TECHNICAL PRESERVATION GUIDELINES

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HVAC UPGRADES IN HISTORIC BUILDINGS

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EXECUTIVE SUMMARY

Effective coordination between preservation, sustainability, architecture, and engineering disciplines helps to ensure that preservation issues are appropriately addressed in design scopes of work and construction budgets. GSA Regional Historic Preservation Officers and preservation program staff are available to assist project teams in tailoring preservation scopes of work and exploring appropriate options. **All HVAC upgrades in historic buildings require RHPO review, beginning early in project planning, to ensure that preservation compliance requirements are met for timely project completion.**

Making the most of a building's original, passive climate control features can reduce system requirements and the impact of the installation on historically significant spaces. GSA's *P100 Facilities Standards* include detailed guidance for integrating HVAC sensitively into historic buildings. GSA Building Preservation Plans (BPP) and Historic Structure Reports (HSR) identify significant spaces and ornamental features that may be concealed by alterations which should be removed so that compromised public spaces can be restored.

Sensitively installing ductwork in buildings designed to accommodate only heating and natural ventilation presents one of the greatest challenges involved in upgrading historic buildings to meet current codes and comfort standards. Fan coil units are a popular choice for historic buildings because they can be easily exchanged for radiators and because pipes are smaller and less intrusive than the ducting required for forced air systems. Using ducts to meeting ventilation requirements only enables use of smaller ducts than would be required to meet both ventilation and temperature conditioning requirements.

Thoughtful routing, configuration and concealment of ductwork plays a major role in the aesthetic success of HVAC retrofitting projects at historic buildings. Flatten ductwork or create architecturally integrated false beams to route ducts across corridors and large spaces. Vertical routing is often the best solution for preserving vaulted ceilings where little or no space is available above the ceiling. In some locations, well designed, exposed ductwork is the only practical option for keeping vaulted ceilings and ornamental details exposed to view.

In rehabilitation and renovation zone spaces where new ceilings are being installed, ensure that suspended ceilings are no lower than necessary to conceal ductwork and maintain the full window clearance. Recess suspended ceilings from windows or slope ceilings upward above window heads to maintain interior daylight and preserve the appearance of the window from the outside. Place roof mounted equipment where it will not be visible from accessible locations at grade.

FIGURES 1-2 Thoughtful routing, configuration and concealment of ductwork plays a major role in the esthetic success of HVAC retrofitting projects at historic buildings.

Split systems can offer a low architectural impact solution for individual ornamental spaces where ventilation is provided by other sources and independent control is advantageous. Low profile window units and freestanding portable AC units are additional alternatives for historic spaces requiring supplemental cooling, where other options cannot meet the preservation and performance requirements of the space.

Require schematic drawings showing any proposed ceiling reconfigurations as early as possible in design development to allow time for revision and refinement. Also specify sample review of new features and finishes to be installed in historically significant spaces to ensure that preservation design criteria have been met.

INTRODUCTION

Mechanical upgrades consume a large proportion of GSA's capital investment budget. Most historic buildings constructed before World War II were not designed to accommodate air conditioning. Many still rely on window air conditioning units. Others have central systems installed during the 1950s and 1960s with little regard for historically significant spaces and materials. Ornamental ceilings remain concealed above suspended ceilings. Windows and door transoms are truncated. Many of these aging systems are now reaching the end of their service life. **GSA seeks opportunities, when upgrading HVAC systems, to remove inappropriate alterations and restore important spaces and features.**

Cooling the Federal Government

The first federal building to be air-conditioned was the U.S. Capitol, beginning in 1928. By the early 1930s, new offices built in the Federal Triangle were installing air conditioning systems. Air conditioning was added to GSA's Central Office Building (originally built for the Department of Interior) in 1935. Most federal buildings, however, were not retrofitted with central air conditioning systems until GSA established new facility standards in 1955, making HVAC installation standard practice for new federally funded office buildings. During the 1950s and 1960s, window air conditioning units were installed in many existing federal buildings as an interim climate control measure for improving tenant comfort. By the 1970s, advances in heating and cooling technology offered a greater range of technical choices, capabilities, and system flexibility to respond to varying needs and conditions --sometimes at the expense of reliability and manageable maintenance.

