

Greening Project Status Report
The Pentagon



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Federal Energy Management Program**

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Greening of the Pentagon

Status Report and Accomplishments

1. Introduction

The Pentagon is one of the world's largest office buildings, with 6.5 million square feet of space, 17.5 miles of corridors, and approximately 23,000 occupants. It was built in just 16 months, between September 1941 and January 1943, to provide a single location for the War Department and its military services as the United States entered World War II. Because steel was needed for the war effort, the structure is made almost entirely of reinforced concrete.

When the Pentagon was designated a National Historical Landmark in 1992, it had never undergone a major renovation. Discussions about renovations had been held since 1982, long before the building's ownership was officially transferred to the Department of Defense (DOD) in 1991. By 1992 it was evident that all the building's major systems needed to be replaced.



Aerial view of the Pentagon

2. Context of the Project

In 1990, Congress approved a concept plan for the Pentagon. The plan proposed renovating the building in five 1,000,000 gross-square-foot “wedges” (plus a separate basement renovation) that would enable most of the building's occupants to continue to work in their offices throughout the long process. A wedge was determined to be one-fifth of the building, from the approximate center of one side, around a corner, to the approximate center of the next side.

The plan proposed complete removal and replacement of all mechanical, electrical, and plumbing systems. It also provided for new sprinkler systems, vertical transportation, cable management systems, fire and life safety systems, better access for persons with disabilities, flexible office designs, modern telecommunications support, and many other features. The plan included compliance with energy conservation and environmental requirements.

There are several important constraints on the renovation, however. First, the building's status as a National Historical Landmark limits the modifications that can be made to the facades and roof. Second, because of its mission, security interests are paramount. Third, the renovation has to be done within a set budget, which was established as \$1,118,000,000 in 1991 and later amended to \$1,220,000,000, to include additional security measures. Although life-cycle costs are important, first costs cannot exceed this budget.

In addition, critical functions cannot be interrupted by the renovations, and this presents challenges in terms of testing new systems and bringing them on line.

3. The Design and Decision Processes

“Greening” is taking place within the context of the overall renovation and the budget for that renovation. The major greening goals at the Pentagon are these:

- Improve energy management to save taxpayer dollars and reduce emissions that contribute to air pollution and global climate change, and
- Promote energy efficiency, water conservation, and the use of renewable energy products, and help foster markets for emerging technologies.



Exterior of the Pentagon

In 1994, the Pentagon Renovation and Planning Office convened an intensive three-day charrette to identify and suggest potential strategies for incorporating energy efficiency and other environmental strategies into the renovation. (A charrette is a highly focused, interactive brainstorming session composed of as many project design team members as possible.) Approximately 30 experts participated in the charrette; they developed recommendations in these five areas:

- Energy, including windows and building envelope, lighting, plug loads, and heating, ventilation, and air-conditioning (HVAC).
- Building ecology, including materials and indoor air quality.
- Water, landscaping, and grounds.
- Materials, waste, and resource management, including waste and recycling.
- Cultural change and behavioral issues, including pollution prevention and human factors.

In addition, participants stressed the importance of an integrated design to the success of the effort. They noted that both cost savings and environmental benefits result when the project design team integrates energy-efficient strategies with efficient systems.

The Pentagon Renovation Office includes sustainability issues in performance criteria for projects and in criteria for selecting Design-Build Teams; these issues include energy efficiency, recycling, and product selection. Performance contracts allow contractors some flexibility in meeting specific levels of performance. There is also an Energy and Environmental Integrated Process Team, which is composed of Federal Facilities Division energy and environmental personnel and Pentagon Renovation personnel. Chaired by the Renovation Program Manager, this team makes decisions about energy and environmental issues. In addition, as new issues arise, Process Action Teams are formed, composed of stakeholders and experts on the issues.

Though the renovation will permit more productive use of space, the Pentagon workforce will increase from the 25,000 occupants it had when the renovation began. This increase will affect the project’s ability to meet energy targets; for example, the targeted 30% reduction in energy

use by 2005 might not be met because of increases in the number of building occupants, the number of computers, and the hours of operation of many groups. However, progress has been satisfactory, and in 1996 the Pentagon was designated the Department of Defense's first Federal Energy Saver Showcase building.

4. Highlights of Environmental Strategies and Accomplishments

A. Status of Recommendations from the Greening Charrette

A detailed report on the status of recommendations from the 1994 charrette and report are presented in the tables at the end of this publication. Examples of specific actions taken in the various topic areas follow.

Energy

- **Windows:** All 7,748 windows in the Pentagon will be replaced. The original windows are single-pane, metal windows without thermal breaks; the new windows are double-pane aluminum with thermal breaks. A 17% energy savings is anticipated as a result of the new windows.
- **Envelope:** Approximately 2.5 inches of insulation is being used in all exterior walls. Vestibules have been added to most doorways, and glass doors are automatic, double-pane glass. The roof was renovated in 1990 and insulation was added at that time.
- **Lighting:** T5 and T8 fluorescent lighting with electronic ballasts has been specified with task lighting.
- **Plug loads:** All equipment specified for Wedges 2 through 5 is, at a minimum, ENERGY STAR® compliant. Also, energy efficiency ratings are specified for various equipment that is not currently covered under the ENERGY STAR® program. The renovation team anticipates that personal heaters will not be allowed in the renovated space; instead, floor heat blankets will be provided for those who require additional heat.
- **Pentagon heating and refrigeration plant:** The new plant is a state-of-the-art computer-controlled facility that supplies steam to the Pentagon, Navy Annex, and Henderson Hall, and chilled water to the Pentagon and Navy Annex. The new chillers are approximately 30% more efficient than their predecessors. In the heating plant, a digital control system optimizes operation. Electric motor-driven pumps have replaced old, noncondensing steam turbine pumps for boiler feed water; the boilers now incorporate economizers, which take



New windows and insulation in Pentagon walls

heat from stack gases and transfer it to incoming boiler feed water. The boilers also include a stack gas recirculation system, which reduces pollutants.

