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**System.**

# INTRODUCTION

This report summarizes courthouse building features and project delivery concepts, advocated by a panel of experts and leaders in sustainable architecture (*Green Building* design.) In so doing, this report addresses a range of environmental issues, impacting the workplace, building construction, the community, and the larger ecosystem. While the panel considered a broad base of environmental concerns that apply to many building types, recommendations were made considering the unique space and functional needs of Federal Courthouses.

The 20-member interdisciplinary panel consisted of leading architects, engineers, environmentalists, planners and research scientists. They were assembled in response to the General Services Administration's (GSA s) desire to recognize and help deliver appropriate *Green Building* technologies for its multi-billion dollar courthouse construction program.

The Panel recommendations listed in this report provide a technical foundation for *Green Building* project design programming and subsequent design phase benefit-cost assessments. In addition to providing a comprehensive listing of possible building features, the report also suggests sample language for GSA design programming directives that may be used to help scope the delivery of professional services necessary to achieve *Green Building* design.

# APPROACH

An actual courthouse project was used as a model to structure the Panel s assessment of *Green Building* design opportunities. The Panel evaluated possible *Green Building* systems, materials, and delivery techniques for the proposed Federal Courthouse Expansion in Denver, Colorado. This project was chosen because it was documented by an existing concept design that provides design details for discussion and defines a performance baseline for current GSA design criteria.

*Green Building* functional objectives were used to organize the Panel s discussion of building features. *Green Building* design was defined by discussing: 1. Site and Transportation, 2. Energy-Building Design, 3. Energy-Electricity, 4. Energy-Heating, Cooling, and Ventilation, 5. Materials, 6. Indoor Air Quality, 7. Water Utilization, 8. Occupant Productivity, 9. Facility Operations, and 10. Construction. The objective was to package system recommendations into integrated solutions oriented toward more sustainable building designs.

GSA asked the Panel to classify its recommendations according to their perceived first cost as either low, moderate, or high. This grouping of recommended design strategies allows funding limits to be considered and highlights low cost features that should be considered for most projects.

# PROCEEDINGS

The *Green Buildings* Panel was convened for a one-day session on November 14, 1996. In introductory remarks to the panel, Robert A. Peck, Commissioner of GSA s Public Buildings Service (PBS), described the Federal government's tradition of using the Federal building program to promote technical innovation, and GSA's leadership role in providing environmentally sensitive building design, construction, and management practices. He explained that Federal buildings should reflect the image and values of the United States and respond to the obligation of all citizens to be stewards of the environment. He also indicated that in an era of fiscal conservatism, attention must be given to insuring long term cost effectiveness even if higher initial spending is required. His remarks concluded with a commitment to pursue the Panel s recommendations.

The Panel session began with a presentation of the Denver Federal Courthouse Expansion project design concept, as currently planned and represented within the Enhanced Prospectus Development Study (EPDS). Appendix C provides a brief summary of the EPDS programming direction and the design concept that served as the panel s starting point.

Curt Dale, of Anderson, Mason Dale, Architects (the project’s design Architect-Engineer), discussed the design constraints of courthouses and decisions made by the Judiciary that influenced the design of the Denver facility. Judicial security requirements limit configurations and efficiencies by requiring three separate circulation systems (public, judiciary, and prisoners). The clear space and volume of courtrooms requires greater floor to floor heights than found in a typical Federal or private sector office building. The judges of the Denver court preferred that courtrooms should be in the center of the courthouse and situated in interior spaces to achieve consistent and controlled lighting. The judges also chose to have their chambers located adjacent to the courtrooms. He noted that the building's design constraints will make revision of the floor and stacking plans difficult; however, significant flexibility exists in the facade design and the architectural expression of the building.

Following the account of architectural issues and constraints, Michael Holtz, Architectural Energy Systems, described current options that may be considered for the electrical and mechanical systems. A list of sustainable design measures being considered by the design team are included in the Summary EPDS, Appendix C. It was generally concluded that a higher level of flexibility existed to consider change for these operating systems.

The Panel then conducted a brainstorming session facilitated by Bill Reed, Hillier Group. The Panel discussions responded to the case study presentation by identifying sustainable design opportunities and recommending *Green Building* design strategies for the Denver Courthouse Expansion. The Panel s recommendations are listed in Section I of this report.

It should be noted that the Panel's recommendations are considered applicable to most new courthouse construction. Some recommendations respond to the specific climatic conditions of the Denver courthouse and would be applicable only in similar climates. Many recommendations are appropriate for any type of comfort controlled facility.

The Panel's recommendations were further analyzed by GSA, NIBS, and Mr. Reed to develop guidance for incorporating *Green Building* design objectives into design programming directives. Section II contains sample language for incorporating *Green Building* objectives into the scope of design services.

# USING THIS REPORT

It is important to recognize that effective *Green Building* design represents the comprehensive evaluation of all building materials, systems, and functions. *Green Building*s are more than regular buildings that have one or two sustainable architecture features. Also, to fully optimize a building's environmental performance, a designer must take advantage of the synergistic effects of integrated features and technologies. System integration is the fundamental challenge of *Green Building* design.