FIGURE 3 Before: GSA Building corridor ductwork installation in progress, 1935.

FIGURE 4 After: Relocating corridor ductwork to adjoining office spaces enabled GSA to restore previously concealed cove cornices and door transoms that now flood the corridor with welcomed daylight.

GSA Resources

Today, GSA's Offices of Design and Construction and Federal High Performance Green Buildings work together to ensure that mechanical systems design is integrated with the design of other building systems, features, and operations. GSA's *P100 Facilities Standards*, online at www.gsa.gov/p100, recommends taking historic features such as porticos and masonry walls into account in calculating system needs and including preservation goals and requirements in HVAC design planning.

GSA's *Sustainability Matters* includes a historic building modernization case study that has become nationally recognized as a model for showcase restoration and optimal system design. It also includes guidance for making incremental system improvements. GSA also contributes to the federal government's online *Whole Building Design Guide*, which includes cross references to related design topics and links to a variety of design resources, including specific guidance for historic building systems, at http://www.wbdg.org/design/historic_pres.php.

There are many ways that energy reduction and climate control needs can be met while preserving historic spatial volumes and materials. Mechanical upgrades and interior renovation projects often provide opportunities to restore compromised spaces and make historic buildings more comfortable and marketable.

FEDERAL GUIDES AND STANDARDS

Every successful GSA historic building project begins with review of the specific building's BPP or HSR to ensure that GSA teams involved in developing project requirements and overseeing design and execution are well informed on the building's preservation goals at the earliest stages of project planning and design. The BPP or HSR identifies spaces of architectural importance and character-defining features and finishes such as coffered ceilings and paneled walls to be preserved. BPPs and HSRs also outline restoration goals for altered public spaces, sometimes including original detail drawings that can serve as a basis for restoration.

Standards and guidance for all federal projects involving historic buildings are provided in the Secretary of the Interior's Standards for Rehabilitation and guidelines for applying the standards published by the National Park Service (NPS), U.S. Department of the Interior (DOI Standards). NPS has also published a variety of briefs and technical notes addressing a range of energy conservation issues. The most comprehensive NPS briefs relevant to GSA HVAC upgrade projects are "Preservation Brief 3: Conserving Energy in

Historic Buildings" and "Preservation Brief 24: Heating, Ventilating, and Cooling Historic Buildings: Problems and Recommended Approaches." All guidance publications are available free online at www.nps.gov/hps/tps/publications.htm.

Central to the DOI Standards, which are based on established standards used throughout the world, are the principal goals of:

- maintaining authenticity, by
- doing no harm to historic materials,
- designing changes sympathetically, and
- restoring significant spaces correctly, based on historic documentation.

FIGURES 5-6 GSA Building Preservation Plans identify spaces of architectural importance and character-defining features to be preserved and restored, such as this hidden ornamental ceiling restored as part of the building systems upgrade.

GSA's PBS P100 Facility Standards provide the following guidance for HVAC improvements at GSA historic properties:

PBS 100 Facilities Standards for the Public Buildings Service

Mechanical Engineering – Alterations in Existing Buildings and Historic Structures (Excerpts)

When a system is designed, it is important to anticipate how it will be installed, how damage to historic materials can be minimized, and how visible the new mechanical system will be within the restored or rehabilitated space. The following guidelines shall be followed for HVAC work in historic buildings:

- Reduce heating and cooling loads to minimize size and other impacts of modern equipment.
- Calculate the effect of historic building features such as wall thickness, skylights, and porticos, and interior design features such as draperies, shutters and windows shades, and existing site features such as landscaping.
- Select system types, components, and placement to minimize alteration of significant spaces. In previously altered spaces, design systems to allow historic surfaces, ceiling heights, and configurations to be restored. Reuse of existing system components is only permitted with written documentation obtained from GSA Property Management and by the A/E certifying that the condition of the components warrants use.
- Retain decorative elements of historic systems where possible. Ornamental grills and radiators shall be retained in place.
- Design HVAC systems to avoid impacting other systems and historic finishes, elements and spaces.
- Place exterior equipment where it is not visible. Recess equipment from the edge of the roof to minimize visibility of the equipment from grade. Alternatively, explore creating a vault for easier access to large mechanical equipment. If equipment cannot be concealed, specify equipment housing in a color that will blend with the historic facade. As a last resort, enclose equipment in screening designed to blend visually with the facade.
- Locate equipment with particular care for weight and vibration on older building materials.
- If new ceilings must be installed, insure that they do not block any light from the top of existing windows or alter the appearance of the building from the outside. Original plaster ceilings in significant

spaces such as lobbies and corridors should be retained, to the extent possible, and modified only as necessary to accommodate horizontal distribution. Use soffits and false beams where necessary to minimize alteration of overall ceiling heights.

- In buildings containing ornamental or inaccessible ceilings, piping or ductwork may have to be routed in furred wall space or exposed in the occupiable building area. Exposed ducts must be designed to complement the building architecture in forms and materials used. Use of exposed ducts is encouraged in locations where concealing ducts would obscure significant architectural surfaces or details, such as vaulted ceilings. Exposed ducts shall also be considered in historic industrial buildings and open plan, tall ceiling, high window spaces suited to flexible grid/density treatments.
- If new risers are required, they should preferably be located adjacent to existing shafts.
- To the greatest extent possible, insure that space is available to maintain and replace equipment without damaging significant materials, selecting components that can be installed without dismantling window or door openings.
- Use custom rather than commercial standard products where elements are exposed in formal areas.
- Select temperature and humidity conditions that will not accelerate deterioration of building materials.
- Where equipment is near significant features, insure that leaking from pipes and HVAC units does not cause deterioration. Use deeper condensate drain pans, lined chases and leak detectors.

PRELIMINARY PLANNING

Given the intrusion inherent in the scale and extent of equipment required for heating, cooling and ventilating a large office building, effective coordination between preservation, sustainability, engineering, facilities, and related disciplines is important for ensuring that preservation issues and opportunities are identified early in design development. Historic features to be preserved and existing passive heating, cooling, and ventilation features should be identified as a basis for assessing HVAC requirements and options. Effective integration of HVAC and other building components is of paramount importance to the success of every HVAC installation.

Design teams for all systems-related projects potentially affecting a building's restoration zones must include a preservation architect and mechanical engineer able to demonstrate successful experience integrating HVAC into historic buildings containing significant interior spaces. Construction specifications should require historic building expertise as well. A standard preservation design scope of work and qualification requirements for design and construction are available online at www.gsa.gov/historicpreservation>Project Management Tools.

FIGURE 7 Retain and reuse historic features such as ornamental grilles.

Character-defining historic features and finishes in restoration zones, including original ceilings and walls concealed by suspended ceilings or added partitions, should be identified and their condition assessed to determine requirements for repair, restoration, or reconstruction. Significant features such as ornamental radiators and grilles should be preserved and opportunities for their reuse explored.

In examining technology and design options, begin by considering the building as a whole to identify inherent and potential opportunities for integrating architecture, interior, and system design and determine the best options for meeting preservation, performance, conservation, cost, and maintenance goals. Reuse of system components such as ductwork can reduce the cost and intrusiveness of HVAC upgrades, but must be supported by extensive investigation and analysis of existing conditions to confirm any component's viability for reconditioning and reuse.

PASSIVE CLIMATE CONTROL FEATURES

Making the most of a building's historic climate control features can reduce system capacity requirements and the impact of the installation on historically significant spaces. Envelope characteristics such as wall materials and thickness, windows, skylights and shading devices such as porticos and overhangs affect heat gain and retention. Shades, blinds, and landscaping also effect daylight and heat management, in addition to indoor equipment, lighting, occupant density and use. Light sensor driven operating devices for window shades and other daylight control devices can enhance the energy conserving potential of historic architectural features and finishes.

