – Seismic design criteria, such as earthquake zone, and response factors 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.
   – Include details for steel connections.
   – 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.

Structural Review Checklist.

☐ Floor elevations shown on drawings.

☐ Camber requirements shown on drawings.

☐ Beam and girder connections detailed.

☐ Clearances for bolts and fasteners shown (steel and wood construction).

☐ Fire resistance of structural members indicated.

☐ Beam reactions shown for moment connections.

☐ Equipment, piping and ductwork supports detailed (may be shown on structural, mechanical or electrical drawings, as applicable).

☐ Hoists shown in major mechanical rooms (if required).

- ☐ Interference with piping and ductwork coordinated.
- ☐ Interference with electrical ducts and conduit coordinated.
- ☐ Concrete inserts shown for anchorage of architectural, mechanical or electrical systems and components.
- ☐ Roof drains coordinated with architectural and mechanical drawings.
- ☐ Subdrainage and foundations coordinated with mechanical drawings/piping.
- ☐ Details for drift, anchoring of exterior walls and anchoring of nonstructural full-height partitions shown in drawings.

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.

Mechanical Review Checklist.

- ☐ Interference with structural framing members coordinated.
- ☐ Equipment pad locations coordinated with structural drawings.
- ☐ Adequate clearances to install and service mechanical equipment.
- ☐ Hoist (or other means of equipment replacement) coordinated with structural drawings.
- ☐ Motors and special power needs coordinated with electrical drawings.
- ☐ Location of roof drains and floor drains coordinated with architectural drawings.
- ☐ Air diffusers and registers coordinated with architectural drawings.
- ☐ Louver sizes and locations coordinated with architectural drawings.
- ☐ Inverts of piping coordinated with civil drawings.
- ☐ Supports and bracing for major piping and equipment coordinated with structural drawings.
- ☐ Penetrations through rated wall/floor/roof assemblies detailed and specified.
- ☐ BAS system specified, including software and point schedules.
- ☐ Start up and testing requirements specified.

Special Checklist for VAV Systems.

- ☐ Minimum amount of outside air to be admitted during occupied hours shown on drawings; also minimum ventilation supplied at lowest setting of VAV box.
- ☐ Fan schedule for both supply and return fans, showing minimum and maximum airflow rates and total pressure at minimum flow, maximum sound power level and blade frequency increment at peak air flow.

- □ VAV terminal units to be specified indicating maximum and minimum air flow rates minimum static pressure required, maximum static pressure permitted and noise ratings at maximum air flow.

- □ Supply air outlets specified by face and neck sizes, ADPI performance for maximum and minimum airflow.

- □ Controller pressure setting and sensor location shown, including reference pressure location. For multiple sensors all locations must be shown. Also show pressure setting for high limit of supply fan.

- □ Maximum and minimum air flow rates shown for air flow measuring stations. Air flow measuring stations located.

- □ All required control instruments shown and located.

- □ Location of supply and exhaust systems coordinated with security barriers, detection devices, and other related concerns.

Fire Protection

Fire Submission requirements may be met in one of two ways, either as a separate Fire Protection section (as outlined in this document) or integrated into the construction documents as Architectural, Plumbing, Mechanical, Electrical etc. However, if integrated into the documents, the A/E must provide a summary sheet identifying where each of the following requirements is met.

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 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.

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.

Fire Protection Review Checklist.

Building Construction

☐ Verify details for fire walls and smoke partitions.

☐ Verify Underwriters Laboratories or U.S. Gypsum Association design numbers with fire walls, smoke partitions, and partitions.

☐ Verify firestopping for penetrations in fire rated walls and floors meet Code requirements.

☐ Verify structural components are fire rated if applicable.

☐ Verify fireproofing meets Code requirements if applicable.

- ☐ Verify proper building separation for exposure protection.
- ☐ Verify interior finish meets Code requirements.

Life Safety

- ☐ Verify the number of exits based on occupant load.
- ☐ Verify exits discharge outside.
- ☐ Verify travel distance to exits.
- ☐ Verify remoteness of exits.
- ☐ Verify common path of travel limits meet Code requirements.
- ☐ Verify door swings meet Code requirements.
- ☐ Verify stair details.
- ☐ Verify horizontal exit details.
- ☐ Verify exit signs meet Code requirements.
- ☐ Verify emergency lighting meet Code requirements.
- ☐ Verify each occupancy classification meets specific exiting requirements.
- ☐ Verify the type, size, and location of each portable fire extinguisher.

Water Supply

- ☐ Verify water supply is adequate to meet design density.
- ☐ Verify detail of anchorage of underground fire protection water supply line.
- ☐ Verify location of valve box and cover plate on buried gate valve.
- ☐ Verify fire pump calculations justify the size of the fire pump and jockey pump.
- ☐ Verify riser diagram for fire pump meets Code requirements.
- ☐ Verify detail of fire pump configuration.
- ☐ Verify sensing lines for both the fire pump and jockey pump are indicated on the details.
- ☐ Verify all piping for fire pump is identified on the drawings.
- ☐ Verify the location of the test header.
- ☐ Verify the location of both controllers.
- ☐ Verify the power feeds to the fire pump and jockey pump are identified on the drawings.

