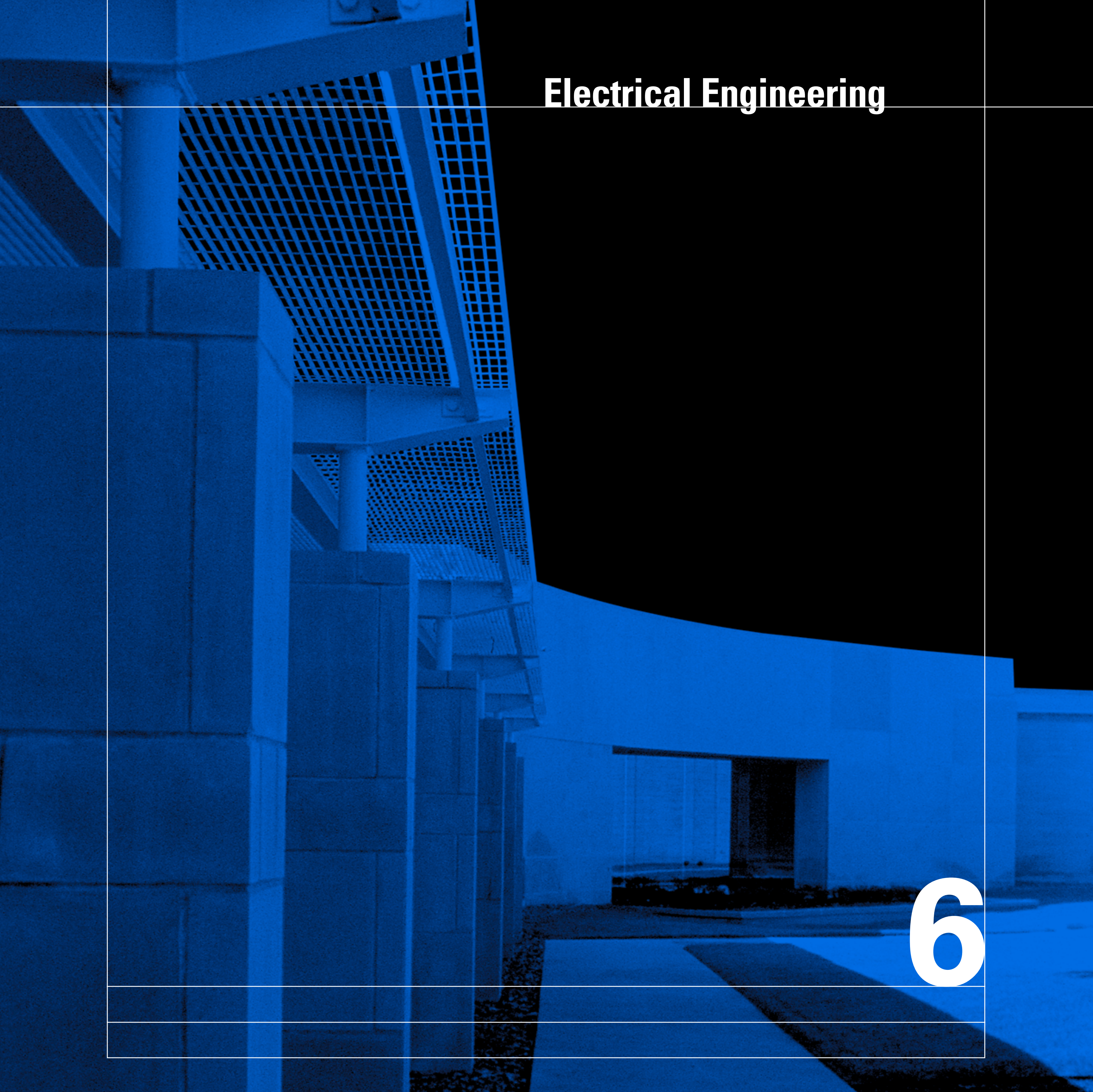
Electrical Engineering



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Harry S. Truman Presidential Library and Museum Addition and Renovation
Architect: Gould Evans
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Photo: Mike Sinclair

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.

Consult Chapter 4.1: *Installation Standards of the Fine Arts Program Desk Guide* for additional information.

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.

Atrium, Sandra Day O'Connor U.S. Courthouse, Phoenix, AZ

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.

Electronic Industries Alliance / Telecommunications Industry Association (EIA/TIA) Standards:

- EIA/TIA Standard 568: *Commercial Building Telecommunications Wiring Standard* (and related bulletins)
- EIA/TIA Standard 569: *Commercial Building Standard For Telecommunications Pathways And Spaces* (and related bulletins)
- EIA/TIA Standard 606: *Administration Standard For The Commercial Telecommunications Infrastructure* (and related bulletins)
- EIA/TIA Standard 607: *Commercial Building Grounding (Earthing) And Bonding Requirements For Telecommunications* (and related bulletins)

Ronald Reagan Building, Washington, D.C.

Oakland Federal Building, Oakland, CA.

6.3 Commissioning

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

- Emergency Power Equipment Modes of Operation.
- Clean Power/Grounding Characteristics.
- Functionality of Building-wide Communication Systems.
- Lighting Levels.
- Lighting Control Functions.
- Effectiveness of Building Automation System Interface.
- Functionality of Applied Innovative Technologies.

6.4 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 EIA/TIA Standard 569: *Commercial Building Standard For Telecommunications Pathways And Spaces* (and related bulletins). 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.

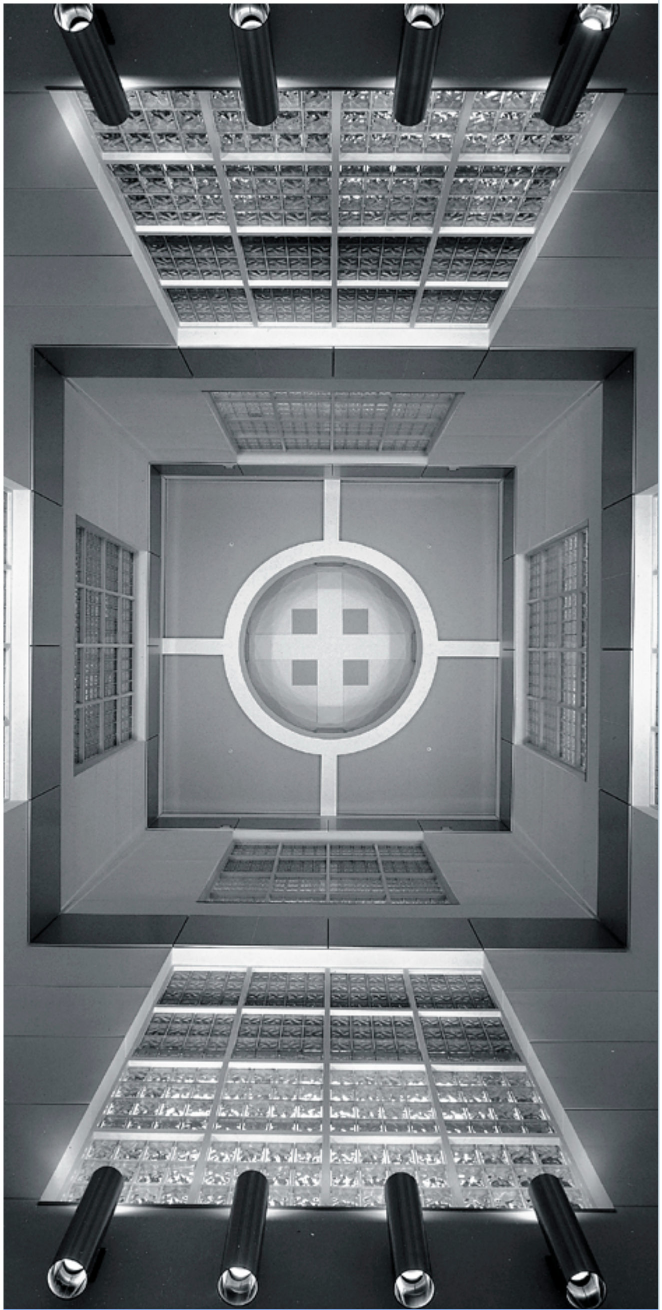
Power, data and telephone cables shall be grouped together in pathways that are separated into channels for each system. Independent channels are required in horizontal pathways for normal power, emergency power, mechanical, fire alarm, security, television and communications. The communications channel 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. EIA/TIA Standard 569: *Commercial Building Standard For Telecommunications Pathways And Spaces* (and related bulletins) 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

6.5 General Design Criteria

Energy Conservation. 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. The Office of Chief Architect assigns an energy goal for each GSA new construction and building modernization.

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 EIA/TIA Standard 607: *Commercial Building Grounding (Earthing) And Bonding Requirements For Telecommunications* (and related bulletins).

Lightning Protection. Lightning protection shall be provided in accordance with NFPA 780. 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. Cathodic protection shall be provided for all metal underground storage tanks. See Appendix A: *Submission Requirements*. Cathodic protection should be designed by a qualified specialist.

Artwork. Museum standards for lighting works of art range from 5 to 10 foot-candles for extremely light sensitive materials such as paper and textiles, to 20 to 40 foot-candles for moderately sensitive materials such as oil paintings and wood.

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

6.6 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 6-2		

6.7 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.