It was beyond the scope of the *Green Building* Panel to determine, analyze, and integrate the wide variety of possible design solutions represented by the concepts and ideas in this report. Some options have multiple impacts to *Green Building* performance and others may be mutually exclusive. It is up to a project's design team to conceive and optimize the unique features and opportunities offered by an individual project. This report provides only a framework for applying *Green Building* design principles.

# Section I

## Panel Recommendations for The Denver U.S. Courthouse Expansion Organized by Functional Categories and Cost

# 1. SITE AND TRANSPORTATION

## Low Cost

1.1 Use alternatives to snow and ice removal methods that consume large amounts of energy and release chemical pollutants. Alternative methods include: covering pedestrian and auto areas, using waste heat to melt snow on exposed paving and concentrating the sun on these areas to assist in the removal process.

1.2 Increase shade and provide cooling from evapo-transpiration by using a high percentage of landscape coverage. Excessive paving contributes to heat build-up on the site as well as creating an inhospitable and uncomfortable environment. Dark and dense site materials absorb heat and raise overall temperatures within the site's microclimate. To alleviate heat build-up and increase visual delight, a high percentage of landscape coverage should be provided. In addition, high albedo (reflective) materials should be used.

1.3 Alleviate storm water runoff from impermeable surfaces, such as parking lots and buildings which adds pollutants to the water shed and prevents rain water from benefiting the soil and local ecosystem. The paved surface area should be reduced and made permeable to increase the water absorption capacity of the site.

1.4 Balance landscape design and species selection so that the site becomes a reasonably self-contained ecosystem. Landscapes in nature are balanced in a way that allows the land to perpetuate itself; however, in an urban setting this balance is difficult to duplicate. The goal should be to make the site self maintaining. Irrigation can be accomplished by gravitational flow from storm water retention cisterns. In addition, xeriscaping (low water plantings) techniques can be employed. Well-landscaped properties and carefully placed buildings can also provide meaningful public amenities and contribute to the surrounding community.

1.5 Protect existing trees, plant life, and animal life that will be impacted by the construction. Wildlife enhancement should be integrated into the site's design.

1.6 Provide interconnected plant zones. This means that plants, helpful insects, and water can more easily interact in a natural and diverse manner. Interconnected zones encourage natural biological synergies to occur with greater ease, thus providing for healthier and easily maintained plants.

1.7 Use Xeriscaping techniques by planting species and varieties that are native to the local ecosystem. In the dryer areas of the United States, irrigation of planted sites is contributing to drastic changes in the microclimate, such as high humidity and fungus growth in what were comfortably dry climates.

1.8 Minimize the use of toxic chemicals to control pests. Control pests, such as roosting birds and destructive insects by using integrated pest management that employs native plants and insects to help control a wide variety of pests.

1.9 Configure the building and site to minimize adverse wind effects. Provide plants and site features that shelter the building and exterior spaces from cold winds and help direct the wind for cooling and ventilation purposes. Provide special building features and/or landscape features at the entrance to mitigate the effects of the wind.

1.10 Provide a strong building facade and landscape design. Design features on the 19$^{th}$ Street side of the Denver courthouse expansion site and building have been neglected. A stronger building facade and landscape design are needed to project the presence of the courts and provide public amenities on 19th Street.

1.11 Facilitate pedestrian access and the use of mass transit in the site design. Analyze traffic flows and community infrastructure to identify strategies for improving transportation. For example, orient the building entries and open spaces to encourage the use of public transit and the courthouse public space.

1.12 Provide a pressurized entry vestibule between the underground parking garage and occupied spaces to minimize air infiltration from the parking area. Underground parking can produce indoor air quality problems.

1.13 Locate major ventilation equipment (intake air, exhaust, mechanical system, etc.) away from public open spaces to decrease the noise on the site and increase building security.

1.14 In temperate climates, orient exterior public spaces for maximum solar exposure. Public spaces will be used more effectively if planned with the sun to help grow foliage and provide winter warmth. The use of deciduous tree cover and planted ground plane can provide for Winter solar benefits while providing shade and cooling in Summer.

1.15 Locate buildings on the north side of the site with expansion space on the south, since north facing open areas are rarely used. This strategy generally ensures the maximum use of open space.

**Moderate Cost**

1.16 Provide on site rain water retention. Use cisterns or other storm water retention devices to use and reuse captured rain water. Use rain water for site irrigation to reduce potable water consumption.

1.17 Maximize site amenities by providing building users roof access. To more efficiently use the site, the normally unused roof area of the building may provide space for a fitness center.

1.18 Consider photovoltaic energy as the power source for decorative site lighting.

1.19 Encourage bicycle commuting by providing a secure parking space for bicycles that is protected from the weather. Also provide changing rooms for bike riders.

