EPA's Green Future for Laboratories

A Case Study Of the Kansas City Science & Technology Center

Kansas City Science & Technology Center
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Introduction

Kansas City, Kansas, has a new green building that's going for the gold. The U.S. Environmental Protection Agency's (EPA) Region 7 laboratory, known as the Kansas City Science & Technology Center (KCSTC), is applying for a Gold Level sustainable design rating from the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED™) program. For more than 7 years, a dedicated team of individuals and agencies has pursued a sustainable approach to the development and construction of this new laboratory facility.

The Center is one of 10 EPA regional laboratories throughout the country that provide monitoring, analytical support, and data assessments. In the mid-1990s, EPA realized that effective implementation of the Kansas City laboratory's mission was no longer feasible in its existing location, which it had occupied for 30 years.

In deciding to construct and occupy a new laboratory building, EPA incorporated lessons it learned when successfully designing and building its Region 7 headquarters office building in 1999. That project showcased many green features and strategies that could be incorporated in the construction and operation of the regional lab. More information about the Region 7 green office building project can be found at <www.epa.gov/region7/p2/offtheshelf>.

Native flower insets on main lobby desk.




Kansas City Science & Technology Center Acquisition, Development, & Construction Team

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- **CB Richard Ellis** (developer/owner): www.cbre.com
- **The Clark Enerson Partners** (architect/engineers of record): www.tcep.net
- **Commercial Mechanical, Inc.** (mechanical subcontractor): www.cmidiv15.com
- **EPA Headquarters Facilities Management Services Division** (planning, aquisition, project management): www.epa.gov/greeningepa
- **EPA Region 7 Environmental Services Division; Air, RCRA and Toxics Division; Office of Policy and Management** (tenant planning/construction review): www.epa.gov/region07/p2/r7lab.htm
- **Hoefer Wysocki Architects** (design architect): www.hwa.net
- **Koll Construction** (design builder/LEED™ certification coordinator): www.kollconstruction.com
- **Lillie & Company** (commissioning agent): www.lillienco.com
- **SKCE Electric, Inc. (a Faith Technologies, Inc. company)** (electrical subcontractor): www.webrytesolutions.com/skce/home.htm
- **Unified Government of Wyandotte County, Kansas City, Kansas** (land donor): www.wycokck.org
- **U.S. General Services Administration (GSA) Region 6** (acquisition, project management): www.gsa.gov/portal

A typical laboratory uses far more energy and water per square foot than a typical office building because of intensive ventilation requirements and other health and safety concerns. This project employed as many energy, resource, and water-efficient features as possible in its design and construction to preserve natural resources, ensure occupancy health, and serve as a model for future laboratory design.

The construction and operation of the Kansas City Science & Technology Center was contracted as a build-to-suit facility with a 20-year lease. As such, EPA and GSA selected the development team through a design competition and source selection process conducted in two stages. First, teams consisting of a developer/owner, design builder, and architect/engineer submitted a general qualifications bid for designing and constructing a green laboratory.

Then, EPA and GSA selected four teams to move forward with an actual building proposal based on the Solicitation for Offers (SFO). All bids required a narrative explaining why particular architecture, sustainability, and energy-efficient features were chosen, and how they would reduce resource use in construction and building operation. The U.S. Green Building Council's LEED™ program provided the framework for measuring achievements in each of these elements.

KCSTC Vital Statistics

Site:	Brownfield redevelopment site
Access:	Two blocks from EPA's Region 7 Office and on Metro bus line
Size:	72,100 gross square feet
Occupancy:	Up to 75 occupants
Completion:	Spring 2003




Green Features Requested in the SFO

The SFO included the following language to ensure that construction features and the facility's operation would promote energy efficiency, water conservation, and environmentally preferable materials and design. The SFO also called for the project to be LEED™ certified, as explained on the next page.

Energy Efficiency

- Consideration of building siting
- Passive solar design approaches
- Use of energy-efficient lighting
- Daylighting
- Energy-efficient building shell design
- Low-energy glass
- Efficient mechanical systems
- Minimization of waste energy
- Recapture of waste energy streams
- Renewable/innovative energy sources
- Technologically advanced building and mechanical control systems
- Energy modeling conducted upon completion of design to identify additional conservation options

Water Conservation

- Low-flow plumbing fixtures
- Water-efficient mechanical system design
- Landscape design using native species
- Minimal water for irrigation (e.g. drip system)
- Building site that considers water use, retention, and reuse