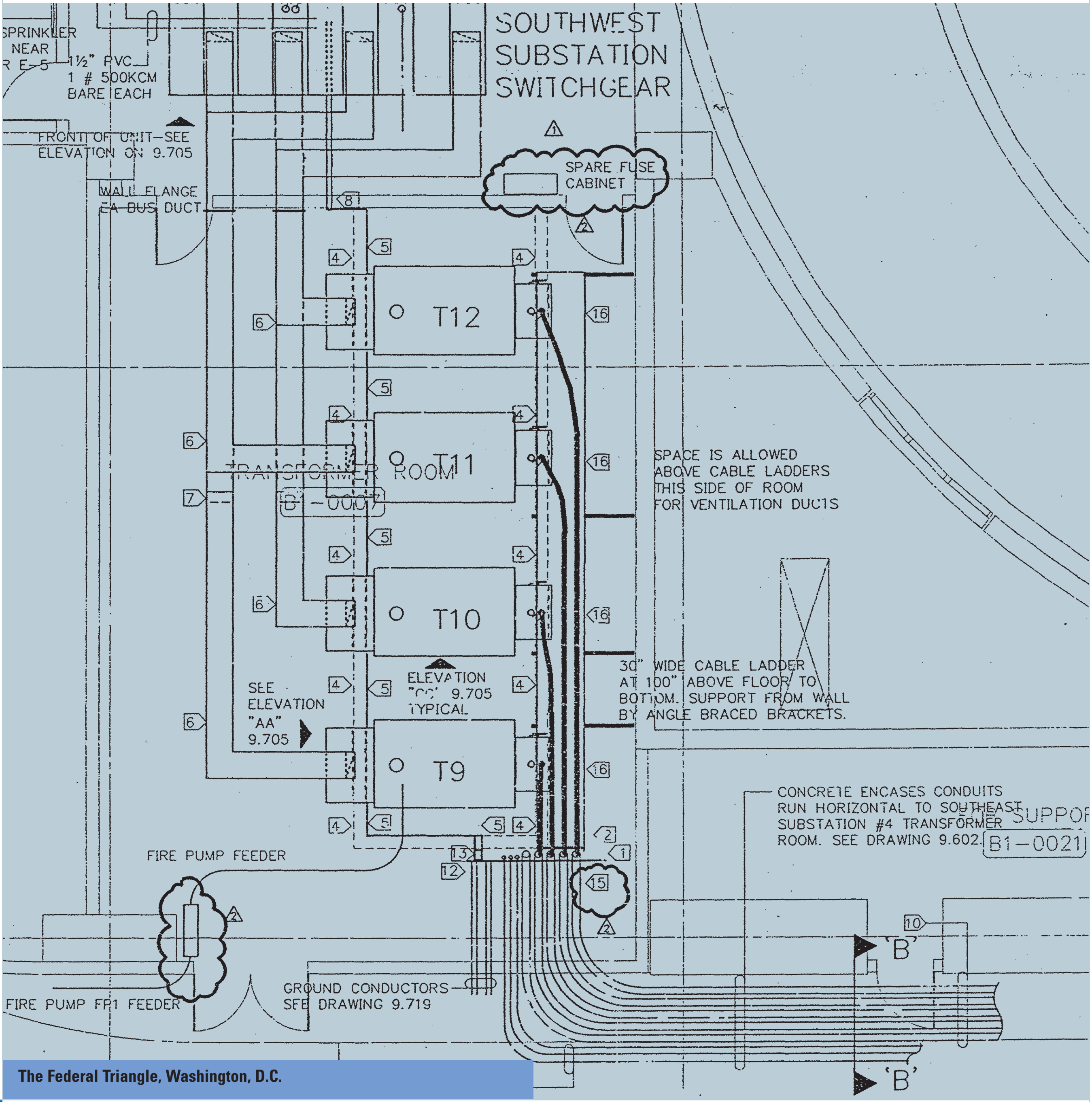
The service entrance location for commercial electrical power should be determined concurrently with the development of conceptual design. Space planning documents and standards for equipment furnished by utility companies should be incorporated into the concept design. Locations for transformers, vaults, 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. The Architect/ Engineer shall coordinate with the client agency to determine the enclosure and pathway requirements for telecom systems. The Scope of Services varies with each project; it includes as a minimum design of the infrastructure (pathway and enclosure) and may include full design and specification of the telecom system.



The Federal Triangle, Washington, D.C.

6.8 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.

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 GSA Federal Technology Service.

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.

6.9 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.

See Chapter 7: *Fire Protection Engineering* for additional requirements.

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.

6.10 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 the *National Electrical Code*. Also reference general design criteria (this chapter) for equipment grounding conductor. Grounding for communications systems must follow the requirements in EIA/TIA Standard 607: *Commercial Building Grounding (Earthing) And Bonding Requirements For Telecommunications* (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.

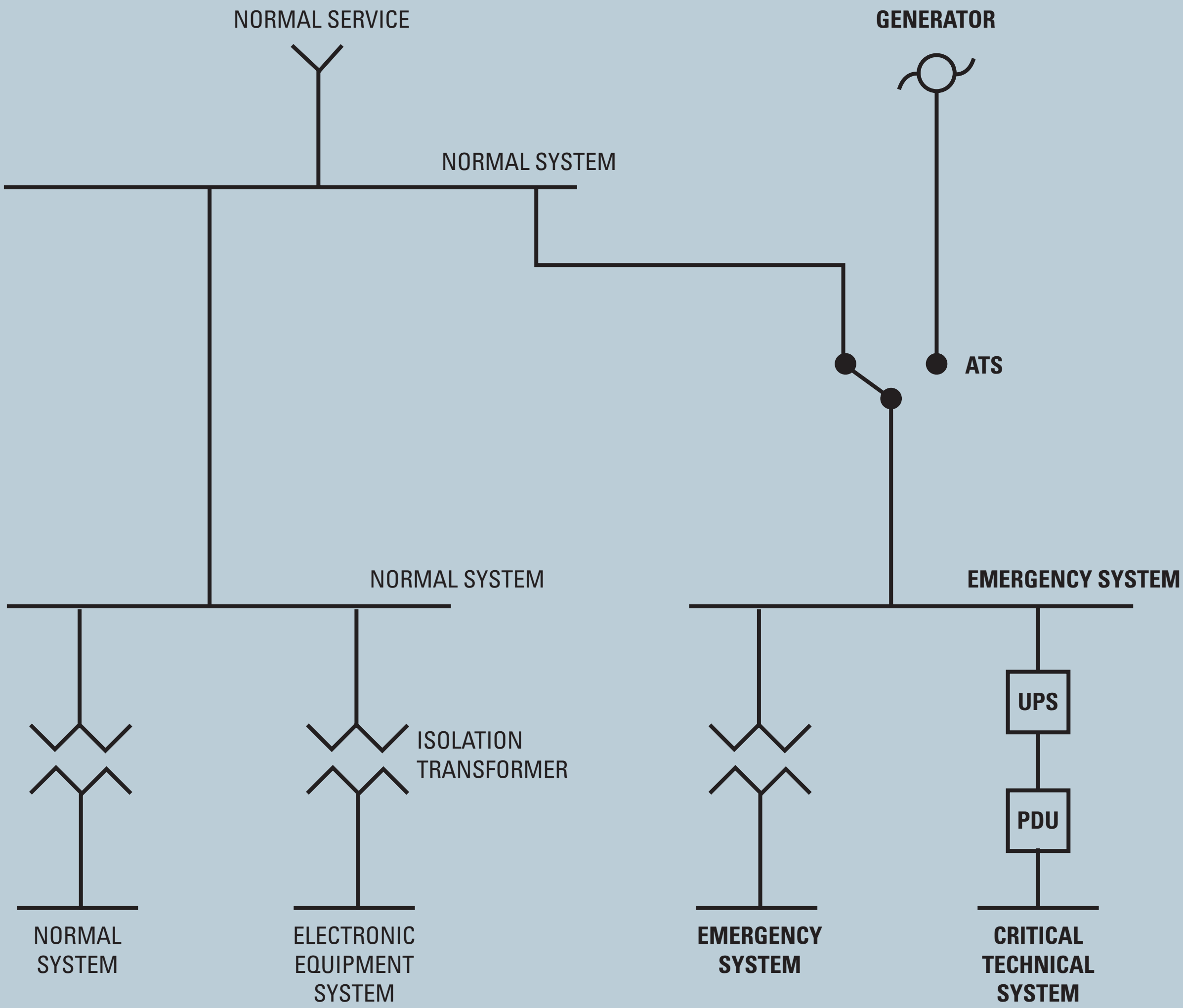
Elevator Power. Elevators should be powered from a shunt trip circuit breaker located in the elevator machine rooms. Electrical design standards in elevator standard ANSI/ASME A17.1 must be followed.

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 6-2 shows a typical power distribution scheme.

Figure 6.2 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.

6.11 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 rigid or flexible conduit to underfloor distribution boxes. One distribution box per bay is recommended (see section *Placing Electrical Systems in Buildings, Horizontal Distribution of Power and Communications*). Flush-mounted access floor service boxes 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 that is identified as Emergency Power at the 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 that is identified as Emergency Power at the receptacle.

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

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

6.12 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: *Fire Protection Engineering* 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 (BAS).
- 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 for communications closets.
- Emergency power receptacles.
- Horizontal sliding doors.
- Other associated equipment designated by code.

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 within the Fire Command Center.

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.

6.13 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. Tenant agencies with UPS requirements are advised that a maintenance contract is recommended.