**High Cost**

1.20 Provide battery charging stations for electric powered government vehicles.

## 2. ENERGY -- BUILDING DESIGN

### Low Cost

2.1 Reduce the square footage and volume (floor to floor space) of the building to minimize energy use. Only design space that is necessary to fulfill the requirements of the program. Evaluate the program to assure all requests for space are absolutely necessary.

2.2 Stack spaces that require only one story volumes (offices and chambers) to utilize the space required by the two story volume of the courtrooms. This space may be used for HVAC equipment but it is very expensive and inefficient for this use.

2.3 Reduce the building floorplate depth to provide access to natural light and ventilation for all staff. In office areas, the maximum distance from a natural light source should be seven meters. Locate unoccupied spaces, such as storage and mechanical rooms, in the interior to increase occupant access to perimeter windows.

2.4 Provide operable windows as a source of natural ventilation and to allow a greater sense of nature for the occupants; however, it is not necessary for windows to open all the way. Effective ventilation is accomplished with a small percentage of open window. Heat and cooling sources should be turned off by a switch that is activated by the open window.

2.5 Use concrete construction or other dense materials to increase thermal mass. Additional thermal mass provides improved energy storage capability and temperature lag that balances diurnal temperature swings. This can work in any climate but is most effective in dryer areas with warn days and cool nights. Cool night air is distributed throughout the building to remove the heat build-up of the day. The cooled mass of the building then helps to temper the heat build-up during the work day.

2.6 Use corridors located along the south and southeast side of the building for pre-heating and cooling building ventilation air. The facade will need to be comprised of glass, with proper shading, and operable windows. The corridors can be utilized for this purpose because the temperature can be allowed to vary more widely than in an office area.

2.7 Integrate the design of the building envelope with an overall energy efficiency strategy. The facade should be designed to respond to the micro-climate and sun angles. Windows should be placed in areas that maximize solar heat gain in winter, reduce cooling loads by shading and ventilation in summer, increase access and improve control of daylight, and increase occupants psychological association with nature.

2.8 Use high performance glazing to minimize radiant heat loss. This type of glazing is considered by some designers to be so efficient that the perimeter heat requirement may be eliminated. (There was disagreement among the panel on whether or not perimeter heat can be eliminated.) Modeling of the building might be required to determine perimeter heating requirements.

2.9 Provide daylight exposure for jury rooms. People function better and are healthier with natural light as a major light source.

2.10 Evaluate concepts for one hundred percent passive heating and cooling, and daylighting. This is conceivable in the Denver area or similar climatic conditions.

2.11 Use roof spray cooling system for efficient heat transfer at night and store coolant in cisterns for use during the day.

**Moderate Cost**

2.12 Design the building to maximize the envelope surface area. This will allow greater access to natural light and increase radiant and ventilated cooling. Investigate the cost and benefit of using the skin of the building as a radiator to help cool the interior as an alternative to insulation.

2.13 Design the envelope to form a continuous air-tight plane to insulate the building and control moisture.

2.14 Use exposed concrete in the interior of the building. Concrete does not contribute to poor indoor air quality and provides a thermal mass as described in the Low Cost Energy comments.

2.15 Provide funds required for design analysis such as computational fluid dynamic modeling. Many different design strategies and passive hybrid-systems may require a substantial design effort.

**High Cost**

2.16 Design the building to maximize the envelope area. (Refer to 2.12)

2.17 Use natural ventilation to control temperatures in the entire building. (Refer to 2.15)

2.18 Use electronic based information storage in lieu of paper based information storage systems to reduce space requirements. (Refer to 2.2)

2.19 Use a dynamic building envelope that responds to changing light and thermal conditions. Adjustable elements should be placed in strategic areas to maximize heat gain in winter, reduce cooling loads by shading and ventilation in summer, and improve daylighting.

## 3. ENERGY -- ELECTRICITY

### Low Cost

3.1 Provide natural lighting. Daylighting reduces dependence on artificial lighting and its resultant energy consumption and heat load. It also provides better quality light and stimulating environment through occupant exposure to daylight and the rhythms of the day

3.2 Combine ambient general lighting with workstation task lighting. This mixture is more efficient than lighting the entire space to the level of light intensity required for detailed tasks. The ambient light should be kept at a low level in offices and passageways. The lighting level should be higher in file areas and other space that require higher general lighting.

3.3 Meet or exceed the EPA Energy Star requirements for all building lighting designs.

3.4 Analyze the potential for load reduction. Do not just use equipment maximum load ratings but analyze the aggregate averages and peaks. Avoid systems designed with electric service that far exceeds the actual requirements for the installed equipment.

3.5 Use daylight for 90 percent of the ambient lighting requirements.

3.6 Use dimmable ballasts for fluorescent fixtures and control them with area daylight sensors to provide efficient, balanced, and integrated lighting systems. Fluorescent fixtures should be able to be controlled so that they emit only the necessary level artificial light to supplement the available natural daylight.