Water Based Fire Extinguishing Systems

- ☐ Verify specifications contain information stating the static and residual pressures are available at a measured flow rate.
- ☐ Verify the sprinkler riser is sized properly on the riser diagrams.
- ☐ Verify that sprinkler piping is not shown on the construction contract drawings. Only the interior fire main piping shall be shown, in addition to the location of obstructions, structural components, construction of walls, floors, and ceilings.

- ☐ Verify the location and size of underground or standpipe water supplies.
- ☐ Verify the location and arrangement of all waterflow and tamper switches.
- ☐ Verify the location of the riser and all points where it penetrates a floor.
- ☐ Verify the location of the fire department connection.
- ☐ Verify the location of all control valves and alarm valves.
- ☐ Verify all areas of the building have sprinkler protection.
- ☐ Verify accuracy of symbol list.
- ☐ Verify all floor control valves and sectional valves have drains.
- ☐ Verify inspector's test valve arrangements.
- ☐ Verify wall and ceiling construction is indicated, as well as ceiling height.

Non-Water Based Fire Extinguisher Systems

- ☐ Verify kitchen equipment is protected by a wet chemical system, monitored by fire alarm system.
- ☐ Verify power and gas shut down for kitchen equipment meet Code requirements.

Fire Alarm System

- ☐ Verify location of all audible notification appliances on the drawings and riser diagram meet Code requirements.
- ☐ Verify audible notification appliances are identified in stairways and elevator cabs.
- ☐ Verify location of all visible notification appliances on the drawings and riser diagram meet Code requirements.
- ☐ Verify accuracy of fire alarm riser diagram.
- ☐ Verify that at least two vertical fire alarm risers are installed remote as possible from each other. Verify that the second riser is separated from the first riser by at least a one-hour fire rated enclosure, not common to both risers.
- ☐ Verify location and construction requirements of fire command center.
- ☐ Verify location of graphic annunciator panel.
- ☐ Verify fire alarm system wiring is solid copper.
- ☐ Verify location of all manual fire alarm stations meet Code requirements.
- ☐ Verify smoke detectors are installed in each elevator lobby and elevator machine room to initiate elevator recall.
- ☐ Verify locations of all area smoke detectors on the drawings and riser diagram meet Code requirements.
- ☐ Verify locations of all fire fighter telephone stations and telephone jacks on the drawings and riser diagram meet Code requirements.
- ☐ Verify locations of all duct smoke detectors on the drawings and riser diagram meet Code requirements.

- ☐ Verify accuracy of fire alarm system input/output matrix.
- ☐ Verify accuracy of symbol list.
- ☐ Verify accuracy of final smoke control calculations where applicable (e.g., atrium, etc.).
- ☐ Verify accuracy of final stairway pressurization calculations where applicable.
- ☐ Verify accuracy of interface of fire alarm system and Building Automation System.
- ☐ Verify accuracy of interface of fire alarm system and the building security systems.

Miscellaneous

- ☐ Verify that the locations of the fire dampers meet Code requirements.
- ☐ Verify that the location of smoke dampers meet Code requirements.
- ☐ Verify that the elevator systems meet Code requirements.
- ☐ Verify that sprinklered elevator machine rooms are provided with a means to automatically disconnect power.

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).

Electrical Review Checklist.

- ☐ Interference between major conduit and structural framing members coordinated.

- ☐ Adequate clearances to install and service electrical equipment.

- ☐ Light fixture locations and types coordinated with architectural drawings and interior design.

- ☐ Screens for exterior generators and transformers coordinated with architectural drawings.

- ☐ Penetrations through rated wall/floor/roof assemblies detailed and specified.

- ☐ Normal and emergency power requirements supplied for all mechanical and fire safety equipment.

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.