Requirements for UPS systems must be evaluated on a case by case basis. If UPS is required, it may or may not require generator back-up. When generator back-up is unnecessary, sufficient battery capacity 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 6-2 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. 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 NEC and Chapter 7: *Fire Protection Engineering* for additional requirements.

6.14 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.

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 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.

6.15 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 6-3. 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 6-3 for occupancy changes.

Energy Efficient Design. Lighting design must comply with ASHRAE/IES 90.1 as modified by Table 6-4. 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 6-3
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 6-4
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, have an EnergyStar rating, 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 command 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 buildings. These exterior lighting fixtures shall be connected to the emergency lighting circuit.

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

6.16 Raceway System for Communications

Communications systems for all GSA buildings will meet the requirements of EIA/TIA Standard 569: *Commercial Building Standard For Telecommunications Pathways And Spaces* (and related bulletins). 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 with EIA/TIA Standard 607: *Commercial Building Grounding (Earthing) And Bonding Requirements For Telecommunications* (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 EIA/TIA Standard 607: *Commercial Building Grounding (Earthing) And Bonding Requirements For Telecommunications* (and related bulletins). 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 narrowband 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: *Fire Protection Engineering.*

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.

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.

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.

6.17 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.

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.

6.18 Alterations in Existing Buildings and Historic Structures

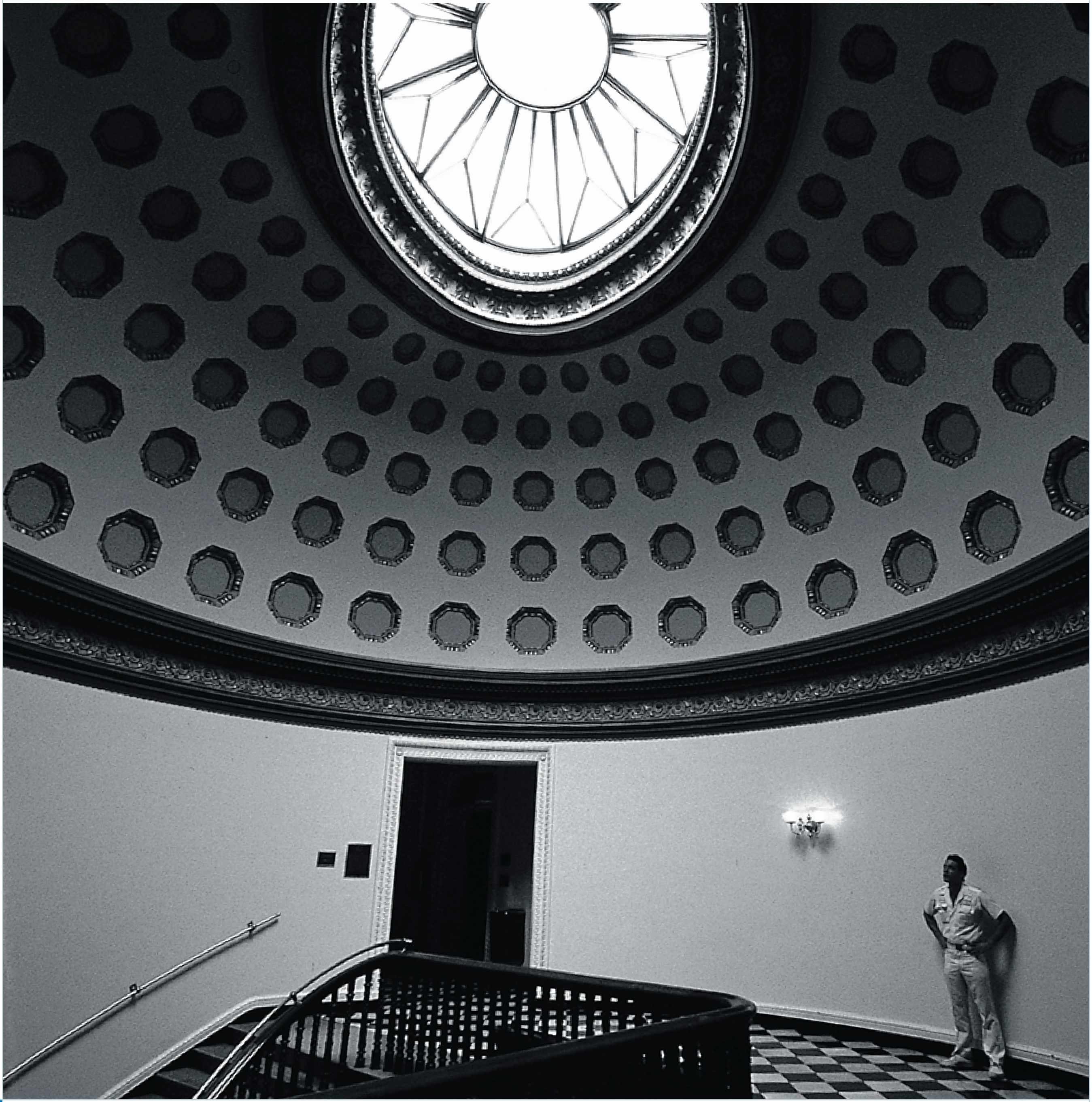
The goal of GSA's alteration projects is to approximate as well as possible the facilities standards described in this book for new projects. Renovation designs must satisfy the immediate occupancy needs but should also anticipate additional future changes. Remodeling should make building systems more 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 specified by the client agency, 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. A cable tray or raceway system 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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7.18 Historic Structures

James H. Quillen United States Courthouse
Greeneville, Tennessee
Architect: Kallmann McKinnell & Wood Architects, Inc.
GSA Project Manager: Donna Lamb
Photo: Robert M. Fouts

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. Performance based designs are encouraged.

A registered fire protection engineer is required to be a full participant of the architect/engineer (A/E) design team for the project. The design team fire protection engineer must have at least 6 years experience from which at least 3 consecutive years are directly involved in the fire protection engineering field. This same or an equally competent professional must remain on the A/E's project staff for the entire design of the project and shall perform the design of all fire protection and life safety systems including but not limited to: building construction, occupancy classifications, means of egress, water supply, fire alarm system(s), water based fire extinguishing systems, non-water based fire extinguishing systems, fire dynamics calculations, egress calculations, smoke control calculations, etc. See Appendix A for specific submission requirements.

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 Certificate of Occupancy

No new building or portion thereof shall be occupied until the regional fire protection engineer has issued a certificate of occupancy to the GSA Project Manager. Issuance of a certificate of occupancy shall not be construed as an approval of any violation of a Code or GSA design standard or criteria.

Once the regional fire protection engineer has ensured that to the best of their knowledge all fire protection and life safety systems have been completed, inspected, successfully tested and approved and all outstanding fire and life safety deficiencies have been corrected to afford a reasonable degree of safety to the building occupants from fire and similar emergencies, a certificate of occupancy will be issued to the GSA Project Manager.

The regional fire protection engineer is authorized to issue a temporary certificate of occupancy. This certificate shall allow partial occupancy of specific areas, prior to completion of the building. All life safety and fire protection systems serving the areas proposed for occupancy and all floors below shall be completed, inspected, successfully tested and approved by the regional fire protection engineer. The temporary certificate of occupancy shall identify the specific area(s) of the building where occupancy is permitted. Following the issuance of a temporary certificate of occupancy, the regional fire protection engineer shall set a time frame for the completion, inspection, testing and approval of all life safety and fire protection systems, and the correction of any outstanding life safety and fire protection deficiencies. Upon completion, inspection, successful testing and approval of all fire protection and life safety systems and correction of all outstanding fire and life safety deficiencies, the regional fire protection engineer will issue a certificate of occupancy for the entire building to the GSA Project Manager.

7.3 Fire Safety During Construction and Renovations

General. Fire safety during construction and renovations shall comply with the requirements of the International Building Code (IBC), International Fire Code (IFC), 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. The regional fire protection engineer shall make the final determination of the adequacy of proposed equivalent levels of fire protection prior to the disruption of any fire protection system. For example, the provision of a 24 hour fire watch by qualified individuals may provide an equivalent level of fire protection during system disruption in some circumstances.

7.4 Commissioning

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

- Fire Alarm System Testing.
- Smoke Control System Effectiveness.
- Areas of Refuge Pressurization.
- Effectiveness of Building Automation System Interface.
- Functionality of Applied Innovative Technologies.

7.5 Building Construction

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

Exterior 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.

7.6 Interior Finishes

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

Special Requirements. The requirements below supersede the requirements of the International 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).

7.7 Occupancy Classifications

General. Occupancy classifications shall meet the requirements of the International Building Code.

Courtroom, Robert C. Byrd U.S. Courthouse, Charleston, WV

7.8 Means of Egress

General. The egress requirements in NFPA 101 shall be used in lieu of the egress requirements in the International Building Code.

Special Requirements. The requirements below supersede the requirements of the NFPA 101:

- 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 the 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 International Building Code.

Stair Identification Signs. In addition to meeting the requirements of the NFPA 101, the stair identification signs shall meet the following requirements:

- The signs shall have a background made of photoluminescent material complying with ASTM E 2072-00 as a minimum standard.
- The signs shall be a minimum size of 12 inches by 12 inches.
- The large letter and number type shall be a minimum of 1-1/2 inches tall.
- The small letter and number type shall be a minimum of 9/16" tall.
- The directional arrows shall be a minimum of 1-3/8 inches tall.
- Letters and numbers on the signs shall have a width-to-height ratio between 3:5 and 1:1; and a stroke width-to-height ratio between 1:5 and 1:10.