- **Solar dish/Stirling system demonstration:** The Pentagon demonstrated the feasibility and value of a 25-kilowatt dish/Stirling concentrating solar power system. The panels were placed to ensure visibility from parking lots and nearby highways as a way of increasing interest in the demonstration. At the end of the demonstration period, the system was relocated to Phoenix, Arizona.
- **Photovoltaic array:** A large alternating-current photovoltaic (PV, or solar electric) array has been installed at the Pentagon to demonstrate the reliability and feasibility of PV systems. The array uses Ascension Technology SunSine 300 modules and has a maximum output of 15-18 kilowatts. Using this power system will eliminate 48,000 pounds of carbon dioxide, 121 pounds of nitrogen oxides, and 335 pounds of sulfur dioxide emissions, which result from fossil-fuel power plants, each year.
- **Energy management system:** A new energy management system, supplied by Johnson Controls, will manage heating, cooling, and lighting systems throughout the Pentagon. It will make adjustments for occupancy, sunlight, and outdoor temperature; schedule maintenance; and pinpoint malfunctions.

Water

- **Irrigation project:** A project was proposed to use water from the nearby Potomac River to irrigate the Remote Delivery Facility, the heliport, the parade grounds, and other areas. An automated underground irrigation system is planned. This will replace an estimated 16,828,560 gallons of potable water formerly used for irrigation.



New low-flow plumbing fixtures and efficient lighting in the Pentagon bathrooms.

- **Solar hot water system:** A solar hot water system was proposed for a section of the Pentagon to provide hot water for kitchens in cafeterias and lunchrooms. The system would produce approximately 350 MBtu per year and reduce demand on conventional water heaters.
- **Plumbing:** All toilets are low-flow to meet current standards. Automatic flush toilets are being installed.

Materials/Resources/Waste

- **Recycling of demolition waste:** Approximately 70% of the demolition waste from Wedge 1 has been recycled. Approximately 15 million pounds of debris, including 600,000 pounds of

steel, has been recycled. Lead-based paint on window frames was an impediment to recycling them.



Environmentally preferable materials were used in the Pentagon renovation.

- **Environmentally preferable materials:** The Pentagon Renovation Office is working with the EPA's Environmentally Preferable Purchasing program to develop specifications and identify greener products. A market survey identified at least three suppliers offering products with enhanced environmental features for each product on DOD's initial list of 178 conventional building products. This information was used in modifying more than 300 product specifications for the RFP used to solicit contractors. In addition, the evaluation criteria for selecting contractors included items designed to measure bidders' commitment to the environmental goals of the project and their

ability to identify, evaluate, and obtain products meeting environmental specifications. Following the selection, DOD continued to educate the contractor and suppliers on environmental considerations.

- **Parking lot paving project:** The 5-year, \$1 million-per-year contract awarded in 1997 to maintain and repair the parking lots and access roads at the Pentagon and several nearby Federal facilities incorporated environmentally preferable purchasing. The U.S. Environmental Protection Agency (EPA) assisted DOD in defining attributes that could be built into this procurement to enhance its environmental aspects. The pilot included project worksheets for 20 products to make it easier for the contractor to assess environmental performance and financial incentives for the contractor to use environmentally preferable products.

Indoor Environmental Quality

- **Asbestos removal:** Approximately 2.5 million pounds of asbestos will be removed from each wedge. None will be encapsulated.
- **Daylighting:** Dropped ceilings have covered the upper portions of windows in the Pentagon, reducing the daylight available to the space. In the renovation, the top portion of the windows will be uncovered and



With 7,748 windows and relatively small distances between exterior walls, the Pentagon has a great opportunity for daylight penetration and connection to the outdoors for occupants.

the dropped ceiling will begin approximately two feet from the window wall. Open office space with modular furniture and partitions will be used to allow daylight to penetrate the space and to allow more occupants a view of the outdoors.

- Cleaning supplies: Nontoxic cleaning supplies with fewer emissions are in use.

B. Future Plans and Goals

Energy Goals and Strategies

- Reduce greenhouse gas emissions from facility energy use by 30% by 2010 from a 1990 baseline.
Strategies:
 - FY 1999 – 30-kW photovoltaic (PV) panel array installation
 - FY 2001 – 200-kW natural gas fuel cell installation
 - FY 2001 – 90-kW expansion of existing PV panel array
 - FY 2001 – utility plant and distribution system improvements (steam line insulation, leak repairs, trap replacements, metering, variable-frequency-drive [VFD] equipment, controls)
 - Energy Initiative – proposed rooftop solar water heating for Pentagon
 - Energy Initiative – indoor air quality (IAQ) monitoring and ventilation control
 - Sustainable Design Initiative – environmentally preferable products
- Reduce facility energy consumption per gross square foot by 30% by 2005 and 35% by 2010 from a baseline year of 1985.
Strategies:
 - FY 2001 – utility plant and distribution system improvements
 - FY 2001 – direct digital control (DDC) improvements
 - FY 2001 – lighting and lighting control improvements
 - FY 2001 – window replacements
 - FY 2001 – heat recovery system
 - Energy Initiative – building envelope improvements (insulation, windows, doors)
 - Energy Initiative – electrical system improvements (lighting, lighting controls, plug load, motors, food service equipment)
 - Energy Initiative – mechanical system improvements (HVAC, IAQ, heat recovery, DDC)
 - Sustainable Design Initiative – lighting design (open by concept, daylighting, perceived quality, ambient light levels, surface finishes)
 - Energy Master Plan Study
- Implement renewable (solar, wind, geothermal, biomass) energy projects and purchase electricity from renewable sources. In support of the Million Solar Roofs initiative, the Federal Government shall strive to install 2,000 solar energy systems in Federal facilities by the end of 2000 and 20,000 systems by 2010.