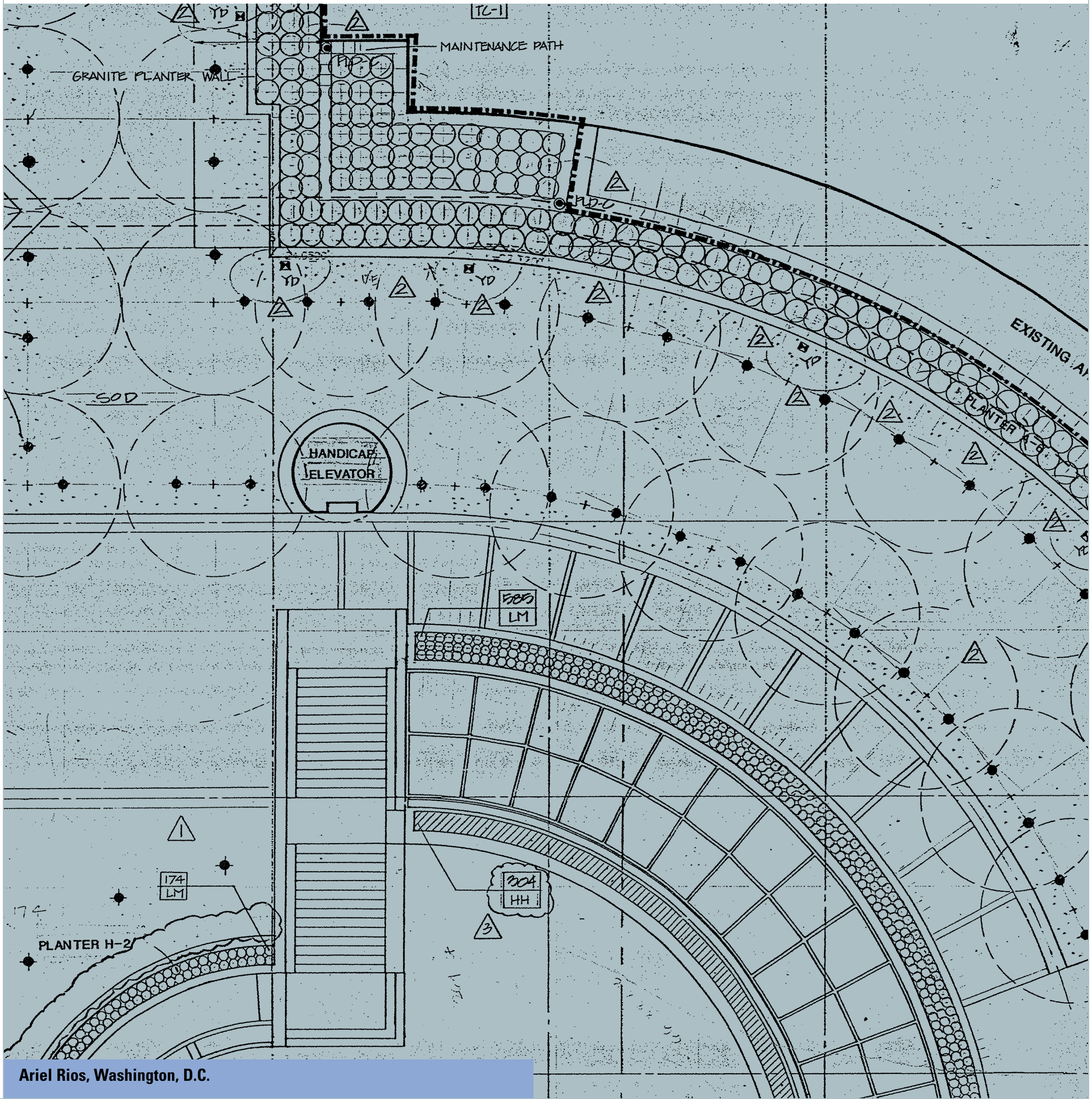
Construction Documents Specifications

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 final working drawing stage estimate stated in GSA document *Project Estimating Requirements*.



Ariel Rios, Washington, D.C.

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 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 includes the geotechnical investigation in the scope of the A/E services.

Purpose. The purpose of the geotechnical investigation during building design is to determine the character and physical properties of soil deposits and evaluate their potential as foundations for the structure or as material for earthwork construction. The type of structure to be built and anticipated geologic and field conditions have a significant bearing on the type of investigation to be conducted.

The investigation must therefore be planned with a 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, including:

- 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 ground floor construction, including recommended bearing capacities and recommended subgrade modulus (k).
- Discussion of evidence of expansive surface materials 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 objectionable material.
- Discussion of potential for consolidation and/or differential settlements of substrata encountered, with recommendations for total settlement and maximum angular distortion.
- Use and treatment of in-situ materials for controlled 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 zones 2A, 2B, 3 and 4, except for those facilities judged to be minor or relatively unimportant facilities for which earthquake damage would not pose a significant risk to either life or property. In zones 2A and 2B, reports need not be prepared for buildings having an importance factor, I, of 1.0 if the structure has less than 4500 m^2 (50,000 sf) of floor area. Geologic hazard reports are not required for zones 0 and 1.

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 Compaction. 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 compaction 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.

Amplitude of Strong Ground Shaking. The amplitude of strong ground shaking used to assess geologic hazards is characterized by peak ground acceleration. Site-specific peak ground accelerations shall conform to the following: except as otherwise specified herein, site peak ground accelerations shall be assumed equal to the zone factor assigned by the ICBO Uniform Building Code (e.g., 0.40 g for zone 4, 0.30 g for zone 3, etc.). When a probabilistic ground motion analysis is carried out, the site peak ground acceleration shall have not less than a 10-percent probability of being exceeded during the design life of the structure. The design life shall be assumed equal to 50 years unless specified otherwise by GSA. For any site located in a region where active faults have been identified, the site peak ground acceleration shall not be lower than the mean values of peak acceleration estimated (using appropriate attenuation relationships) for maximum earthquakes on the active faults.

Duration of Strong Ground Shaking. Estimates of the duration of strong ground shaking at a site are reflected 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 credible 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 significant 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.