For projects in historic structures, the design team shall consult with the Regional Historic Preservation Officer regarding these requirements.

Stair Treads. In addition to meeting the requirements of the NFPA 101, stair treads shall incorporate photo-luminescent paint or photolumi-nescent adhesive strips that are to be applied to the leading edge of the stair tread. Photoluminescent materials shall comply with ASTM E 2072-00 as a minimum standard. For projects in historic structures, the design team shall consult with the Regional Historic Preservation Officer regarding these requirements.

7.9 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. For emergency power requirements see Chapter 6.

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 unless the local responding fire department cannot 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.

7.10 Water Based Fire Extinguishing 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 International Building Code, and the appropriate GSA sprinkler system specification.

Special Requirements: The requirements below supersede the requirements of NFPA 13 and the International 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 International 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.
- All quick response glass bulb sprinklers shall be equipped with a protective device to reduce damage prior to installation. The protective device shall be removed after sprinklers are installed.
- U.L. listed concealed sprinklers are allowed only when approved by the GSA regional fire protection engineer.
- 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 Underwriters Laboratories Inc. (UL) listed or 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.
- All automatic sprinklers installed less than 7 feet above the floor shall be equipped with sprinkler guards to provide protection against accidental damage.

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 wet-pipe sprinkler piping. Chlorinated polyvinyl chloride (CPVC) sprinkler piping shall be allowed to be installed only when approved by the GSA regional fire protection engineer.
- Galvanized (internal and external) sprinkler piping shall be used for all dry-pipe sprinkler systems.
- Steel pipe sizes 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 installed in electrical rooms and electrical closets shall be equipped with sprinkler guards to provide protection against accidental damage.

Places of Confinement.

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

7.11 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.

7.12 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.

7.13 Portable Fire Extinguishers and Cabinets

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

Special Requirements. The requirements below supersede the requirements of the International 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, kitchen areas, special hazard areas, etc.

7.14 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.
- For floor loading requirements see Chapter 4.

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.

7.15 Special Fire Protection Requirements

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.

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.

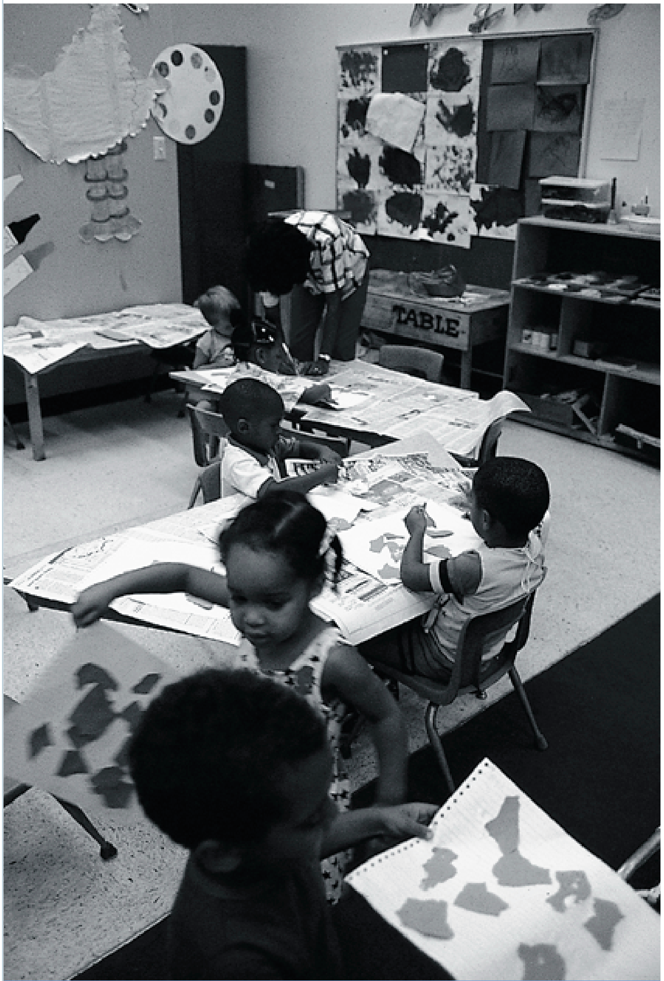
Special Requirements. The requirements below supersede the requirements of NFPA 75.

- 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 conventional photo-electric smoke detectors or the activation of one intelligent analog/addressable photoelectric smoke detector utilizing early warning smoke detection technology (e.g., smoke detectors having enhanced algorithms, fire alarm control panel having capability to program individual smoke detector response parameters, or smoke detectors using air sampling technology for use in essential electronic facilities, etc.) within a single protected area shall disconnect power to the computer equipment and to the HVAC system after a pre-set time delay.

EPA Headquarters

Elevator Systems

Entrapment Prevention: When the regional fire protection engineer has determined that there may be a possibility that occupants may get trapped in an elevator cab due to the power shut-down of the elevator controller prior to complete elevator recall via Phase I Emergency Recall Operation, earthquake mode emergency condition software shall be incorporated into the project. The earthquake mode emergency condition software is available on all manufacturer microprocessors. Normally, the elevator displacement switch initiates the earthquake mode emergency condition. When the displacement switch is activated, the elevators, if in motion, proceed to the nearest available landing and park with their doors open and shut down. The project shall incorporate the installation of heat detector(s) in the elevator machine room(s) to initiate the "earthquake mode" emergency condition software protocol in lieu of or in addition to the elevator displacement switch depending on the seismic region in which the building is located. The heat detectors installed shall have both lower temperature rating and higher sensitivity as compared to the automatic sprinklers within the elevator machine rooms.



Child Care Center

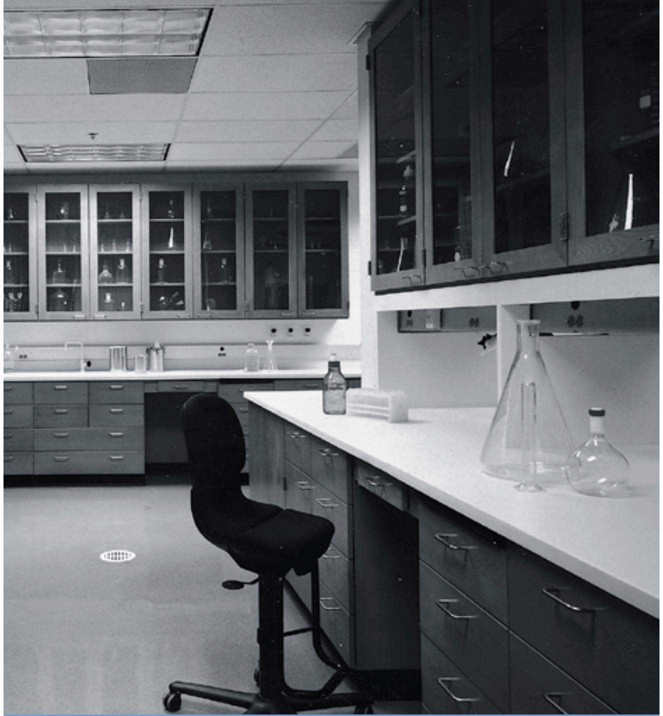
The following operating sequence would apply:

- Prior to activation of sprinklers, a signal shall be received from heat detectors in the machine room and the input connected to the elevator controllers.
- When the signal is received into the microprocessor, it will activate "earthquake mode". The "earthquake mode" is available on all manufacturer microprocessors and is required on all elevators in regions of moderate and high seismicity.
- When the signal from the heat detector is received, the "earthquake mode" rescue sequence shall be activated. The cars will proceed to the closest available landing and park with their doors open.

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

Atrium Smoke Removal System

An atrium smoke removal system shall be designed and installed in accordance with the requirements of the International Building Code. Additional design guidance may be found in NFPA 92B.



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

Smoke Control Systems

Smoke control systems shall be designed and installed in accordance with the International Building Code. Additional design guidance may be found in NFPA 92A, the ASHRAE/SFPE manual, *Design of Smoke Management Systems*, and NFPA publication, *Smoke Movement and Control in High Rise Buildings.*

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.*

Laboratories

Laboratories shall meet the design requirements in NFPA 45 and the International 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.

7.16 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 the NFPA 101.

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

7.17 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 International Building Code, and the appropriate GSA fire alarm system specification.

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

- All new and replacement fire alarm systems shall be addressable systems as defined in NFPA 72.
- All new and replacement fire alarm systems installed in buildings having a total occupant load of 500 or more occupants or subject to 100 or more occupants below the level of exit discharge shall be a voice/alarm communication system. The voice/alarm communication system shall provide an automatic response to the receipt of a signal indicative of a fire emergency. Manual control capability shall also be provided to notify all occupants either on a selective or all-call basis during an emergency.
- 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 International Building Code.

Special Requirements. The design requirements below supersede the requirements of NFPA 72 and the International 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 International Building Code.

Special Requirements. The design requirements below supersede the requirements of NFPA 72 and the International 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 International Building Code.

Special Requirements. The design requirements below supersede the requirements of NFPA 72, NFPA 90A, and the International Building Code:

- Smoke detectors shall not be installed in each of the following rooms: mechanical equipment, electrical closet, telephone closet, emergency generator room, uninterruptible power service and battery rooms, 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

Performance, location, and mounting 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.
- The design for the placement and location of all audible notification appliances shall be based on the applicable calculation methods contained in *The SFPE Handbook of Fire Protection Engineering* for calculating sound attenuation through doors and walls.