Strategies:

- FY 1999 – 30-kW PV panel array installation
 - FY 2001 – 90-kW expansion of existing PV panel array
 - Energy Initiative – proposed rooftop solar water heating system
- Each agency shall reduce the use of petroleum within its facilities by switching to less greenhouse-gas-intensive, nonpetroleum energy sources (natural gas or renewables), or eliminating unnecessary fuel use and improve system efficiency.
Strategies:
 - FY 2000 – use of alternative fuel (compressed natural gas) vehicles and installation of fueling station at local Navy Exchange gas station
 - Reduce total energy use (power generation, transmission, and distribution losses), associated greenhouse gas and other air emissions, as measured at the source. Agencies shall undertake life-cycle cost-effective projects in which source energy decreases, even if site energy use increases.
Strategies:
 - FY 2001 – 200-kW natural gas fuel cell installation
 - FY 2001 – utility plant and distribution system improvements
 - FY 2001 – heat recovery system

Site/Water Goals and Strategies

- FY 2001 – water distribution system study
- FY 2001 – utility plant and distribution system improvements (condensate, metering)
- FY 2001 – heliport irrigation system
- Energy Initiative – water-efficient fixtures (toilets, faucets, showerheads, food service)
- Energy Initiative – domestic water alternatives (instantaneous, tankless heaters, solar)
- Energy Initiative – water-efficient irrigation alternatives
- Sustainable Design Initiative – water-efficient landscape practices

In addition, trees and shrubs displaced by construction will be preserved to the extent possible.

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The New Executive Order: Greening the Government through Efficient Energy Management, Pentagon Reservation Management and Conservation Plan, July 23, 1999.

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The Pentagon Renovation Program, brochure.

Windows and Building Envelope	
<u>Actions Implemented</u>	<u>Comments</u>
Window standard established at R3.13 winter and R3.03 summer	Based on market research for all window performance and cost requirements, including light transmittance, radiant absorption/reflectance, blast resistance, frame strength and anchorage, historic color and appearance
Added vestibules to most doorways and double glass on automatic doors; added roof insulation	
Exterior walls to be furred out 2.5 inches and insulated (foil-backed fiberglass batt, R11)	High thermal delay in massive building and excess internal heat generated at any time building is occupied
<u>Actions Not Implemented</u>	<u>Comments</u>
Recommended window rating of R3.5	Market research showed doubling of price when combined with other required features
Recycle or reuse window glass and frames	<ul style="list-style-type: none"> • Steel frames too corroded to reuse • Coated with lead-based paint • Neither frame nor glazing meets today's thermal insulation standards • Straight material recycling is being done
Glazed weather skin over light wells	<ul style="list-style-type: none"> • Interferes with obtaining outside air for HVAC through the light wells • Adds a summer thermal load • Noncompliance with historical requirement to maintain 5 separate ring appearance from above
Install skylights at base of light wells However, skylight provided on roof of 2 nd floor cafeteria over a-e drive	<ul style="list-style-type: none"> • Mechanical systems occupy ceiling cavity • Would eliminate use of variable-air-volume cooling system • Light savings more than offset by additional HVAC load from solar gain and insulation loss
Install skylights configured to allow daylighting of the upper floors served by the escalators	<ul style="list-style-type: none"> • Concrete beams and historical slate roof prevent skylights of useful size • Light would barely penetrate below the top floor • HVAC load increase more than offsets light gains
Lighting	
<u>Actions Implemented</u>	<u>Comments</u>
Illuminating Engineers Society of North America (IESNA) recommended practice #1 (rp-1) incorporated	<ul style="list-style-type: none"> • Control veiling reflections on pc displays -Parabolic troffers and fairly even ceiling brightness • Control specular reflections -Matte finish work surfaces • Brightness ratios between tasks within 3:1 • Lighting adaptable to individual acuity and type of work • Maximize daylight use -Automatic dimming of overhead lights in daylight areas • Avoid brightness ratios over 10:1 in surroundings

	<ul style="list-style-type: none"> -Window glare controlled by manual venetian blinds. -Careful selection of wall and floor reflectance
General lighting 300 lux (30 foot-candles)	<ul style="list-style-type: none"> • Bi-level switching provides 200–300–500 lux – lower level for partial daylighting, upper level for cleaning
Cove lighting and wall wash lighting in hallways for improved aesthetics	
High-performance electronic ballasts and T-8 fluorescent tubes specified	<ul style="list-style-type: none"> • Areas with high data processing density use hybrid ballasts because of h-f interference concern
Standard 3500°K color temperature and minimum CRI standard to be incorporated for fluorescent fixtures	
Compact fluorescent fixtures complement linear and ceiling lay-in fixtures for architectural interest	
Incandescent bulbs installed only for special applications	<ul style="list-style-type: none"> • Some normally incandescent functions to be filled by compact fluorescent; e.g., HVAC plenum and elevator inspection lights
Occupancy sensors control lighting in intermittently occupied areas; e.g., conference rooms, private lavatories	
Metal halide lamps provided outdoors for large areas requiring good color rendition. Sodium vapor in other outdoor areas	<ul style="list-style-type: none"> • Ceilings too low for efficient use of metal halide indoors
Luminaires specified on the basis of all aspects of performance	<ul style="list-style-type: none"> • Efficacy lumens per watt • Illumination maintenance factor and ease of cleaning • Acceptable and even distribution • Brightness and control of glare • Color rendition • Relocation flexibility • Heat removal to ceiling plenum • Visual interest in common areas
<u>Actions Not Implemented</u>	<u>Comments</u>
Pendant mounted indirect fixtures	<ul style="list-style-type: none"> • Ceiling is low (8'0") to cover mechanical equipment and piping in ceiling cavity. Not enough room for pendant lighting in most locations • Ceiling is flat for flexibility of relocatable partitions • Covers coffered formed by concrete beams
Light pipes/fiber optics for daylighting to circulation areas	<ul style="list-style-type: none"> • Historic roof and concrete beam structure prevents light inlets of useful size
Raise ceilings to 10' or higher, or at least no lower than top of windows, with furred down areas for duct trunks	<ul style="list-style-type: none"> • Raised ceiling to top of windows, but only for 18-24" in front of windows; remainder of ceiling is below duct trunks