3.7 Use occupancy sensors for control of lighting. Occupancy sensors traditionally have been used to turn off lights when space are not occupied. Reduce electric energy consumption by using Direct Digital Control and Building Management Systems for efficient operation of equipment and systems.

3.8 Use photovoltaic-assisted power to provide energy for fans. Photovoltaic power can be used to power any system in the building. However, it is most cost-effective to power systems that have the majority of their use during the day and low level requirements at night.

**High Cost**

3.10 Use dimmable ballasts for fluorescent fixtures and control them with individual daylight sensors to provide efficient, balanced, integrated lighting. Fluorescent fixtures should have individual versus zoned controls.

3.11 Use daylight for 100 percent of the ambient lighting requirements. (Refer to 3.5)

3.12 Use photovoltaic-assisted power for fans. (Refer to 3.7)

3.13 Integrate photovoltaic power throughout the building's electrical system. (Refer to 3.7)

3.14 Use light pipes or fiber optics to bring daylight into interior spaces that do not have the exposure to windows or need more light than can be obtained through the window.

3.15 Consider self-contained electrochemical generators (fuel cells) as an efficient and clean power source. Fuel cells convert fossil fuels (usually natural gas) into heat and electricity directly through chemical reactions and do not require turbines or other moving equipment. They are an emerging technology that has been demonstrated to be extremely clean and efficient but is currently exceedingly expensive.

# 4. ENERGY -- HEATING, COOLING AND VENTILATION

## Low Cost

4.1 Provide individual control of HVAC to enhance comfort. The greater the number of HVAC and lighting zones in a building, the more responsive it can be to differences in HVAC requirements. A fine array of localized zones provides greater control by individuals.

4.2 Use evaporative cooling in lieu of conventional refrigeration/cooling equipment. In dry climates, evaporative cooling can work effectively because it can also provide humidification. In humid climates, this strategy can be used by drying the air with desiccant de-humidification (this is more efficient in removing latent heat than chillers) and then using evaporative cooling to cool and add humidity back to the supply air at the same time. Elimination of conventional cooling will also eliminate chemical use

4.3 Locate air intake vents away from pollution sources and exhaust air. For example, if the air intake is located near the loading dock, diesel fumes may enter the building's air supply. Filter s for outside air must be effective and properly maintained.

4.4 Conduct a night-time ventilation purge to cool the mass of the building overnight. The HVAC system should be able to provide 100% outside air in a controlled fashion to remove the heat build-up of the day. The cooled mass of the building then helps to absorb heat produced during the high load periods of the work day.

4.5 Reduce duct and fan sizes by employing a displacement ventilation delivery system. Deliver air in a steady, but slow, process from the floor of the spaces. Ventilation is unhampered by walls and furniture since the air is being filled from the bottom towards the ceiling. Such systems can be integrated with a raised floor air distribution concept.

4.6 Separate ventilation from heating and air conditioning systems to provide continuous fresh air delivery with a smaller, easily cleaned duct system. Slow, but continuous, air movement requires less energy. This type system is also compatible with operable windows because heat and cooling can be separately shut off when the windows are open and the system ventilation can help continue to move fresh air throughout the space when the breezes die down.

4.7 Recover heat and cooling energy from the exhaust air. Energy recovery systems can also recover humidity. Large amounts of energy are wasted if energy is not recovered form exhaust air.

4.8 Provide multiple vertical cores and chases to reduce the size of horizontal distribution of systems. This is a space saving technique as well as a method of encouraging a finer array of HVAC, electric, communication and data zones.

4.9 Use variable speed motors.

4.10 The HVAC system should be sized to respond to actual loads as opposed to rules-of-thumb. For example, actual connected lighting load will most likely be around 1 watt per square foot, not the older general rule-of-thumb of 2.5 watts per square foot. The plug load of the building should be calculated on actual as used load versus the name plate rating of equipment, which only tells the start-up spike load. This translates into the difference between 3 to 5 watts per square foot for name plate load and the actual average load of 0.8 watts per square foot. This is called right sizing of mechanical systems. Oversizing equipment results in higher energy use and operating cost.

4.11 The HVAC system should be designed to operate most efficiently at average loads, not peak loads. Peak load is a condition that occurs typically less than 5 percent of operating time. The system should be most efficient during the greatest number of operating hours. Part loads should be handled by designing a system that can be dispatched in incremental adjustments.

4.12 Specify a maximum 75 $^{o}$ F indoor temperature to minimize degredation of indoor air quality (IAQ). Heat increases the chemical off-gassing from man-made and natural materials.

4.13 Use a variety of different HVAC systems adapted to different conditions throughout the building. The south facade of the building may benefit from a passive solar approach while the north side will be more dependent on mechanical supply. It is possible that the computer rooms will require compressor-type air conditioning. A narrower wing of the building may more effectively use natural ventilation while broader areas need a duct system.

**Moderate Cost**

4.14 Use ground water geothermal heat pumps as an energy resource. This can eliminate the chiller/tower by using the consistent temperature of the ground water to supply a steady source of energy for heating and cooling.