Supported by operational policies and oversight for efficient and appropriate use, operable windows provide added flexibility for meeting tenant comfort needs and a backup source of fresh air at times when mechanical systems are not fully operational or building wide cooling may not be cost effective. Even where sash are ordinarily kept latched to meet security requirements, operable windows in historic buildings are character-defining features that must be retained.

CENTRAL SYSTEMS

Fan coil units

The scale of GSA's historic office buildings demands central HVAC solutions for all but perhaps a few residential-scale structures. In recent years, fan coil units using piped water for heating and cooling have gained favor for historic building climate control for a number of reasons, including individual workstation control of the heating and cooling units. Fan coil heating and cooling units can be easily exchanged for radiators in many locations, reducing demolition disturbance and costs. Using pipes for heating and cooling and ducts for ventilation only often enables reuse of existing ducts, as an alternative to replacement with the larger ducts generally required to meet current codes, also eliminating costs for associated work such as asbestos removal in ceiling areas being disturbed.

Four pipe systems provide greater flexibility for on demand, individually controlled heating and cooling, albeit at greater cost, than two pipe systems—most valuable for meeting changing heating and cooling needs during transitional periods in the spring and fall when temperatures can vary dramatically. For buildings sharing a chilled water source, standard operating schedules for heating or cooling may cancel out the benefits of such flexibility, indicating a need for supplemental systems or units at certain locations, such as conference rooms, for on-demand or off-hours operation.

Proper design for drainage is critical to ensure against flooding in work areas. Sometimes fan coil systems can make use of existing rain leaders, in which case valves must be installed to prevent back flow during heavy rains.

Duct routing and configuration

Thoughtful routing, configuration and concealment of ductwork within, around, and through historically significant spaces determines the success or intrusiveness of an installation to a greater extent than any other HVAC design decision. Survey the building for available chases such as closets, dumbwaiters and abandoned chimneys available to conceal ductwork serving restoration zones. Avoid damaging ornamental ceilings and walls in courtrooms and other ceremonial spaces by routing ductwork through adjoining spaces of less significance, if necessary. Vertical routing is often the best solution for preserving vaulted ceilings where little or no space is available for routing ductwork horizontally.

FIGURE 8 Ducts aligned with pilasters and flattened to read as shallow beams blend into historic ceilings.

Flatten ductwork or create architecturally integrated false beams to route ducts across corridors and large spaces. Ducts aligned with pilasters and flattened to read as shallow beams incorporated into plaster ceilings are another approach for blending ductwork into historic ceilings.

In rehabilitation or renovation zone spaces where new ceilings are being installed, ensure that suspended ceilings are no lower than necessary to conceal ductwork and maintain the full window clearance. Recess ceilings from windows and door transoms: slope ceilings upward toward the exterior wall, or step ceilings down from window heads toward interior walls to preserve the exterior appearance of the windows and admit daylight as deeply as possible into the building interior.

Where vertical distribution or supply and return through adjoining spaces is not possible, carefully configured, exposed ductwork may be the best option for keeping vaulted ceilings and ornamental details exposed to view. Cylindrical ducts placed along walls or linear elements and painted to match adjoining surfaces generally appear less intrusive than standard square-section ducts.

FIGURE 9 Recess, slope, or step ceilings to maintain window clearance.

FIGURES 11-12 Linear diffusers located in the plaster walls at each end of this 1917 executive suite increase air supply volume and coverage, reducing the number of wall penetrations otherwise required for conventional grilles. Louvered grilles were confined to end bays and grain painted to blend with the room's paneled oak walls.

Installing exposed ductwork as part of thoughtfully designed open ceiling, exposed system workspace design can help to mitigate the claustrophobic effect of inherently low ceilings. Exposed duct approaches also allow occupants in historic industrial buildings adapted for modern office use to enjoy the benefits of tall ceilings, clerestory windows, skylights, monitor windows and other daylighting features designed to support the manufacturing-related functions for which these buildings were originally constructed.

FIGURE 10 Thoughtfully exposed ductwork allows vaulted ceilings to remain exposed to view.