Demonstration space for quality lighting	<ul style="list-style-type: none"> • Areas available for demonstration are different from permanent areas with respect to fenestration and ceiling conditions • Completed renovation areas serve as demonstration spaces
Plug Loads	
<u>Actions Implemented</u>	<u>Comments</u>
Corps of Engineers Construction Engineering Research Lab (CERL) survey of existing office plug loads resulted in reduced projection of future load for sizing renovation power and cooling requirements	
Agencies and services are procuring ENERGY STAR® office equipment in compliance with SECDEF directive	<ul style="list-style-type: none"> • Significant reduction in HVAC size for renovation
Agency and service network managers configure power-managed equipment to use ENERGY STAR® features	
Minimize personal appliances – federal facilities division requires and issues permits	
Centralize kitchenettes and provide more efficient common refrigerators and coffee bars	
Service voltage change to 480V and the potential for submetering creates incentives for food service and other contractor operations to install new, energy-efficient equipment	
Tenant build-out A/Es are under renovation contract	<ul style="list-style-type: none"> • Helps assure adherence to renovation energy/environmental principles
<u>Actions Not Implemented</u>	<u>Comments</u>
Add-on power management for office equipment	<ul style="list-style-type: none"> • Turnover is rapid and new equipment is ENERGY STAR® rated
Sponsor demonstrations of “best technology” office equipment and systems	<ul style="list-style-type: none"> • DOD energy personnel (Environmental Security, and Installations and Activities) welcome commercial demonstrations • Renovation is not funded for this activity
Heating, Ventilating, and Air-Conditioning	
<u>Actions Implemented</u>	<u>Comments</u>
Renovate HVAC systems	<ul style="list-style-type: none"> • Watchwords are occupant health and comfort, energy efficiency, and ease of maintenance
Improve air quality in as-yet-unrenovated parts of the Pentagon	<ul style="list-style-type: none"> • Installing energy monitoring and control systems (EMCs) compatible with renovation • Restoring outside air function and control • List of low-emission cleaning and finishing compounds compiled and used by maintenance staff
Reduced height of cubicle partitions to enhance air flow	

Provide an energy monitoring and control system	<ul style="list-style-type: none"> • Johnson Controls selected for building-wide contract • Optimizes HVAC and lighting energy use for occupancy, pinpoints malfunctions, and manages peak demands
Add cooling tower to central plant	<ul style="list-style-type: none"> • Insufficient space • Fouling by river water or additional use of city water • Plume interference with aircraft on approach to national airport
Add waterside free cooling cycle to central plant (river-water-to-chilled-water heat exchangers)	<ul style="list-style-type: none"> • Being analyzed by Vepco for energy master plan • Expensive alterations to plant piping • Plugging by silt and aquatic organisms results in high maintenance on heat exchanger • Useful only a small part of the year
Waterside economizer for central plant (modify chillers to transfer heat from chilled water to river water without running compressors)	<ul style="list-style-type: none"> • Plant chillers are not adaptable to this modification. Would require new equipment
Materials	
<u>Actions Implemented</u>	<u>Comments</u>
Include indoor air quality impact as an evaluation criterion	<ul style="list-style-type: none"> • Renovation specifications have been tailored to eliminate products that cause long-term indoor air quality (IAQ) degradation
Include formaldehyde content, total volatile organic content (VOC) emissions, particulates and 4 phenyl-cyclohexane content as selection factors	<ul style="list-style-type: none"> • The obvious offenders, e.g., carpet and wall covering adhesives, certain plastic materials, and foaming agents have been eliminated from renovation specifications • More work to do in this area – Environmentally Preferred Products (EPP) Working Subgroup
Observe threshold limit values (TLVs) and national ambient air quality standards (NAAQS)	<ul style="list-style-type: none"> • The renovation is in full compliance with American Conference of Government Hygienists criteria, federal law and executive orders, and state environmental regulations with regard to toxic substances in air and water • The Pentagon Renovation Final Baseline Environmental Compliance Assessment and Requirements Plan, Sept. 1995, includes consideration of local air quality • The renovation has and will continue to contribute to local air quality improvement through reduced emissions <ul style="list-style-type: none"> -New boilers with flue gas recirculation for lower NO_x -New classified incinerator with baghouse minimizes flyash -New generator plants will include best available emission control technology
(Not included in greening recommendations) building manager purchases low-mercury-content, non-carcinogenic-content fluorescent tubes	