4.15 Use active or passive solar collectors to provide all, or a large percentage of domestic hot water; however, using the waste heat from the building systems is often more cost effective.

4.16 Use solar panels to pre-heat ventilation air. Fresh air can be efficiently heated by drawing the air through small holes on a black metal panel that is exposed to the sun.

4.17 Use occupancy sensors in each space to control heating and cooling water loops. These sensors will vary the flow depending on the number of people in the vicinity of the sensor. $CO_2$ sensors are not appropriate for this application.

4.18 Use radiant heated and cooled concrete slabs or radiant ceiling panels. Delivery of energy by radiant means is usually more comfortable and efficient than by ducted air. Radiant systems require a climate with relatively low humidity or systems to control condensation.

4.19 Investigate the potential efficiencies of electric and thermal energy co-generation using absorption chillers. Co-generation systems use the waste heat produced when generating electricity to provide energy for other purposes such as thermal conditioning and domestic hot water.

**High Cost**

4.20 Utilize power from a shared central plant (PSCO steam). If this option is available the efficiencies can be considerable.

4.21 Use ground water geothermal heat pumps. (Refer to 4.14)

# 5. MATERIALS

## Low Cost

5.1 Optimize design efficiency to use smaller spaces and a minimum quantity of materials. Materials should be durable and minimize life cycle repair costs. Select materials to allow for flexible uses and future adaptability.

5.2 An approximate determination of which materials are best for the project and the environment can be easily ascertained. Two basic issues to consider are the embodied energy and the environmental impact of pollutants generated during the manufacturing process and installation process. Specify materials that have low environmental impact and resource utilization. Consider the amount of energy required to extract raw materials, the manufacturing process, the transportation of the finished material, maintenance requirements, and the material's potential to be recycled.

5.3 Specify materials that provide a safe, comfortable, and healthy indoor environment. The chemical composition of materials should be analyzed for the potential of harmful off gassing as well as their propensity to collect and disperse pollutants.

5.4 Develop selection criteria to evaluate and to compare the environmental impact of materials. Develop a performance matrix to compare the various criteria determined to be of importance for each project. Material selection should emphasize durability, maintainability, flexibility, material renewability, low embodied energy, and recycled content.

5.5 Avoid using assemblies and sub-assemblies that cannot be efficiently removed for reuse and recycling purposes.

5.6 Investigate the use of new agricultural-based construction materials. Wood and paper are agricultural products that have traditionally been used in construction. New products are available that use agricultural by-products or renewable crops to make construction materials. Wall systems using compressed straw are currently used for commercial partitions as well as composite hardboards from agricultural by-products.

5.7 Minimize construction waste. This can be done through efficient purchasing of materials, using scrap materials for other parts of the job, rejoining scrap materials into whole pieces (i.e. finger jointed studs), and requesting manufacturers to minimize packaging. Also, pre-fabrication of building components in a factory environment controls construction waste more efficiently.

5.8 Use wood products derived from certified sustainably-managed forests. Use engineered woods for rough framing and veneer plywood for finish materials. Do not use solid dimension hardwoods and softwood lumber unless absolutely necessary.

5.9 Resurface and replace materials and equipment only as necessary. Repair equipment and reuse materials to minimize environmental impact.

**Moderate Cost**

5.10 Use exposed concrete in the interior of the building. Exposed concrete can also functions as a durable, acoustically-appropriate finish material. In addition, concrete does not contribute to poor indoor air quality.

5.11 Plan buildings for 100 years of service. The building should be planned to be durable and adaptable to changing space requirements.

5.12 Consider reusable systems. Select systems that can adapt to anticipated change versus planned obsolescence and replacement Select building systems (communications, data, HVAC, lighting) that can be relocated and reconfigured by unskilled workers.

5.13 Utilize a raised floor system for direct, or point-to-point, wire management. Raised floors are the most flexible systems for ease of wire management. Coupling the productivity benefits of individually-controlled HVAC systems with the flexibility of altering workstations gives greater cost and benefit justification for a raised floor system.

**High Cost**

No recommendations.

# 6. INDOOR AIR QUALITY

## Low Cost

6.1 Select materials to maximize indoor air quality (IAQ). The composition of materials should be analyzed for the potential of harmful off gassing as well as their propensity to collect and disperse pollutants. Materials containing toxic chemicals, carcinogens and mutagens should be avoided. Specify materials that provide a safe, comfortable, and healthy indoor environment.

6.2 Avoid fleecy materials that collect particulate matter. These are known as pollution sinks.

6.3 Use cleanable surfaces to facilitate removal of particulates and other pollutants.

6.4 Use contract specifications that make the maintenance contractor and the building operator responsible for indoor air quality.

6.5 Air out buildings before occupancy. The air out process should start as early as possible. Do not heat the building warmer than normal (bake-out); only ventilate with filtered outdoor air to remove the more volatile chemicals from the building before they settle on building surfaces.