- 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 distinctive three-pulse temporal pattern for three (3) cycles followed by the automatic voice messages which shall be repeated until the control panel is reset (i.e., three-pulse temporal pattern - three-pulse temporal pattern - three-pulse temporal pattern - voice message; three-pulse temporal pattern - three-pulse temporal pattern - three-pulse temporal pattern - 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

Special Requirements. The requirements below are in addition to the survivability requirements specified in NFPA 72.

- At least two vertical risers shall be installed as remote as possible from each other. A minimum two-hour fire rated assembly, shaft, or enclosure, not common to both risers shall protect one riser. A minimum one-hour fire rated assembly, shaft, or enclosure shall protect the second riser. A minimum one-hour fire rated assembly, shaft, or enclosure shall protect the horizontal interconnection between the two risers.
- 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 and visual appliances shall be on separate circuits.

Fire Command Center

The fire command center shall be provided in a location approved by the regional fire protection engineer after consultation with the local fire department.

The equipment and contents of the fire command center shall meet the requirements of the International 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

7.18 Historic Structures

For an overall fire protection plan and to emphasize the Design Team's responsibility to address fire protection and to preserve the historic integrity of historic structures, the Design Team shall explore alternative approaches outlined in state rehabilitation codes, International Existing Building Code (IEBC), and performance based codes to resolve conflicts between prescriptive code requirements and preservation goals. In addition, the requirements and recommendations of NFPA 914 shall be considered for rehabilitation projects in historic structures. The Design Team shall also evaluate the HUD Guideline *Fire Ratings of Archaic Materials and Assemblies* that provides test data on the fire resistance of a variety of historic materials and GSA publication titled *Fire Safety Retrofitting in Historic Buildings*.

GSA's regional fire protection engineer serves as the AHJ, who must exercise professional 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.

Fire Protection Alternatives for Consideration. Listed below are fire protection alternatives for the Design Team's fire protection engineer to consider when designing a project:

- New stair enclosures in historic buildings should be designed to minimize visual impact on significant spaces, including historic lobbies and corridors. Cross-corridor doors should be designed to provide maximum height and width clearance and avoid visually

Spokane Federal Building/U.S. Post Office 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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Ariel Rios Federal Building Façade Completion
Washington, District of Columbia
Architect: Karn Charuhas Chapman & Twohey
GSA Project Managers: Norton Crichlow and Len Weiser

8.1 Planning and Cost

Planning

Designing and constructing safe and secure cost effective buildings has always been one of GSA's primary goals. To design and construct a safe and secure building, a collaborative approach to the design process is required, starting at the conceptual phase of the project and continuing throughout the process. It is necessary for all persons responsible for the safety and security of the building components to interact closely throughout the entire design and construction process. This means that all interested parties involved in issues pertaining to safety and security understand the issues and concerns of both parties. This also involves inviting the client, local building and fire officials, the appropriate designers and consultants to participate in such discussions. This process is particularly helpful in complex situations where many people represent different interests and a common goal needs to be achieved (i.e., a safe and secure building).

A multidisciplinary team will determine the appropriate design criteria for each project, based on a building-specific risk assessment and an analysis of all available information on security considerations, constraints, and tenant needs. However, a delicate balance must be achieved between safety and the security measures proposed. Therefore, the GSA fire protection engineer shall be a full participant on the subject multidisciplinary team to ensure that the safety of the building occupants exiting the building and the emergency responders entering the building are not impacted unknowingly by any proposed security measure.

In historic buildings, to minimize loss of character, design criteria should be based on facility-specific risk assessment and strategic programming. Strategic programming includes focusing security modifications on vulnerability points and locating less vulnerable activities in the historic buildings.

Zones of Protection

A zoned protection system is used, with intensifying areas of security beginning at the site perimeter and moving to the interior of the building.

Crime Prevention Through Environmental Design (CPTED). CPTED techniques should be used to help prevent and mitigate crime. Good strategic thinking on CPTED issues such as site planning, perimeter definition, sight lines, lighting, etc., can reduce the need for some engineering solutions.

For further information on CPTED, see:
- Publications by the National Institute of Law Enforcement and Criminal Justice (NILECJ).
- Crowe, Timothy D., *Crime Prevention Through Environmental Design*. National Crime Prevention Institute (1991).

Capability to Increase or Decrease Security. Designs should include the ability to increase security in response to a heightened threat, as well as to reduce security if changes in risk warrant it.

Multidisciplinary Approach. Improving security is the business of everyone involved with Federal facilities including designers, builders, operations and protection personnel, employees, clients, and visitors. Professionals who can contribute to implementing the criteria in this document include architects and structural, mechanical, fire protection, security, cost, and electrical engineers. Blast engineers and glazing specialists may also be required as well as building operations personnel and security professionals experienced in physical security design, operations, and risk assessment.

Each building system and element should support risk mitigation and reduce casualties, property damage, and the loss of critical functions. Security should be considered in all decisions, from selecting architectural materials to placing trash receptacles to designing redundant electrical systems.

Site Security Requirements. Site security requirements, including perimeter buffer zones, should be developed before a site is acquired and the construction funding request is finalized. This requirement may be used to prevent the purchase of a site that lacks necessary features, especially sufficient setback, and to help reduce the need for more costly countermeasures such as blast hardening.

Adjacent Sites. When warranted by a risk assessment, consideration should be given to acquiring adjacent sites or negotiating for control of rights-of-way. Adjacent sites can affect the security of Federal facilities.

Access Control and Electronic Security. Electronic security, including surveillance, intrusion detection, and screening, is a key element of facility protection; many aspects of electronic security and the posting of security personnel are adequately dealt with in other criteria and guideline documents. These criteria primarily address access control planning - including aspects of stair and lobby design - because access control must be considered when design concepts for a building are first conceived. While fewer options are available for modernization projects, some designs can be altered to consider future access control objectives.

Cost

Initial Costs. When cost is not considered, one risk can consume a disproportionate amount of the budget while other risks may go unmitigated or not addressed at all. Budgets should match the requirements of the risk assessment. It is important that decision-makers know funding needs early so that they can request funding to fully implement the requirements of the risk assessment. Should projects be over budget, security, along with other building elements, may be reevaluated. However, if security is decreased, there should be compensating operational procedures and/or periodic reevaluation to see if technology or procedures can mitigate the risk.

The security budget 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, 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. Two such economic practices are ASTM E 917 to measure life-cycle costs, and ASTM E 1074 to measure net economic benefits. ASTM E 1765 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 Protection Zone and Landscaping* below, and Chapter 9). See Chapter 2: *Site Circulation Design*, for fire department/fire apparatus access requirements for which design must also be in compliance.

Thomas Eagleton Courthouse, St. Louis, MO

Perimeter Protection Zone. Site perimeter barriers are one element of the perimeter protection zone. Perimeter barriers capable of stopping vehicles of _______ lbs., up to a speed of ______, shall be installed (project-specific information to be provided). A vehicle velocity shall be used considering the angle of incidence in conjunction with the distance between the perimeter and the point at which a vehicle would likely be able to start a run at the perimeter. A barrier shall be selected that will stop the threat vehicle. Army TM 5-853-1 and TM 5-853-2/AFMAN 32-1071, Volume 2 contain design procedures. See Chapter 2: *Site Circulation Design,* for fire department/fire apparatus access requirements for which design must also be in compliance. In designing the barrier system, consider the following options:

- Using various types and designs of buffers and barriers such as walls, fences, trenches, ponds and water basins, plantings, trees, static barriers, sculpture, and street furniture;
- Designing site circulation to prevent high speed approaches by vehicles; and
- Offsetting vehicle entrances as necessary from the direction of a vehicle's approach to force a reduction in speed.

Perimeter Vehicle Inspection

- Provide space for inspection at a location to be specified.
- Provide design features for the vehicular inspection point that stop vehicles, prevent them from leaving the vehicular inspection area, and prevent tailgating.

Site Lighting

Effective site lighting levels: At vehicular and pedestrian entrances, ____ (project-specific information to be provided) horizontal maintained foot candles; and for perimeter and vehicular and pedestrian circulation areas, ____ horizontal maintained foot candles. In most circumstances, perimeter lighting should be continuous and on both sides of the perimeter barriers, with minimal hot and cold spots and sufficient to support CCTV and other surveillance. However, for safety reasons and/or for issues related to camera technology, lower levels may be desirable. Other codes or standards may restrict site lighting levels.

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. Historic buildings generally require alternative design schemes that will not alter the exterior or lobby configuration. Consult the Regional Historic Preservation Officer regarding appropriate solutions.

Forced Entry. See section on *Exterior Walls* for swinging door, horizontal sliding door, and wall criteria. See section on *Structural Engineering, New Construction, Exterior Windows* for window criteria.

Equipment Space. Public and employee entrances should include space for possible future installation of access control and screening equipment. In historic buildings place security equipment in ancillary spaces where possible.

Entrance Co-location. Combine public and employee entrances.

Garage and Vehicle Service Entrances. All garage or service area entrances for government controlled or employee permitted vehicles that are not otherwise protected by site perimeter barriers shall be protected by devices capable of arresting a vehicle of the designated threat size at the designated speed. This criterion may be lowered if the access circumstances prohibit a vehicle from reaching this speed (see section on *Site Planning and Landscape Design, Vehicular Control, Perimeter Protection Zone*).