Include investment return, initial cost, maintenance, recycled and energy content, disposal, and human factors as material selection factors	<ul style="list-style-type: none"> • EPP subgroup has been formed under the energy and environmental working group • Requires continuous market research
Use the Washington state guidelines for lower VOC emissions as an interim standard	<ul style="list-style-type: none"> • The Pentagon Safety and Environmental Management Division (SEMD) standards already meet or exceed the Washington guidelines.
Specify products containing the highest percentage of recycled post-consumer or manufacturer waste acceptable without compromising performance, durability, or health impacts	<ul style="list-style-type: none"> • Wedge 1 and modular furniture specifications have been modified • More work to do in this area – EPP subgroup
<u>Actions Under Consideration</u>	<u>Comments</u>
Specify forestry products from regional, well managed, sustainable source	<ul style="list-style-type: none"> • Manufacturer advertising of managed forestry is sparse and does not always tell the entire story • If there are no local regional certified forests, transportation energy becomes a concern • Further compliance will be evaluated by the energy and environmental subgroup
Use environmental impact over product's full life as a criterion	<ul style="list-style-type: none"> • EPP subgroup tasked with developing implementation • Data on life-cycle environmental impact is sparse • There are "good's" and "bad's," but no numerical measurements • Superimposing requirements beyond present laws and regulations will have an extreme effect on price
Indoor Air Quality (IAQ)	
<u>Actions Implemented</u>	<u>Comments</u>
Prevent microbial growth	<ul style="list-style-type: none"> • Renovated HVAC has easily cleaned condensate drain pans, no fissured duct liners or silencers • Wall hung toilets for easy floor cleaning • Carpet and work station enclosures can be a problem
Refurbish outside air controls in unrenovated parts of building (building manager program)	
Provide high-efficiency air filtration in renovated HVAC	
IAQ walkthrough inspections	<ul style="list-style-type: none"> • SEMD function
Catalog of alternative maintenance and cleaning supplies	<ul style="list-style-type: none"> • SEMD authorship — living document
Enforce building non-smoking policy	<ul style="list-style-type: none"> • Building manager function
Provide direct exhaust for all areas generating potentially harmful vapors/particulates	<ul style="list-style-type: none"> • Code requirement — building manager and renovation fully comply
Continue to remove asbestos and lead-based paint	<ul style="list-style-type: none"> • Renovating "contract" with Federal Facilities Division (FFD) • Building manager has a team for short-term small projects

Minimize use of pesticides (building manager function)	<ul style="list-style-type: none"> • Integrated pest management program (SEMD) • Concentrate on removing food supply for rodents and insects (entomologist) • Keep vegetation away from air intakes in case spraying is necessary (included in renovation design) • Use plants that are naturally insect repellent and resistant to fungus (horticulturalist)
Establish a construction area management plan to contain construction particulates, chemical, and other hazardous emissions generated during the renovation	<ul style="list-style-type: none"> • Separately developed for each construction project • Cooperation with Pentagon environmental engineer (FFD technical staff) for all construction area plans • Barrier walls are learning experience, initial designs leaked • Phased tenant fitout and occupancy flushes out offgasses and reduces chemical absorption by furnishings
Provide outside air quantities in accordance with ASHRAE Standard 62-1989	
Locate outside air intake louvers at roof level and co-locate intakes for multiple air-handling units	<ul style="list-style-type: none"> • Outside air intakes are well above ground level pollution • Individual air handlers are all located with direct outdoor access to save energy
Provide high-quality air filtration	<ul style="list-style-type: none"> • 30% efficient filters in series with 85% efficient filters to remove particulates down to diesel exhaust size
Provide environmentally sound cleaning and maintenance supplies (developed list)	
IAQ education program for custodial and maintenance personnel	<ul style="list-style-type: none"> • Building manager function • Maintenance by contract requires written requirements
Adopt environmentally preferred building materials	<ul style="list-style-type: none"> • Some progress (low VOC adhesives and paints, recyclable materials in modular furniture, recycled content in some building products) • Attended recent EPA-sponsored EPP seminar organized by OSD assistant for engineering and technology • EPP sub-working group formed to rank desired EPP qualities for the program with EPA as a member

<u>Actions Under Consideration</u>	<u>Comments</u>
Variable outside air with occupancy	<ul style="list-style-type: none"> • Present designs provide for scheduled on-off periods only. • Present designs provide automatic ventilation increase in conference rooms using occupancy sensors • Building manager is using CO₂ as surrogate indicator in existing Pentagon; renovation has not adopted as yet <ul style="list-style-type: none"> -Possible other IAQ concerns in new building -Small air handler zones require more sensors to save energy • Variable O.A. can easily be implemented via EMCs at any time with addition of suitable sensors
Formal IAQ program for the renovation	<ul style="list-style-type: none"> • Intend to use SEMD program; all records in one place
IAQ audit and immediate remediation	<ul style="list-style-type: none"> • SEMD maintains records • SEMD has appropriate measurement instruments
<u>Actions Not Implemented</u>	<u>Comments</u>
Restrict personal care and consumer products from public use throughout the Pentagon Reservation	
IAQ education program for general occupancy	<ul style="list-style-type: none"> • Not a renovation function • Occupants are generally well read • Labor unions help enforce IAQ standards
Water	
<u>Actions Implemented</u>	<u>Comments</u>
Preventive maintenance program and water leak survey with priority repairs	<ul style="list-style-type: none"> • Building manager function
Water-efficient plumbing fixtures	<ul style="list-style-type: none"> • 0.5 gallon/flush urinals • 1.6 gallons/flush water closets • 0.5 gpm faucet flow restrictors • Infrared proximity sensors for flush valves and bathroom faucets
Minimize use of once-through potable water for HVAC refrigerant condensers	<ul style="list-style-type: none"> • A few emergency spot HVAC units use once-through water <ul style="list-style-type: none"> -When distance to outside of building is a problem -Domestic water is a separate reliable heat-rejection sink -Run only upon failure of highly reliable primary system
Require washing of full loads only	<ul style="list-style-type: none"> • Building manager policy for janitor and maintenance
Lawn and plant irrigation confined to exact area, some drought-resistant plants (xeriscaping)	