6.6 Isolate mechanical systems during construction to avoid contamination, i.e., close off ducts and mechanical equipment to keep them clean.

6.7 Maintain and clean ducts on a regular basis. Use shorter ducts to minimize the cleaning effort.

6.8 Use a plenum floor (or raised floor) for air distribution because it is easy to clean and facilitate maintenance of indoor air quality

6.9 Evaluate maintenance products and services for their contribution to IAQ. Toxic maintenance products and improper applications of some products can seriously impair IAQ.

6.10 Locate air intake vents away from pollution sources and exhaust air.

6.11 Filters for outside air must be effective and properly maintained. Outdoor air, as well as indoor air, may contain particulates and pollutants.

6.12 Provide continuous ventilation and operable windows. (Refer to 3.6)

6.13 Establish an air quality maintenance plan and respond to occupant complaints. It is a good business practice to assure building occupants that the building management is interested in their well being.

6.14 Monitor IAQ continuously or on a scheduled periodic basis. There is debate about how often one needs to evaluate the quality of the indoor air. Certainly it should be done at least once every heating and cooling season.

Prohibit smoking in the building or at entrances. Environmental tobacco smoke is the one IAQ issue that has been definitively identified as a danger to health. No exceptions should be made. Even smoking rooms are not able to totally isolate smoke. Smoke at entrances is sucked into the interior and confronts visitors as they enter the building.

**Moderate Cost**.

6.15 Isolate air distribution systems by floor. This helps control dispersal of contaminants and allows other floors to operate if there is a problem (or construction) on one floor.

6.16 Phase construction processes so that finish materials do not absorb dust and toxic or chemical odors from other construction activities. For example, do not install wall covering or carpeting before using chemicals for the installation of other materials or performing a construction activity that produces airborne particles (i.e., drywall sanding).

6.17 Control point source pollution from indoor equipment and activities. Particulate and chemical emissions from computer equipment, laser printers, and other process machinery should be removed from occupied spaces by exhaust systems or prevented from entering occupied space.

**High Cost**

6.18 Provide closed file storage to minimize dust other indoor air quality concerns associated with exposed paper storage and open shelving.

6.19 Control point source pollution from indoor equipment and activities as described in 6.17; however, related environmental controls may require high cost expenditures.

## 7. WATER UTILIZATION

### Low Cost

7.1 Use low water consuming toilets in high use areas.

7.2 Use low flow faucets with infrared on-off valves (no touch). Infrared control valves have proven to be cost-effective for maintenance and water consumption.

### Moderate Cost

7.3 Use low water consuming toilets throughout building.

7.4 Use low flow faucets with infrared on-off valves (no touch).

7.5 Use impervious paving materials and roof drains with storm water collection systems for storm water management and to provide water for irrigation.

### High Cost

7.6 Use a separate gray water system to supply toilets. Low flow toilets and low water consuming toilets may preclude this strategy.

## 8. OCCUPANT PRODUCTIVITY

### Low Cost

8.1 Use computer modeling to assure the lighting design will produce balanced daylighting and artificial lighting that provides glare free and low contrast light.

8.2 Emphasize occupant comfort in areas of thermal control, air movement, and acoustic control. Thermal control and air movement can be addressed by increasing the number of zones in the HVAC system on each floor. Open and closed office systems may suffer from air stagnation and temperature differences if occupants change wall and partition configurations without reanalyzing the HVAC system. Designers are usually not contracted to analyze and control the acoustic environment.

8.3 Reduce ambient illumination levels below the standard 55 foot-candle criteria by using separate ambient and task lighting. Reduce lighting levels in corridors and other non-work spaces. Environments with diverse lighting levels are more interesting and reduce energy consumption.

8.4 Design lighting and work area spaces to be modular. Modular spaces minimize disruption when reconfiguring workplaces as well as provide an efficient distribution of light without high level or general area illumination.

### Moderate Cost

8.5 Use systems that allow individuals to control their immediate environment. Examples include: operable windows, personal HVAC controls, and flexible lighting scenarios at each workstation. Individually controlled environments have been demonstrated to significantly increase productivity (16% improvement in one study), and increase the comfort of the staff.

8.6 Provide adequate work space for each individual. One size does not fit all. Work space should accommodate individual methods and specific task requirements.

8.7 Provide flat panel computer screens for visual acuity, reduced electronic emissions, and reduced space requirements.

### High Cost

8.8 Provide a view to the outside for all building occupants. A majority of people spend their daylight hours working inside buildings separated from nature and natural processes. Provide a view that links occupants to nature, the time of day, and the weather should be provided.

# 9. FACILITY OPERATIONS

## Low Cost

9.1 Plan for the evaluation and adjustment of every system in the entire building. This should be repeated for each thermal season to assure that all systems are functioning at peak efficiency.