Wall and ceiling penetrations

Minimize penetration of ornamental surfaces and locate supply and return grilles as inconspicuously as possible. Linear diffusers aligned with ceiling cornices may be useful for supplying air to large spaces and reducing the number of wall penetrations that would otherwise be required to accommodate conventional grilles. Finish grilles and diffusers to blend onto adjoining surfaces. Oxidized bronze and skilled faux graining can be very effective in blending grilles and louvers into paneled walls.

SMALL SPACE OPTIONS

While generally not practical for large office buildings, high velocity, mini-duct systems have emerged in recent years as a flexible and less intrusive alternative for residential-scale applications such as historic row houses and small-to-medium scale commercial buildings. As the capabilities of these systems continue to improve, expect an increasing variety of applications, including their use as part of a larger system, to address individual space needs.

Where space for outdoor equipment is available, split systems can offer a low architectural impact solution for individual ornamental spaces where ventilation is provided by other sources and independent control is advantageous. Heating and cooling units are relatively small and can be mounted on walls or ceilings.

In some cases, freestanding portable AC units may be helpful for supplemental or occasional use within small or highly significant spaces in challenging circumstances where other options cannot fully meet the preservation and performance requirements of the space. Some products now available have a negligible effect on window views and require less floor space than earlier portable units. Connecting these units to a central drainage system eliminates the maintenance burden of manually emptying condensate pans.

Low profile window units may offer the simplest solution for cooling small areas where units can be placed inconspicuously and spaces are not easily served by other cooling solutions.

EQUIPMENT PLACEMENT

Place roof mounted equipment where it will not be visible from accessible locations at grade. For confined areas in which placement options are limited, scope sightline studies as part of design development to guide placement of rooftop equipment in locations that may be visible to pedestrians. Take into consideration the impact of equipment weight and vibration on older building materials and make necessary adjustments prior to installation. Explore ways to avoid or minimize the impact of equipment noise on building users, particularly where rooftop areas serve as tenant amenities or condensing units must be placed in lightwells or other areas adjoining occupied space.

Large sites may be able to accommodate underground vaults to eliminate equipment visibility and simplify access for repair and replacement. As a last resort, enclose equipment that cannot be concealed in screening designed to blend visually with the facade or landscape, as appropriate.

SUCCESSFUL PROJECT COMPLETION

HVAC upgrades often present opportunities to dramatically improve the appearance of a historic building while reducing fuel consumption, improving tenant comfort, and simplifying building maintenance. Studies confirm that climate control and air quality play a major role in tenant satisfaction. Integrating HVAC into historic spaces successfully can also contribute to positive first impressions and tenant retention. Meeting these preservation and performance goals in a timely manner depends on early, effective, and ongoing coordination between preservation, engineering, architecture, interior design, and other disciplines.

An important resource for every historic building project is GSA's Regional Historic Preservation Officer (RHPO). RHPOs assist project teams in identifying significant historic materials as well as resources and design solutions of potential interest. **All projects affecting historic building restoration zones require RHPO review, beginning early in project planning to ensure that design scopes, qualifications, and budgets address preservation compliance requirements.** Include a completed GSA Section 106 Compliance Report-Short Form with each design submission to document the preservation design issues and solutions for RHPO clearance.

FIGURES 13-14 Before (top) and after (bottom) view of this courthouse entrance lobby illustrate how well designed HVAC systems contribute to positive first impressions and tenant satisfaction.

For ceiling or wall changes within historic building restoration zones, require schematic drawings showing proposed configurations as early as possible in design development to allow time for revision and refinement. Also require sample review of new features and finishes, such as grilles, prior to overall installation, to ensure that preservation design criteria have been met. Allow time to make appropriate adjustments.

Help GSA promote solutions that preserve original materials and design features that make historic buildings unique. Toward that end, the Center for Historic Buildings invites readers to share images and information documenting their own project successes for the benefit of future updates to this guide (contact caroline.alderson@gsa.gov).

For additional guidance and building specific information, contact your RHPO (see www.gsa.gov/historicpreservation>Contacts for a current listing).