Use trash bins instead of water for discarding tray waste	<ul style="list-style-type: none"> • In DOD concessions contract with food service vendors
Discontinue use of garbage disposers in favor of plastic and paper. Edible garbage disposed in trash bins	<ul style="list-style-type: none"> • In DOD concessions contract with food service vendors and trash collectors, also provided in new RDF design
Maintain existing irrigation practice	<ul style="list-style-type: none"> • Pentagon horticulturalist function • Renovation provides new automatic irrigation equipment as coordinated for renovated areas.
Monitor and assess automatic irrigation system efficiency	<ul style="list-style-type: none"> • Pentagon horticulturalist function • Horticulturalist has installed a river-water irrigation system for river terrace side of pentagon
Support current xeriscape-oriented design plans	<ul style="list-style-type: none"> • <u>Pentagon horticulturalist function</u>
Replacement project for aged exterior federally owned water mains	<ul style="list-style-type: none"> • Not originally budgeted in renovation, but had to be done • 1st segment replaced during south terrace construction • 2nd segment (heliport) replaced by 8a contract • 3rd segment (mall terrace) will be replaced by remote delivery facility project - Various projects need to occupy the same area as 3rd segment of water main—RDF, basement, storm drain relocation, communications ductbanks
<u>Actions Under Consideration</u>	<u>Comments</u>
Shutoff valves on showerheads	<ul style="list-style-type: none"> • Probably not cost effective because all will not use and service life is short in public showers • Needs further consideration, will probably be implemented for concessionaires
Building-wide fixture procurement to minimize spare parts	
Submeter specific users	
Determine baseline water use by function	<ul style="list-style-type: none"> • Needs further consideration; will probably be implemented in some areas, e.g., irrigation, concessionaires, industrial areas
Reclaim gray water	<ul style="list-style-type: none"> • Needs further consideration – Large building, widespread small pipes
Store or re-infiltrate rainwater and runoff	<ul style="list-style-type: none"> • Needs further consideration • Pentagon horticulturist has looked at many ideas already; energy and environmental working group will investigate new techniques periodically • Biggest obstacle is question of EPA requirement for treatment due to airborne pollution (jet aircraft and vehicle exhaust)

<u>Actions Not Implemented</u>	<u>Comments</u>
Waterless urinals	<ul style="list-style-type: none"> • Visited other installations • Tested in renovation office bathroom • Odor unsatisfactory for office environment
Aerators in faucets	<ul style="list-style-type: none"> • Add maintenance, flow restrictors already applied
Toggle-type aerator sprayers on kitchen equipment	<ul style="list-style-type: none"> • Food service experienced high maintenance on sprayers and hoses; most washing now automated • Automated high-efficiency equipment uses only the water necessary and recycles intermediate rinse water
Water meter inspection and water meter repairs	<ul style="list-style-type: none"> • Water meters are being replaced as part of the exterior water main project • Water billing is on metered sewage right now
Post signs reminding staff to turn off water	<ul style="list-style-type: none"> • Reviewed by federal facilities division • Employees leaving water running in reservation facilities is not a problem • Designing, printing, distributing, and maintaining the signs throughout the reservation would be an unproductive taxpayer expense
Landscaping and Grounds	
<u>Actions Implemented</u>	<u>Comments</u>
The horticultural department reviews all renovation program designs and participates in construction inspections	<ul style="list-style-type: none"> • The renovation program and the FFD horticulture department coordinate design and construction projects to minimize digging in root zones • Plants, shrubs and trees in construction areas are relocated and restored at the end of the construction by horticultural department, thereby preserving the plants themselves and the landscaping master plan
Continue emphasis on xeriscape (minimum water use) landscaping	<ul style="list-style-type: none"> • Pentagon horticulturalist function and oversight • Not realistic for turf and some other areas • Historic trees and botanical gifts from other nations require appropriate care
Continue to comply with President's executive order on landscaping of federal buildings	<ul style="list-style-type: none"> • Pentagon horticulturalist function and oversight
Review the integrated pest management program for opportunities to improve the program and reduce pesticide use	<ul style="list-style-type: none"> • Not a renovation function • Horticultural department and the safety and environmental management division control this program • They have effectively reduced pesticide use through elimination of attractive habitat and maintaining cleanliness
Conduct regular soil test analysis of lawn fertilizers and chemicals, and review of turf management	<ul style="list-style-type: none"> • Horticulturalist, and safety and environmental management division function • Annual spring survey determines program for year

<p>The horticultural department is proactive in planting new and maintaining existing trees throughout the Pentagon Reservation</p> <p>The head of the FFD horticultural department is a co-signer of the Save the Elms task force and actively works to preserve existing trees and limit the spread of Dutch elm disease throughout the Pentagon Reservation</p>	
<p><u>Actions Under Consideration</u></p>	<p><u>Comments</u></p>
<p>Add storage area for sand and environmentally acceptable snow-removal chemicals</p>	<ul style="list-style-type: none"> • Sand and deicers are currently stored in a trailer and a box at the edge of the north parking lot (enough for 2 applications) • Deicer is potassium chloride, judged least damaging to the environment • The horticultural department concurs
<p>Reduce north parking area by 20% at the north end and develop wetlands and open space</p>	<ul style="list-style-type: none"> • The recently approved remote delivery facility will occupy the mall parking lot • Its roof will be covered by landscaping and the mall parking lot eliminated
<p>Create “pocket wetlands”</p>	<ul style="list-style-type: none"> • The Pentagon is situated on a high water table • Creation of pocket wetlands may create stagnant, mosquito-infested, odorous water • Wetlands automatically restrict future use of the location
<p>Increase trees in parking areas</p>	<ul style="list-style-type: none"> • Renovation architects agree on aesthetic improvement • Renovation master site plan indicates increased trees • Horticulturist has previously tried – present lane arrangement cannot provide sufficient unpaved space for watering, root zone temperatures too high • Must be integrated with parking space decisions • Will be considered at end of renovation as new demographics set in
<p><u>Actions Not Implemented</u></p>	<p><u>Comments</u></p>
<p>Integrate wildlife habitat enhancement into landscape design; create a “backyard wildlife habitat” demonstration area</p>	<ul style="list-style-type: none"> • Existing wildlife habitats are preserved along the lagoon • Vehicular and aircraft traffic limit suitable locations • Suitable habitat areas are not accessible for recreational observation as implied by “backyard habitat”
<p>Improve contractor education and construction specifications covering landscape protection</p>	<ul style="list-style-type: none"> • Renovation and horticulturist review indicates existing clauses and contractor controls are most practical
<p>Landscape the perimeter of the building and parking areas early</p>	<ul style="list-style-type: none"> • Impractical since most contractor access for large equipment must be from outside the building