9.2 Provide thorough Operation & Maintenance (O&M) Manuals so that all procedures and standards are communicated to the building engineering staff. Understanding standard building engineering practice is not, in itself, enough to understand the unique requirements of individual buildings that are designed to function with resource efficient techniques.

9.3 Formalize the training of O&M staff. Videotape all O&M training for future training sessions and refreshment of existing staff's knowledge.

9.4 Include a five-year estimated operating cost in design and construction budgets. Include design fees to analyze consumption and maintenance alternatives.

9.5 Respond quickly and follow up on occupant complaints. Proactively address potential for IAQ litigation. A quick response assures occupants that the operator is interested in their comfort

9.6 Consider cleaning and maintenance as an issue of building environment control. Contamination from dirt brought into a building by foot traffic, particulates on fabrics and carpeting, and toxins in standard cleaning chemicals can be mitigated by a maintenance and cleaning practice that emphasizes prevention.

9.7 Develop preventative maintenance plans that anticipate maintenance problems and respond immediately to problems that surface unexpectedly.

9.8 Provide adequate tools for maintenance. The affect of cleaning and maintenance on the useful life of the building and the health of the occupants provides reason for providing the systems and tools to make these efforts more effective.

9.9 Recycle and track all toxic chemicals used in buildings to increase safety and reduce liability.

9.10 Design systems for ease of maintenance. Ducts, plumbing, and mechanical equipment should be easily accessed for cleaning and servicing. Wiring should be modular and easily changed. The durability of materials and systems should be considered along with maintenance requirements and procedures.

9.11 Monitor energy consumption to measure and verify maintenance and energy saving equipment against previous benchmarks.

**Moderate Cost**

9.12 Require periodic post occupancy evaluation monitoring of all building systems.

9.13 Provide an on-line diagnostic database for equipment and systems. This is similar to what care manufacturers provide to allow service centers to easily diagnose problems.

9.14 Budget for upgrading for building operations to incorporate future technology and improved processes.

9.15 Include O&M criteria in the facility program. Incorporate the O&M staff review in the design process.

9.16 Comply with the ventilation requirements addressed in ASHRAE 62 during design, construction, maintenance and operation.

**High Cost**

No recommendations.

## 10. CONSTRUCTION

### Low Cost

10.1 Prepare a construction work management plan. Excess material and construction waste should be utilized or recycled instead of thrown in a landfill.

10.2 Protect porous materials from moisture and dust during construction to minimize indoor air quality problems from particulates and microbial growth.

10.3 Track and manage the use of toxic construction materials to increase safety and minimize liability.

10.4 Reduce soil compaction and maintain the absorption and aeration capacity of the site by only allowing heavy equipment and foot traffic in designated areas.

10.5 Avoid contamination of HVAC equipment and duct work. Do not use the systems during construction, if unavoidable, provide and frequently change proper filters. Clean equipment and ductwork as part of commissioning process.

10.6 Encourage the use of local materials to reduce energy consumption for transportation and to support the local economy.

10.7 Cleanup dust and debris daily to protect the environment and facilitate recycling.

10.8 Minimize change order and material substitution in order to adhere to the integrated intent of the *Green Buildings* systems and features. One change can breakdown the interrelationships of integrated *Green Building* systems.

10.9 Use infrared thermography to analyze the efficiency of the building envelope. Air, water and thermal leaks can be detected with this technique.

### Moderate Cost

10.10 Phase construction processes so that materials do not absorb dust, toxic chemicals, and odors from other construction activities.

10.11 Provide accurate as-built drawings, detailed photographs of enclosed construction, and design assumptions and calculations to facilitate future maintenance and renovation activity and increase the useful life of facility components..

**High Cost**

No recommendations.

# Section II
## Design Programming Sample Language

# Design Programming Sample Language

*The following text is guidance for GSA Project Managers who choose to incorporate this report's recommended concepts into design programming directives for capital construction projects. It is prepared in a format that will allow incorporation into the project's Prospectus Development Study (the planning document GSA uses to represent capital project requirements).*

*Note: Text within [square brackets] is provided as suggested optional program direction.*

# GENERAL BUILDING REQUIREMENT

## Integrated Sustainable Design:

This project shall include a comprehensive application of design principles that will result in an environmentally-sustainable (green) building. This will require the integration of various systems, materials and technologies into design solutions to minimize negative environmental impact, and maximize features that conserve natural resources.

The functional objectives typically associated with sustainable architecture (*Green Buildings* design) are addressed within the *Green Courthouse Design Concepts* report, Section I. They include:

1. Site and Transportation
2. Energy -- Building Design
3. Energy -- Heating, Cooling and Ventilation
4. Energy -- Electricity
5. Materials
6. Indoor Air Quality
7. Water Utilization
8. Occupant Productivity
9. Facility Operations
10. Construction

Prior to developing the three preliminary concept schemes, the A/E shall conduct a one- or two-day design charrette to identify and integrate green building technologies into building systems and features. This charrette shall take place with the design leaders from each member of the design team. [The A/E will include, as part of the design team, an expert in the application of sustainable concepts.] The purpose of the charrette is to provide an opportunity for the composite design team to exchange ideas and information to achieve comprehensive and truly integrated solutions.