Resource Conservation

- Use of materials with recycled content at or above average recycled content percentages according to LEED™
- Use of materials that are manufactured, packaged, or transported in a way that reduces energy or material expenditures
- Construction period recycling and waste minimization
- Designing, building, and operating the building to accommodate EPA's active recycling program

Protection of the Ozone Layer

- Avoidance of chlorofluorocarbons (CFCs) as refrigerants
- Avoidance of blowing agents for insulation

Support of Sustainable Forestry Practices

- No consumptive use of endangered rainforest species
- Wood products from certified sustainable sources

Protection of Human Health

- Use of non-leaded paints
- Provision of plumbing systems that prevent elevated lead levels in water

Indoor Air Quality

- Careful placement of exhaust and air intakes to prevent cross-contamination
- Consideration regarding radon in the building
- Protection of the heating and cooling (HVAC) system during construction
- Use of low volatile organic compound (VOC) adhesives, paints, sealants, and caulks
- Construction period installation sequencing
- Sensitive janitorial and cleaning approaches during the building's operating life
- No use of asbestos or asbestos-containing materials

Final Design: The LEED™ Scorecard for KCSTC

U.S. Green Building Council LEED™ System

Leadership in Energy and Environmental Design (LEED™) is a green building rating system developed by the U.S. Green Building Council. The goal of LEED™ is to encourage design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants based on existing, proven technologies.

LEED™ certification is achieved through a rating system that evaluates: sustainable site planning; the safeguarding of water and water efficiency; energy efficiency and renewable energy; conservation of materials and resources; and indoor environmental quality. Applicants receive one to two points for achievement in each of 69 subcategories. See the KCSTC LEED™ scorecard on page 6.

LEED™ has four levels of certification: LEED™ Certified (26 to 32 points); Silver Level (33 to 38 points); Gold Level (39 to 51 points); and Platinum Level (52 to 69 points). More information about LEED™ can be found at <www.usgbc.org/LEED/LEED_main.asp>.

The KCSTC will apply for 46 points, a Gold Level rating using the LEED™ version 2.0 Scorecard that is being submitted for approval (see page 6).

Some of the most notable features of the building are described in more detail on the following pages.

Lessons Learned

Including green building attributes and LEED™ certification requirements from the start ensured an environmental focus throughout the project.

Major benefits resulted from having the Construction Superintendent acquire LEED™ Accredited Professional credentials, because he was responsible for LEED™ documentaion and for reviewing all subcontractor material for "green" content.

Collecting data at each phase of construction was the least costly and most efficient method to attain LEED™ certification.

The Submitted LEED™ Scorecard for the KCSTC

46		23	**Total Project Score**	Possible Points 69

Certified 26 to 32 points Silver 33 to 38 points Gold 39 to 51 points Platinum 52 or more points

Sustainable Sites — Possible Points 14

Y	?	N			
Y			Prereq 1	**Erosion & Sedimentation Control**	0
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Urban Redevelopment**	1
1			Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
1			Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
1			Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
1			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Water Efficiency — Possible Points 5

Y	?	N			
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
1			Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
		1	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Energy & Atmosphere — Possible Points 17

Y	?	N			
Y			Prereq 1	**Fundamental Building Systems Commissioning**	0
Y			Prereq 2	**Minimum Energy Performance**	0
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	0
2			Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2
2			Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2
2			Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2
1		1	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2
		2	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Additional Commissioning**	1
1			Credit 4	**Ozone Depletion**	1
		1	Credit 5	**Measurement & Verification**	1
		1	Credit 6	**Green Power**	1

Materials & Resources — Possible Points 13

Y	?	N			
Y			Prereq 1	**Storage & Collection of Recyclables**	0
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Shell	1
		1	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1			Credit 2.1	**Construction Waste Management**, Divert 50%	1
1			Credit 2.2	**Construction Waste Management**, Divert 75%	1
		1	Credit 3.1	**Resource Reuse**, Specify 5%	1
		1	Credit 3.2	**Resource Reuse**, Specify 10%	1
1			Credit 4.1	**Recycled Content**, Specify 25%	1
1			Credit 4.2	**Recycled Content**, Specify 50%	1
1			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1			Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1

Indoor Environmental Quality — Possible Points 15

Y	?	N			
Y			Prereq 1	**Minimum IAQ Performance**	0
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	0
1			Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
		1	Credit 2	**Increase Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
		1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		1	Credit 6.1	**Controllability of Systems**, Perimeter	1
1			Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
1			Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
1			Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
		1	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Innovation & Design Process — Possible Points 5

Y	?	N			
1			Credit 1.1	**Innovation in Design**: Recycle Content - Achieved 107%	1
1			Credit 1.2	**Innovation in Design**: Local/Regional Materials - Achieved 76%	1
1			Credit 1.3	**Innovation in Design**: Energy Recovery Technology	1
1			Credit 1.4	**Innovation in Design**: Variable Speed Drive Technology	1
1			Credit 2	**LEED™ Accredited Professional**	1

Energy

Energy efficiency was one of the primary goals for the design of the KCSTC, and every effort was made to incorporate energy-efficient design systems into all aspects of construction and operation.