Use cisterns to capture runoff from clean surfaces	<ul style="list-style-type: none"> • The FFD horticultural department is implementing on a small scale • See discussion under water
Reduce mowed lawn areas	<ul style="list-style-type: none"> • The Pentagon grounds are formal, primarily for official ceremonies and quiet recreation. These activities do not lend themselves to informal grounds-keeping practices • Energy and environmental working group will examine areas adjacent to metro station when contractor activity decreases (approximately year 2004)
Change the color of the parking lot pavement	<ul style="list-style-type: none"> • Renovation is not funded for a repaving project of this size • The parking master plan will be revised for the remote delivery facility • Revisit recommendation near the end of the renovation
Waste and Recycling	
<u>Actions Implemented</u>	<u>Comments</u>
Conduct a waste characterization study to provide accurate data	<ul style="list-style-type: none"> • Completed by management, support A/E in May 1991 • Type “o” waste (trash, as opposed to refuse or garbage) • Heating value 8,500 Btu/lb • Approximately 18 tons per day of unclassified material
Purchase more durable/reusable goods	<ul style="list-style-type: none"> • Services/agencies have their own programs • No one agency has oversight • The renovation is purchasing modular furniture with high recyclable content
Continue to use double-sided copying	<ul style="list-style-type: none"> • Services/agencies have their own programs • Renovation copiers are all double-sided capable • Hard copies of renovation specifications are double-sided
Expand the use of e-mail and other electronic communication	<ul style="list-style-type: none"> • Logical result of service/agency-wide business decisions • Renovation is heavy email user • Voice mail is being implemented
Route documents and centralize filing systems	<ul style="list-style-type: none"> • Services/agencies must develop own programs • Renovation has a centralized document control and an electronic scanning file system • In a paperless world, document routing is less necessary, multiple addressees on an email are more efficient
Develop waste prevention and reduction ethic	<ul style="list-style-type: none"> • Building manager program includes recycle containers for paper, glass, plastic and aluminum
“Bring your own mug” program is established at the Pentagon cafeteria and Starbucks coffee shops	

Implement a department-wide “paperless office”	<ul style="list-style-type: none"> • Program under control of services/agencies • Unique service requirements, e.g., command signature authentication • Renovation uses electronic communications to maximum extent • Renovation uses compact discs to distribute construction documents for bids instead of paper
Influence vendors to use reusable shipping containers for transporting and delivering products	<ul style="list-style-type: none"> • Primarily an agency/service function • The greater portion of renovation materials arrives as bulk shipments, i.e., without packaging
Reuse moving boxes or use reusable containers for office moves	<ul style="list-style-type: none"> • The renovation “has this one down to a science”
Establish a surplus supply corner in the facility supply store	<ul style="list-style-type: none"> • Program is managed by the area supply officer • Old computers are offered to schools • A supply warehouse is maintained that holds scheduled auctions of old durable goods and equipment • A “supply corner” table is available at the Pentagon supply store for recycling durable office supplies
Consolidate and expand storage and processing areas for recycling and waste management / keep all recyclables/waste storage at one dock location / ensure that adequate storage space is provided to hold collected recyclables/waste containers	<ul style="list-style-type: none"> • The existing south loading area has an 1800-sf enclosure for recycled materials and waste • The new remote delivery facility plans 3 bays dedicated to recycling and waste
Custodial staff contract includes separation of recyclable materials from trash when reasonable	
Write into new contracts and amend existing contracts to include the requirement for contractor to reuse/recycle construction and demolition waste	<ul style="list-style-type: none"> • The wedge one contract implements a contractor recycle materials exchange/revenue sharing program for the removal or reuse of construction debris removed from the project.
(Not in greening report) renovation evaluated use of classified incinerator heat to generate steam in 1992	<ul style="list-style-type: none"> • Judged not feasible because incinerator operation is not steady enough • Vepco is reevaluating under the energy master plan
Evaluate options to reduce the building solid waste stream / establish waste reduction and recycling goals / implement full-cost accounting for solid waste and recycling costs	<ul style="list-style-type: none"> • Building manager function • Renovation contractors separate and recycle about 35% of demolished materials; new renovation goal is 50% • Numerous programs introduced • Federal Facilities Division technical staff are gathering weight tickets from recycling and waste dumpsters to develop a baseline for day-to-day waste