Additional Features

Areas of Potential Concealment. To reduce the potential for concealment of devices before screening points, avoid installing features such as trash receptacles and mail boxes that can be used to hide devices. If mail or express boxes are used, the size of the openings should be restricted to prohibit insertion of packages.

Roof Access. Design locking systems to meet the requirements of the International Building Code and limit roof access to authorized personnel.

Warren B. Rudman Courthouse, Concord, NH

Sam Gibbons U.S. Courthouse, Tampa, FL

8.3 Commissioning

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

- Glazing/Framing Blast Resistance.
- HVAC Emergency Modes of Operation (for Chemical-Biological Attack).
- Effectiveness of Entrance Card-Key System(s).
- Speech Privacy.
- Effectiveness of Electronic Security.
- Functionality of Assistance/Alarm Systems.
- Effectiveness of Building Automation System Interface.
- Functionality of Applied Innovative Technologies.

8.4 New Construction

Progressive Collapse. Designs that facilitate or are vulnerable to progressive collapse must be avoided. At a minimum, all new facilities shall be designed for the loss of a column for one floor above grade at the building perimeter without progressive collapse. This design and analysis requirement for progressive collapse is not part of a blast analysis. It is intended to ensure adequate redundant load paths in the structure should damage occur for whatever reason. Designers may apply static and/or dynamic methods of analysis to meet this requirement. Ultimate load capacities may be assumed in the analyses.

In recognition that a larger than design explosive (or other) event may cause a partial collapse of the structure, new facilities with a defined threat shall be designed with a reasonable probability that, if local damage occurs, the structure will not collapse or be damaged to an extent disproportionate to the original cause of the damage.

In the event of an internal explosion in an uncontrolled public ground floor area, the design shall prevent progressive collapse due to the loss of one primary column, or the designer shall show that the proposed design precludes such a loss. That is, if columns are sized, reinforced, or protected so that the threat charge will not cause the column to be critically damaged, then progressive collapse calculations are not required for the internal event. For design purposes, assume there is no additional standoff from the column beyond what is permitted by the design.

Discussion: As an example, if an explosive event causes the local failure of one column and major collapse within one structural bay, a design mitigating progressive collapse would preclude the additional loss of primary structural members beyond this localized damage zone (i.e., the loss of additional columns, main girders, etc.). This does not preclude the additional loss of secondary structural or non-structural elements outside the initial zone of localized damage, provided the loss of such members is acceptable for that performance level and the loss does not precipitate the onset of progressive collapse.

Building Materials. All building materials and types acceptable under the model International Building Code are allowed. However, special consideration should be given to materials which have inherent ductility and which are better able to respond to load reversals (i.e., cast in place reinforced concrete and steel construction). Careful detailing is required for material such as pre-stressed concrete, pre-cast concrete, and masonry to adequately respond to the design loads. The construction type selected must meet all performance criteria of the specified Level of Protection.

Exterior Walls

Design for limited load:

- Design exterior walls for the actual pressures and impulses up to a maximum of ___ psi and ___ psi-msec (project-specific information to be provided).
- The designer should also ensure that the walls are capable of withstanding the dynamic reactions from the windows.
- Shear walls that are essential to the lateral and vertical load bearing system, and that also function as exterior walls, shall be considered primary structures. Design exterior shear walls to resist the actual blast loads predicted from the threats specified.
- Where exterior walls are not designed for the full design loads, special consideration shall be given to construction types that reduce the potential for injury (see *Building Materials* in this section).

Design for full load:

- Design the exterior walls to resist the actual pressures and impulses acting on the exterior wall surfaces from the threats defined for the facility (see also discussions in Design for limited load above).

Forced Entry:

- Security of Swinging Door Assemblies ASTM F 476 Grade ____ (project-specific information to be provided).
- Measurement of Forced Entry Resistance of Horizontal Sliding Door Assemblies ASTM F 842 Grade ___ (project-specific information to be provided).
- A medium protection level (per TM 5-853) for walls would be the equivalent of 4" concrete with #5 reinforcing steel at 6" interval each way or 8" CMU with #4 reinforcing steel at 8 in. interval. TM 5-853 provides other alternatives for low, medium, and high protection.

Exterior Windows

The multidisciplinary team shall evaluate the performance requirements for all security-glazing materials proposed for the project. The multidisciplinary team shall ensure that normal tools carried by firefighters, such as a pick head axe, halligan tool, or similar device, can readily overcome the subject glazing barriers. If the use of more specialized tools, such as a rabbit tool, a k-tool, circular saws, rams, or similar devices is necessary to break through the glazing barrier or if the glazing itself is hardened that a blast may not blow out the windows, alternative methods or systems must be designed to ensure smoke from the incident is not trapped inside the building. (See section on *New Construction, Fire Protection Engineering, Smoke Removal Systems*).

The following terms are to be applied and identified for each project-specific risk assessment:

No restriction. No restrictions on the type of glazing.

Limited protection. These windows do not require design for specific blast pressure loads. Rather, the designer is encouraged to use glazing materials and designs that minimize the potential risks.

- Preferred systems include: thermally tempered heat strengthened or annealed glass with a security film installed on the interior surface and attached to the frame; laminated thermally tempered, laminated heat strengthened, or laminated annealed glass; and blast curtains.
- Acceptable systems include thermally tempered glass; and thermally tempered, heat strengthened or annealed glass with film installed on the interior surface (edge to edge, wet glazed, or daylight installations are acceptable).
- Unacceptable systems include untreated monolithic annealed or heat strengthened glass; and wire glass.

The minimum thickness of film that should be considered is 4 mil. In a blast environment, glazing can induce loads three or more times that of conventional loads onto the frames. This must be considered with the application of anti-shatter security film.

The designer should design the window frames so that they do not fail prior to the glazing under lateral load. Likewise, the anchorage should be stronger than the window frame, and the supporting wall should be stronger than the anchorage.

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.

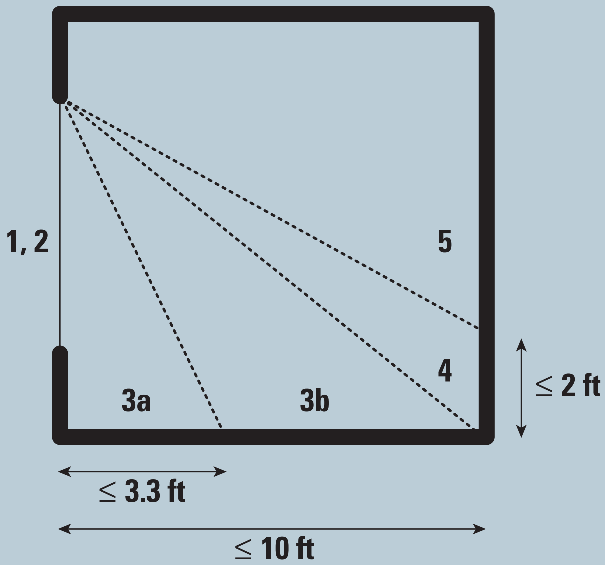
The design strength of a window frame and associated anchorage is related to the breaking strength of the glazing. Thermally tempered glass is roughly four times as strong as annealed, and heat strengthened glass is roughly twice as strong as annealed.

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 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.

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.

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.

- **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.

Robert C. Byrd Courthouse, Charleston, WV

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 resistance to blast may impart large reaction loads to the supporting walls.

- Resistance of Window Assemblies to Forced Entry (excluding glazing) ASTM F 588 Grade___ (project-specific information to be provided; see above for glazing).
- Design for eavesdropping and electronic emanations is beyond the scope of the criteria.

Non-Window Openings. Non-window openings such as mechanical vents and exposed plenums should be designed to the level of protection required for the exterior wall. Designs should account for potential in-filling of blast over-pressures through such openings. The design of structural members and all mechanical system mountings and attachments should resist these interior fill pressures.

Interior Windows. Interior glazing should be minimized where a threat exists. The designer should avoid locating critical functions next to high risk areas with glazing, such as lobbies, loading docks, etc.

Parking. The following criteria apply to parking inside a facility where the building superstructure is supported by the parking structure:

- The designer shall protect primary vertical load carrying members by implementing architectural or structural features that provide a minimum 6-inch standoff.
- All columns in the garage area shall be designed for an unbraced length equal to two floors, or three floors where there are two levels of parking.

Selected Design Areas. For lobbies and other areas with specified threats:

- The designer shall implement architectural or structural features that deny contact with exposed primary vertical load members in these areas. A minimum standoff of at least 6 inches from these members is required.
- Primary vertical load carrying members shall be designed to resist the effects of the specified threat (see *Progressive Collapse* in this section).

Loading Docks. The loading dock design should limit damage to adjacent areas and vent explosive force to the exterior of the building. Significant structural damage to the walls and ceiling of the loading dock is acceptable. However, the areas adjacent to the loading dock should not experience severe structural damage or collapse. The floor of the loading dock does not need to be designed for blast resistance if the area below is not occupied and contains no critical utilities.

Mailrooms and Unscreened Retail Spaces. Mailrooms where packages are received and opened for inspection, and unscreened retail spaces (see *Architecture and Interior Design, Planning, Retail in the Lobby and Mailroom*) shall be designed to mitigate the effects of a blast on primary vertical or lateral bracing members. Where these rooms are located in occupied areas or adjacent to critical utilities, walls, ceilings, and floors, they should be blast and fragment resistant. Significant structural damage to the walls, ceilings, and floors of the mailroom is acceptable. However, the areas adjacent to the mailroom should not experience severe damage or collapse.