Energy Modeling

After EPA and GSA chose a design/build team, preliminary designs were run through an energy model (DOE-2) to compare energy savings of the design to a "normal" (compliant with ASHRAE/IESNA Standard 90.1-1999 Energy Standard for Buildings) building and to determine additional measures that could be incorporated into the lab for improved energy efficiency. Based on the results (which already showed 38 percent reduced energy costs and 44 percent reduced energy use over an ASHRAE 90.1-1999 compliant building), a number of additional energy conservation measures were incorporated, including:

Overhead snorkels and VAV fume hood.

- Replacement of laboratory canopy hoods with smaller, variable air volume (VAV) fume hoods.
- Use of carbon dioxide sensors in the conference, lunch, and reception areas ensure that air flow is increased only when necessary to accommodate additional people in these rooms.
- Addition of a plate and frame heat exchanger to the cooling tower condensing water system, which reduces energy demand for special laboratory equipment.

Energy-Efficient HVAC System

The KCSTC heating, air conditioning and ventilation system (HVAC) includes the following energy-efficient design features:

- Five modular natural gas-fired boilers, which are more efficient than one traditional mega-boiler, because individual smaller boilers are automatically activated as heat demand increases.
- Three small, water-cooled chillers, including one primary variable-speed chiller; one chiller/condenser that employs water heat recovery from other systems to keep laboratory temperatures constant when increased air flow is required; and one back-up chiller that can be activated as needed (e.g., with building expansion).
- VAV and cooling systems activated by conference room and common space carbon dioxide sensors.
- Programmable thermostats.

Plate and frame heat exchanger.

Small water-cooled chillers.




Current modeling predicts the KCSTC will use approximately 270,000 BTUs of energy per gross square foot per year, which translates to a 46.8 percent savings over a "normal" energy-efficient building.

The following table compares nine categories of energy use and shows how the KCSTC can save 16,496,670,000 BTUs per year compared to the estimated consumption of a comparable conventional facility without the same energy-efficient features.

Anticipated Annual Delivered Energy Savings Attributable to the Green Design of the KCSTC

(Baseline=constant volume HVAC system)

Category	Energy Type	"Normal" Building (1000's of BTU)	KCSTC (1000's of BTU)	Energy Savings
Cooling towers	Electric	766,621	309,173	60%
Fans (interior ventilation)	Electric	7,158,583	2,618,662	63%
Interior lighting	Electric	1,202,383	1,244,073	-4%
Exterior lighting	Electric	40,362	40,632	0%
Office equipment	Electric	1,453,276	1,453,276	0%
Pumps	Electric	839,250	543,302	35%
Space cooling	Electric	3,196,015	1,505,365	53%
Space heating	Electric	38,959	34,168	12%
Space heating	Gas	20,283,300	10,841,600	47%
Water heating	Gas	724,200	616,300	15%
Total		**35,702,950**	**19,206,280***	**54% (46.8%**)**

* *SOURCE: LEED™ Credit 1.2 Optimize Energy Performance, 30 percent supporting documentation prepared by Fred Porter, Architectural Energy Corporation, April 3, 2002.*

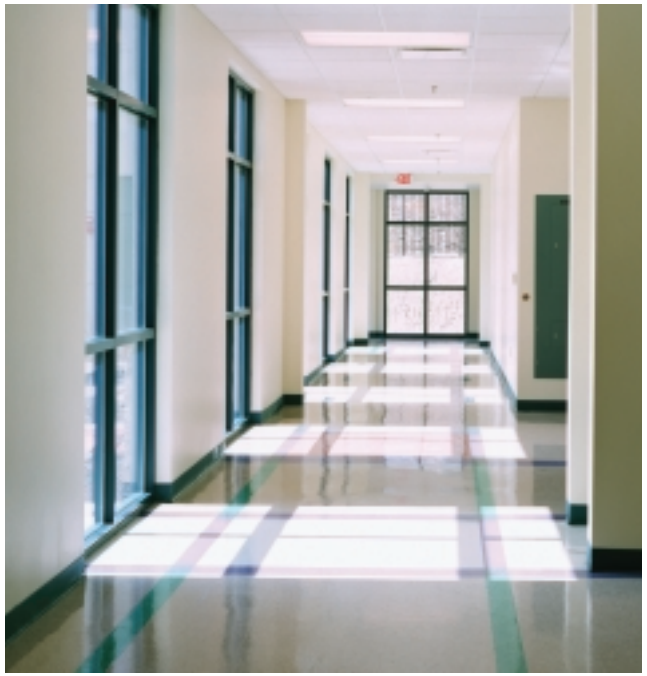
** *Reduction per LEED™ Modeling Protocol for unregulated or plug electrical loads.*