Evaluate alternative collection systems (e.g., wet/dry, commingled collection)	<ul style="list-style-type: none"> • Federal Facilities Division is evaluating alternatives • There is time to integrate into the remote delivery facility
<u>Actions Under Consideration</u>	<u>Comments</u>
Expand the types of paper currently recycled	<ul style="list-style-type: none"> • White paper recycling bin at each work station and at strategic locations such as copy machines • Newsprint recycling bins in offices and public areas • Expansion is a function of what local recycling firms make economic for the hauler • The Pentagon recycles all types of paper acceptable to area haulers • Classified paper excepted
Expand recycling programs to the following: steel cans, fluorescent tubes, wood pallets and wood waste, ferrous and nonferrous metals, non-beverage plastic containers, and consumer batteries	<ul style="list-style-type: none"> • Service/agency/building manager function • Governed by available acceptors
Evaluate alternate packages/materials to reduce waste/increase recycling	<ul style="list-style-type: none"> • Construction industry packaging is standard • Low priority
Demonstrate in the materials handling plan how recyclable materials and waste removal will be handled for maximum efficiency	<ul style="list-style-type: none"> • Existing plan provides routes and space, but not specific procedures • Requires further consideration
Further waste characterization and search for economic opportunities, e.g., sale as fuel	<ul style="list-style-type: none"> • Building manager function
Prepare an affirmative procurement action plan detailing Pentagon recycle content and EPP procurement strategy / monitor the affirmative procurement plan	<ul style="list-style-type: none"> • The Environmentally Preferred Products Working Group has been formed to define renovation priorities • EPA will participate in the working group
<u>Actions Not Implemented</u>	<u>Comments</u>
Reusable plates and utensils are fast food services	<ul style="list-style-type: none"> • Often, patrons desire to take food back to office; pilferage • Water use tradeoff for dishwashing • Opposes previous action implemented to use disposable dishes
Employee education, awareness, and incentive program for recycling	<ul style="list-style-type: none"> • Peer pressure and public media education judged sufficient • Employees react given the opportunity
Installation of chutes on each floor to facilitate transport of recyclables/waste	<ul style="list-style-type: none"> • Chutes are a maintenance problem, harbor organisms • Invariably patrons mix recyclable with non-recyclable waste • Local office recycling containers more accessible and are kept neat by local people

Pollution Prevention	
<u>Actions Implemented</u>	<u>Comments</u>
Perform an environmental audit / establish an environmental baseline	<ul style="list-style-type: none"> • Environmental assessment of the Pentagon Reservation master plan, May 28, 1991
Formal pollution prevention program addressing all processes within the Pentagon	<ul style="list-style-type: none"> • Not a renovation program except for enforcement of contract clauses relating to pollution prevention • Formal program is maintained by FFD technical staff
Implement Secretary of Defense Pollution Prevention Strategy, August 1994	<ul style="list-style-type: none"> • This is a broad order. Renovation contracting generally incorporates the intent of the order. Further refinement is needed, particularly EPP
Implement Executive Order 12856 for all elements, and all disciplines within elements	<ul style="list-style-type: none"> • Same comment as above
<u>Actions Under Consideration</u>	<u>Comments</u>
Implement an electronic news system	<ul style="list-style-type: none"> • To be included in the Pentagon Renovation Energy/Environmental Master Plan development
<u>Actions Not Implemented</u>	<u>Comments</u>
Provide life-cycle analysis and accounting for all equipment, material, and systems	<ul style="list-style-type: none"> • It is not practical to comply fully with this recommendation, i.e., "all" • Major decisions are based on a life-cycle analysis • End-of-life salvage value is often unknown • First cost, delivery, and competition are other major considerations
Human Factors	
<u>Actions Implemented</u>	<u>Comments</u>
Implement a public relations / information program	<ul style="list-style-type: none"> • Full-time public affairs person runs the program • Information kiosks in public areas • Flyers, renovation signs, other information
Workstation prototypes have been constructed at room 1A123 for public view	
Monthly program reviews include renovation goals, including customer relationships. The PM emphasizes measurements	
Washington Headquarters Services is a member of the Arlington County-Falls Church-Reagan National Airport local emergency planning committee (LEPC) and complies with Executive Order 12856, Federal Compliance with the Right to Know Law, August 1993.	
Develop an education program to reach every resident and increase awareness	<ul style="list-style-type: none"> • Includes information kiosks, flyers, signage, tours of areas under renovation, and briefings to operations and command authorities

Expand existing Pentagon public information program to deliver the educational program in user-friendly venues	<ul style="list-style-type: none"> • The renovation effectively uses other public information activities, such as Armed Forces Network, Army Audiovisual Center, etc. • A web site is being developed for visitors to get a safe look at ongoing construction work
Identify existing conditions and concerns	<ul style="list-style-type: none"> • Real Estate and Facilities, Safety and Environmental Management Division (SEMD) prepares annual Occupational Safety and Health report addressing these issues. • The Pentagon Renovation Program has not produced a formal document, but will correct all SEMD issues • The program provides a hotline number for occupant concerns with respect to the renovation
Identify/define energy environmental management policy and implement regular internal reviews	<ul style="list-style-type: none"> • The Energy and Environmental Working Group is expanding the influence of these aspects of the renovation • Several policy letters have been promulgated • The Energy and Environmental Master Plan will form the basis for additional policy
Review and update the energy, management, environmental, and pollution prevention plans	<ul style="list-style-type: none"> • The Renovation Energy and Environmental Master Plan is in development. Federal Facilities Division is developing an energy master plan for the as-yet-unrenovated areas • The Program Management Plan is updated biannually or as required. • The Pollution Prevention Plan is maintained by Federal Facilities Division technical staff
Establish clear lines of responsibility and communications to ensure successful energy and environmental upgrades	<ul style="list-style-type: none"> • The Pentagon Renovation Program implements this recommendation through the integrated product team (IPT) process • The Program Energy and Environmental IPT Working Group is a subgroup of the requirements IPT that establishes Pentagon-wide renovation requirements
Include explicit environmental awareness responsibilities in each job description	<ul style="list-style-type: none"> • The Pentagon renovation Program is composed of professionals who consider environmental protection to be implicit in their work • This is a DOD requirement for job descriptions
<u>Actions Not Implemented</u>	<u>Comments</u>
Define DOD culture	<ul style="list-style-type: none"> • There is no formal document setting forth DOD culture • The renovation is providing an environment comparable to good business practice • The second largest group of personnel in the renovation (after the electronic communications group) deals personally with tenants to ensure the proper business and operational environment is provided

<p>Evaluate and catalog human factors influence on current operations and maintenance procedures</p>	<ul style="list-style-type: none">• The Pentagon Renovation Program has not formally implemented this recommendation.• Instead, the renovation is in close touch with building manager personnel regarding human factors in building operations and maintenance, and cooperatively evaluates O&M requirements.
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