Venting. The designer should consider methods to facilitate the venting of explosive forces and gases from the interior spaces to the outside of the structure. Examples of such methods include the use of blow-out panels and window system designs that provide protection from blast pressure applied to the outside but that readily fail and vent if exposed to blast pressure on the inside.

8.5 Existing Construction Modernization

Existing structures undergoing a modernization should be upgraded to new construction requirements when required by the risk assessment except where noted in Progressive Collapse, below. The requirements of new construction apply to all major additions and structural modifications.

Protection Levels. Risk assessments based on the new construction criteria shall be performed on existing structures to examine the feasibility of upgrading the facility. The results, including at a minimum recommendations and cost, shall be documented in a written report before submission for project funding.

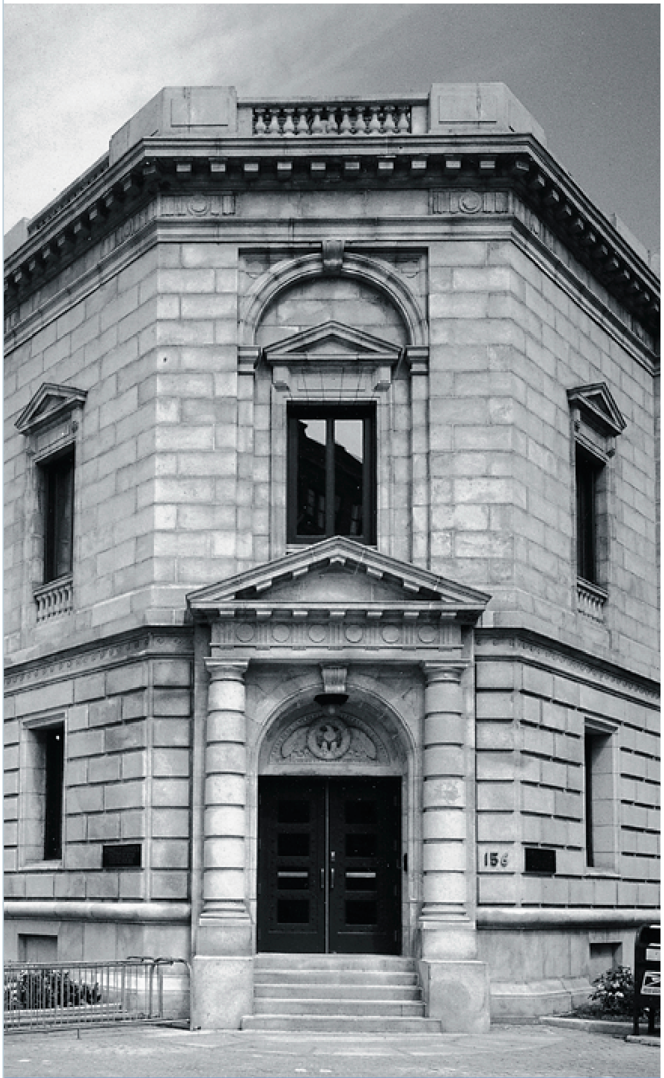
Progressive Collapse. Progressive Collapse analysis must be performed if:

1. The building is to be upgraded for seismic forces
2. The building structural frame will be exposed as part of the current scope of work making any structural upgrade for preventing progressive collapse appropriate at this time.
3. The exterior façade of the building is to be removed making structural upgrade of the perimeter structural system appropriate at this time.

Prior to the submission for funding, all structures shall be analyzed according to requirements for new construction, and a written report shall clearly state the potential vulnerability of the building to progressive collapse. This report will be used as a planning tool to reduce risk. Findings of the design-analysis shall be incorporated into the project's risk assessment and include the methodology, the details of the progressive collapse analysis, retrofit recommendations, cost estimates, and supporting calculations.

8.6 Historic Buildings

Historic buildings are covered by these criteria in the same manner as other existing buildings (see *Existing Construction Modernization* in this section).



Edward T. Gignoux U.S. Courthouse, Portland, ME

8.7 Structural Engineering

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.

U.S. Census Bureau, Bowie, MD

- Lap splices should fully develop the capacity of the reinforcement.

- Lap splices and other discontinuities should be staggered.

- Ductile detailing should be used for connections, especially primary structural member connections.

- There should be control of deflections around certain members, such as windows, to prevent premature failure. Additional reinforcement is generally required.

- Balanced design of all building structural components is desired. For example, for window systems, the frame and anchorage shall be designed to resist the full capacity of the weakest element of the system.

- Special shear reinforcement including ties and stirrups is generally required to allow large post-elastic behavior. The designer should carefully balance the selection of small but heavily reinforced (i.e., congested) sections with larger sections with lower levels of reinforcement.

- Connections for steel construction should be ductile and develop as much moment connection as practical. Connections for cladding and exterior walls to steel frames shall develop the capacity of the wall system under blast loads.

- In general, single point failures that can cascade, producing wide spread catastrophic collapse, are to be avoided. A prime example is the use of transfer beams and girders that, if lost, may cause progressive collapse and are therefore highly discouraged.

- Redundancy and alternative load paths are generally good in mitigating blast loads. One method of accomplishing this is to use two-way reinforcement schemes where possible.

- In general, column spacing should be minimized so that reasonably sized members can be designed to resist the design loads and increase the redundancy of the system. A practical upper level for column spacing is generally 30 ft. for the levels of blast loads described herein.

- In general, floor to floor heights should be minimized. Unless there is an overriding architectural requirement, a practical limit is generally less than or equal to 16 ft.

- It is recommended that the designer use fully grouted and reinforced CMU construction in cases where CMU is selected.

- It is essential that the designer actively coordinate structural requirements for blast with other disciplines including architectural and mechanical.

- The use of one-way wall elements spanning from floor-to-floor is generally a preferred method to minimize blast loads imparted to columns.

- In many cases, the ductile detailing requirements for seismic design and the alternate load paths provided by progressive collapse design assist in the protection from blast. The designer must bear in mind, however, that the design approaches are at times in conflict. These conflicts must be worked out on a case by case basis.

The following additional references are recommended:

- Biggs, John M. *Introduction to Structural Dynamics*. McGraw-Hill. (1964).
- The Institute of Structural Engineers. *The Structural Engineer's Response to Explosive Damage*. SETO, Ltd., 11 Upper Belgrave Street, London SW1X8BH. (1995).
- Mays, G.S. and Smith, P.D. *Blast Effects on Buildings: Design of Buildings to Optimize Resistance to Blast Loading*. Thomas Telford Publications, 1 Heron Quay, London E14 4JD. (1995).
- National Research Council. *Protecting Buildings from Bomb Damage*. National Academy Press. (1995).

8.8 Mechanical Engineering

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

The mechanical system should continue the operation of key life safety components following an incident. The criteria focus on locating components in less vulnerable areas, limiting access to mechanical systems, and providing a reasonable amount of redundancy.

Air System

Air Intakes. On buildings of more than four stories, locate intakes on the fourth floor or higher. On buildings of three stories or less, locate intakes on the roof or as high as practical. Locating intakes high on a wall is preferred over a roof location.

Utility Protection

Utilities and Feeders. Utility systems should be located at least 50 feet from loading docks, front entrances, and parking areas.

Incoming Utilities. Within building and property lines, incoming utility systems should be concealed and given blast protection, including burial or proper encasement wherever possible (see section on Electrical Engineering, Service and Distribution, Utilities and Feeders).

8.9 Electrical Engineering

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

The major security functions of the electrical system are to maintain power to essential building services, especially those required for life safety and evacuation; provide lighting and surveillance to deter criminal activities; and provide emergency communication (see section on *Architecture and Interior Design, Interior Construction, Critical Building Components*, for location of critical building components).

Service and Distribution

Distributed Emergency Power. Emergency and normal electric panels, conduits, and switchgear should be installed separately, at different locations, and as far apart as possible. Electric distribution should also run at separate locations.

Normal Fuel Storage. The main fuel storage should be located away from loading docks, entrances, and parking. Access should be restricted and protected (e.g., locks on caps and seals).

Emergency Fuel Storage. The day tank should be mounted near the generator, given the same protection as the generator (see section on *Emergency Generator*, below), and sized to store approximately _____ hours of fuel (project-specific information to be provided). A battery and/or UPS could serve a smaller building or leased facility.

Tertiary Power. Conduit and line can be installed outside to allow a trailer-mounted generator to connect to the building's electrical system. If tertiary power is required, other methods include generators and feeders from alternative substations.

Emergency Generator. The emergency generator should be located away from loading docks, entrances, and parking. More secure locations include the roof, protected grade level, and protected interior areas. The generator should not be located in any areas that are prone to flooding.

Philadelphia Veterans Center

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.

8.10 Fire Protection Engineering

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

The fire protection system inside the building should maintain life safety protection after an incident and allow for safe evacuation of the building when appropriate.

While fire protection systems are designed to perform well during fires, they are not traditionally designed to survive bomb blast. The three components of the fire protection system are:

1. active features, including sprinklers, fire alarms, smoke control, etc.;
2. passive features, including fire resistant barriers; and
3. operational features, including system maintenance and employee training.

Please note that this chapter focuses only on active features. See Chapter 7: *Fire Protection Engineering*, for additional information.

Security Enhancements

Water Supply. The fire protection water system should be protected from single point failure in case of a blast event. The incoming line should be encased, buried, or located 50 ft. away from high threat areas. The interior mains should be looped and sectionalized where provided. The interior standpipes should be cross connected on each floor.