Daylighting and Energy-Efficient Lamps

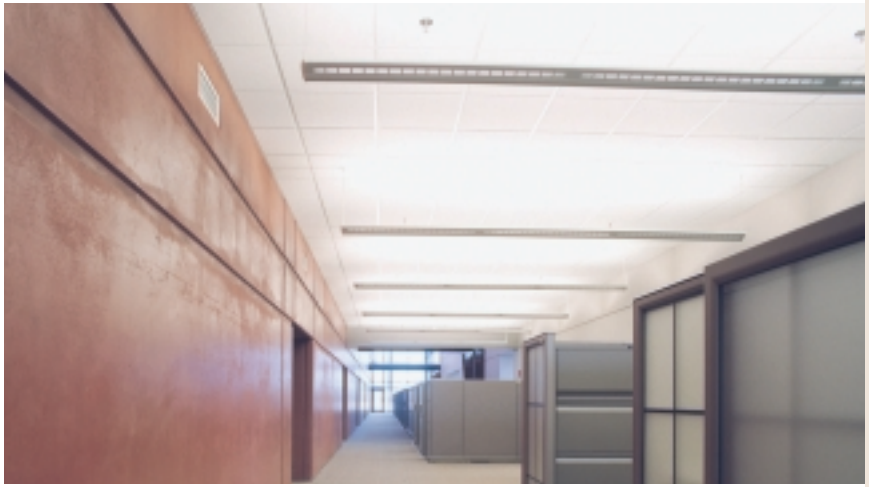
Incorporating an energy-efficient lighting scheme was accomplished through the use of:

- Low-energy glass for all windows.
- Energy-efficient T-5 and halogen lamps for indirect lighting and T-8 lamps for direct lighting.
- Motion-detector lights installed in laboratories.
- A high-ceiling, open-bay office with large clerestory windows to allow natural light into the building.

Clerestory windows provide natural daylighting to open bay offices.



Laboratory corridor with abundant natural daylighting and views of landscaped courtyard.



Pendant light fixtures, providing direct and indirect lighting to second floor open bay offices.




Resource Conservation

The design and construction of the KCSTC took energy efficiency and resource conservation a step further by looking outside the walls of the building for other innovative environmental initiatives.

Materials

Considering all sources of environmental impact from the construction of the KCSTC, the design/build team placed the highest priority on obtaining materials locally. Local materials use minimizes fuel consumption and transportation costs, while stimulating the local economy. Approximately 76 percent of construction and furnishing materials were obtained from within a 500-mile radius of the site.

Transportation

Alternative transportation options have also been accommodated in the design of the KCSTC. Electric car recharging stations, designated car pool parking spaces, bicycle storage, and a shower facility are all located at the building. In addition to these building-specific features, the site is accessible to Kansas City's Metro bus service, further reducing the energy consumed by employees and visitors to the building.

Main entrance under construction.

Electric car recharging station in north parking lot.

Recycling

Construction activities typically generate solid waste (an estimated 28 percent of landfill material in the United States), but much of this is "clean waste" and easily recyclable. In keeping with the mission of reducing resource use in any way possible, construction of the KCSTC was completed with a comprehensive Construction Waste Recycling Plan for concrete, metals, wood, asphalt, and paper.

In addition to training all demolition and construction workers about the recycling plan, the general contractor implemented a cost incentive program for construction waste recycling. All materials placed in the onsite, labeled recycling bins were accepted without charge to the subcontractors. On the other hand, all materials placed in the general refuse bin were subject to a cost-per-ton fee that was charged to the subcontractor's account.

The following table shows some of the materials recycled during the construction of the KCSTC. In addition to conventional recycling, asphalt paving cleared from the original site was milled and reused later as backfill, saving landfill, transportation, and disposal costs.

THE KCSTC'S RECYCLING PLAN DIVERTED 72 PERCENT OF CONSTRUCTION DEBRIS FROM LANDFILLS.