## Functional Objective:

Sustainability

## Performance Requirement:

*Note to specifier -- Consider which of the following may be most appropriate, applying both if additional emphasis is desired.*

[The A/E shall adopt, to the maximum extent practical, the recommendations associated with "Low" cost concepts and practices listed in Section 1 of the "*Green Courthouse Design Concepts* report." This will be in addition to the requirements within GSA's "Facilities Standards for the Public Buildings Service" (PBS PQ100.x) and local building codes. The A/E shall also conduct benefit-cost analyses of the panel's recommended "Moderate" and "High" cost concepts, adopting those as directed by GSA.]

[The project shall be developed to allow certification by the U.S. Green Buildings Council, using the latest version of the "Leadership in Energy and Environmental Design" (LEED) rating system.]

## Design Direction:

The A/E shall identify the recommended "Low" cost concepts and practices that have been adopted in each of the three preliminary concept proposals. The A/E shall document anticipated qualitative benefits and any perceived unusual cost impacts that the adopted concepts have on the project. The A/E shall also identify the "Low" cost concepts that have not been adopted and explain why they are inappropriate.

At the Design Development submission, the A/E shall provide benefit and life cycle cost analyses for [5][10][15] of the Panel recommended "Moderate" and/or "High" cost concepts. The specific concepts to be evaluated shall be defined immediately after the Final Design Concept submission. While the A/E is expected to suggest recommended concepts for study, GSA may choose other concepts, whether or not contained in the Panel's report.

The A/E shall document those commissioning and building turnover tasks that are required to effectively deliver each applied green buildings technology.

Operation and Maintenance manuals developed for this project shall include descriptions of practices necessary to insure efficient and cost effective performance of all green buildings features.

[The A/E shall conduct a LEED self-certification check to identify the level of compliance and achieved rating level.]

As certain innovative green buildings features may be unclear as to cost impact, the A/E may be expected to reflect GSA accepted features as construction contract “Bid Alternates.” Design A/E professional services contract modifications will be considered should the concepts require special study and/or supplemental design representation.

## Trade-Offs:

There will be instances where optimization of one concept will compromise the functionality of another. The design A/E shall work to avoid these conflicts, even though this may mean not achieving maximum possible benefits from individual building technologies.

## Required Analysis:

Energy-related use, cost impacts, and all life cycle cost assessments shall employ those computer based tools and methodologies as reflected within *Facilities Standards for the Public Building Service, PBS-PQ100.x.*

## References:

The A/E is expected to obtain and be familiar with the following documents:

*Greening Federal Facilities, An Energy and Environmental Resource Guide for Federal Facilities Managers*, Issued by the DOE Federal Energy Management Program and available from the Energy Efficiency and Renewable Energy Clearinghouse (800) 363-3732

*Sustainable Buildings Handbook*, EPA, DOE. Public Technology, Inc. and U.S. Green Buildings Council, Available from the Green Building Council, 90 New Montgomery Street, Suite 1001, San Francisco, CA 94105.

# Appendix

# AGENDA

GSA GREEN BUILDINGS PANEL

NOVEMBER 14, 1996

The meeting will convene at 8:00 a.m. (a continental breakfast will be available at 7:30 a.m.) in the Judicial Conference Center, Thurgood Marshall Federal Judiciary Building, One Columbus Circle, NE, Washington, DC.

1. Introductions
   *David A. Harris, President, National Institute of Building Sciences*

2. Welcome and Opening Remarks
   *Robert Peck, Commissioner, Public Buildings Service*

3. Charge to the Panel and Introduction of Facilitator
   *John Petkewich, Assistant Commissioner, PBS*

4. Introduction of Panel Members & Goals and Structure of Meeting
   *William Reed, Facilitator*

5. Project Briefing
   *Curt Dale, Anderson Mason Dale*
   *Mike Holtz, Architectural Energy Corporation*

6. Panelists recommendations of G*reen Building* strategies grouped within the following categories:
   - 6.1 Site and Transportation Issues
   - 6.2 Energy
   - 6.3 Materials
   - 6.4 Indoor Air Quality
   - 6.5 Water Conservation and Quality
   - 6.6 Occupant Productivity (Technical and Management Issues)
   - 6.7 Facility Operations

   Categorize recommendations into the following three groupings based on first costs of *Green Building* concepts:
   - A. No/low first cost
   - B. Moderate cost
   - C. Higher cost/innovative

7. Rate the benefits and practicality of recommendations.

8. Group the most significant recommendations into integrated packages for consideration and further study by GSA.

9. Summary Discussion
   - 9.1 Alternative approaches to GSA procurement of *Green Buildings*.
   - 9.2 Steps to insure the incorporation of *Green Buildings* concepts.

10. Closing Remarks

*John Petkewich, Assistant Commissioner, PBS*

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