Dual Fire Pumps: Electric and Diesel. To increase the reliability of the fire protection system in strategic locations, a dual pump arrangement could be considered, with one electric pump and one diesel pump.

Egress Door Locks. All security locking arrangements on doors used for egress must comply with requirements of the International Building Code.

Smoke Removal Systems

Smoke Removal. In the event of a blast, the available smoke removal system may be essential to smoke removal, particularly in large, open spaces. This equipment should be located away from high risk areas such as loading docks and garages. The system controls and power wiring to the equipment should be protected. The system should be connected to emergency power to provide smoke removal.

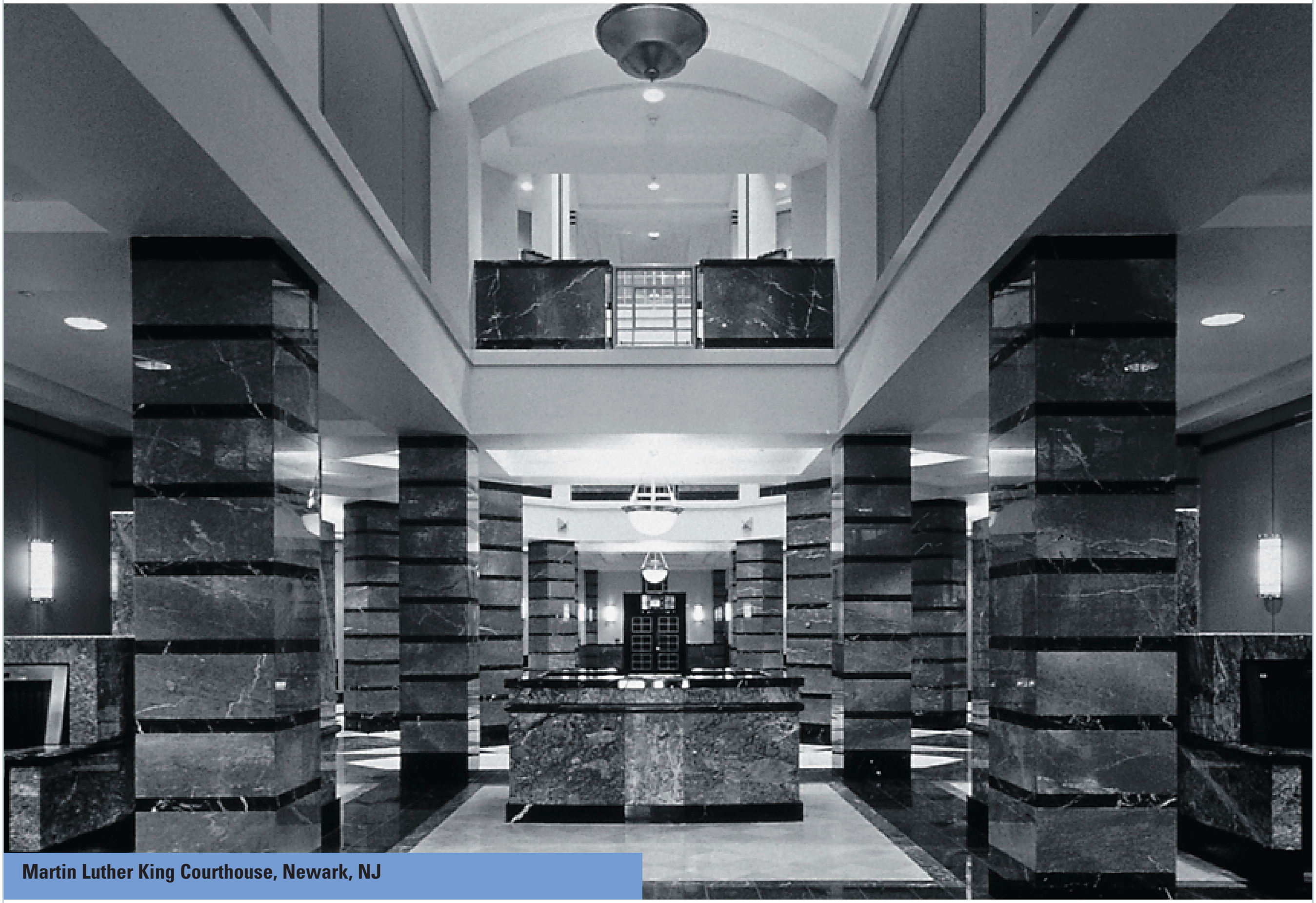
The multidiscipline team should consider having separate HVAC systems in lobbies, loading docks, and other locations where the significant risk of internal event exists.

Smoke removal equipment should be provided with stand-alone local control panels located in the fire command center that can continue to individually function in the event the control wiring is severed from the main control system.

During an interior bombing event, smoke removal and control is of paramount importance. The multidiscipline team should consider the fact that if window glazing is hardened, a blast may not blow out windows, and smoke may be trapped in the building.

The design team fire protection engineer must consult the GSA regional fire protection engineer and the local fire department about the above issues.

8.11 Electronic Security



Martin Luther King Courthouse, Newark, NJ

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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.

8.12 Parking Security

IMPORTANT NOTE: The following criteria do NOT apply to all projects. Follow each criterion only if instructed to by your project-specific risk assessment. Many criteria are based on the recommendations of a specific building risk assessment/threat analysis. Where the criteria include a blank or offer a choice of approaches, the recommendations from risk assessment will provide information for filling in the blank or suggesting a choice of approaches.

Parking restrictions help keep threats away from a building. In urban settings, however, curbside or underground parking is often necessary and/or difficult to control. Mitigating the risks associated with parking requires creative design and planning measures, including parking restrictions, perimeter buffer zones, barriers, structural hardening, and other architectural and engineering solutions.

Parking

Parking on Adjacent Streets. Parking is often permitted in curb lanes, with a sidewalk between the curb lane and the building. Where distance from the building to the nearest curb provides insufficient setback, and compensating design measures do not sufficiently protect the building from the assessed threat, parking in the curb lane shall be restricted as follows:

- Allow unrestricted parking.
- Allow government-owned and key employee parking only.
- Use the lane for stand-off. Use structural features to prevent parking.

Parking on Adjacent Properties. The recommended minimum setback distance between the building and parked vehicles for this project is _____ (project-specific information to be provided). Adjacent public parking should be directed to more distant or better protected areas, segregated from employee parking and away from the facility.

Parking Inside the Building

- Public parking with ID check.
- Government vehicles and employees of the building only.
- Selected government employees only.
- Selected government employees with a need for security.

On-site Surface or Structured Parking. Adjacent surface parking shall maintain a minimum stand-off of _____ feet. Parking within _____feet of the building shall be restricted to authorized vehicles (project-specific information to be provided).

Parking Facilities

Natural Surveillance. For all stand-alone, above ground parking facilities, maximizing visibility across as well as into and out of the parking facility shall be a key design principle.

The preferred parking facility design employs express or non-parking ramps, speeding the user to parking on flat surfaces.

Pedestrian paths should be planned to concentrate activity to the extent possible. For example, bringing all pedestrians through one portal rather than allowing them to disperse to numerous access points improves the ability to see and be seen by other users. Likewise, limiting vehicular entry/exits to a minimum number of locations is beneficial. Long span construction and high ceilings create an effect of openness and aid in lighting the facility. Shear walls should be avoided, especially near turning bays and pedestrian travel paths. Where shear walls are required, large holes in shear walls can help to improve visibility. Openness to the exterior should be maximized.

It is also important to eliminate dead-end parking areas, as well as nooks and crannies.

Landscaping should be done judiciously so as not to provide hiding places. It is desirable to hold planting away from the facility to permit observation of intruders.

Stairways and Elevators:

- Stairways and elevator lobby design shall be as open as code permits. The ideal solution is a stair and/or elevator waiting area totally open to the exterior and/or the parking areas. Designs that ensure that people using these areas can be easily seen — and can see out — should be encouraged. If a stair must be enclosed for code or weather protection purposes, glass walls will deter both personal injury attacks and various types of vandalism. Potential hiding places below stairs should be closed off; nooks and crannies should be avoided.
- Elevator cabs should have glass backs whenever possible. Elevator lobbies should be well-lighted and visible to both patrons in the parking areas and the public out on the street.

Perimeter Access Control:

- Security screening or fencing may be provided at points of low activity to discourage anyone from entering the facility on foot, while still maintaining openness and natural surveillance.
- A system of fencing, grilles, doors, etc. should be designed to completely close down access to the entire facility in unattended hours, or in some cases, all hours. Any ground level pedestrian exits that open into non-secure areas should be emergency exits only and fitted with panic hardware for exiting movement only.
- Details of the parking access control system will be provided for the designer.

Surface Finishes and Signage. Interior walls should be painted a light color (i.e., white or light blue) to improve illumination. Signage should be clear to avoid confusion and direct users to their destination efficiently. If an escort service is available, signs should inform users.

Lighting. Lighting levels should comply with Table 8-3.

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)[1]

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.

8.13 Submission Requirements

Every project will have unique characteristics and requirements for submission and review. These shall be coordinated by the GSA Project Manager.

The general submission requirements for each phase of project development are described in Appendix A.

[1] From Chrest, Anthony P., Smith, Mary S., and Bhuyan, Sam. Parking Structures: Planning, Design, Construction, Maintenance and Repair, 2nd edition. Chapman and Hall. (1996).