Estimated Amount of Materials Recycled During Construction of the KCSTC

Materials	Amounts (tons)	Percent of Waste Stream by Volume
Concrete	630	68%
Rebar and steel	17	2%
Non-treated wood	18	2%
Total recycled material	665	72%




To conserve resources and support recycling within the building industry, the construction and furnishing of the KCSTC included numerous materials with high recycled content. In fact, so many materials exceed above-average recycled content that the lab expects to receive credit through LEED™ for 107 percent recycled content materials use. (LEED™ adds additional percentage points to projects exceeding 50 percent recycled content.) Examples of some of the recycled content products incorporated into the KCSTC are shown in the following table.

Recycled content ceiling tiles.

Recycled content carpet.

Recycled content flooring.

Approximate Recycled Content of Materials Used for Construction and Furnishing of the KCSTC

Materials	Total Recovered Material (%)
Construction	
Concrete (fly-ash content by weight)	3%
Drywall	31%*
Insulation	25%*
Metal Studs	25%*
Rebar	90%
Reinforced Steel	90%
Structural Steel Joists	100%
Miscellaneous Steel	100%
Window Glass	20%
Furnishing	
Acoustic Ceiling Tile	65% to 70%
Carpet	25%
Ceramic Tile Flooring	70%

** Aggregate recycled content includes postconsumer and postindustrial materials.*

Water Conservation

The KCSTC was designed from the ground up with water conservation in mind. Low-flow plumbing fixtures and water-efficient landscaping are all employed to minimize water use. The HVAC system consumes the most water in the facility. To reduce this use of city-supplied potable water, the HVAC system is connected to a rooftop rainwater recapture system.

White pipes on right carry rain water drained from the roof.

Roof drains.

Rooftop Rainwater Recapture System

The KCSTC rooftop rainwater recapture system directs water from a portion of the roof into pipes that lead directly into a 1,500-gallon underground sediment tank near the building's mechanical room. There, the water is held so that any particulate matter can settle out. Following particulate removal, water flows from the top of the sediment tank into a 10,000-gallon, pre-cast concrete, fiberglass-lined underground tank just outside the building. Finally, a sump pump in the holding tank is used to supply the pressure tank, which provides graywater for toilet flushing, cooling tower makeup, and landscape faucets.

Based on Kansas City's average annual rainfall, the rooftop rainwater collection system is expected to supply approximately 763,000 gallons of water per year.

Pressurized holding tank for the rain water.




Landscaping

Xeriscaping is a landscape design concept used at the KCSTC that focuses on the use of native plants to reduce the need for watering and irrigation. It also considers soil types and employs the use of mulches to retain soil moisture. This sustainable landscaping design will also save money on landscape maintenance fees.

Future Water Conservation Measures

The KCSTC is already looking to innovate and improve water conservation even further. Discussions are underway to develop a de-ionized water recycling system so that less water will need to be used and processed for scientific procedures. In addition, there are plans to collect air handler condensate water to add to the rainwater storage tank for reuse throughout the building. Current projections indicate that 100 gallons of water per hour could be saved during peak (summer) cooling with this recapture system.

Indoor Air Quality

Occupancy health and comfort is of utmost importance to EPA. Great care was taken to ensure the highest indoor air quality in the KCSTC.

Low-VOC paint, adhesives, glues, carpet, and floor tiles were used for finishing the building. Sequencing the finishing and furnishing of the building was also essential to address indoor air quality. Nonabsorptive materials were installed first. Later, after chemical odors dissipated, absorptive materials such as carpet, ceiling tile, and furniture were installed. Finally, before occupancy, the HVAC system was flushed and new fresh air filters were installed.

During construction, the HVAC system and duct work were sealed on a daily basis to prevent infiltration of any dust, chemicals, or odors due to construction.

Separated utility corridor provides minimal disruption for maintenance of mechanical equipment, electrical, and plumbing for laboratories.




Compliance With Executive Orders

With the completion of the KCSTC, EPA has succeeded in leading by environmental example. The numerous environmentally friendly innovations and features incorporated into the building's design and construction highlight EPA's commitment to reducing natural resource use while providing functional, attractive space in which to carry out its mission. While accomplishing this task, EPA has also fulfilled its federal obligations under a number of environmental Executive Orders (E.O.s). The following is a summary of KCSTC compliance features:

E.O. 13101—Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition

- Specified environmental and recycling provisions in the SFO and design/build contract.
- Used recycled-content building materials, including ceramic tile flooring, structural steel and concrete, acoustic tile, window glass, aluminum frames, carpet, and gypsum.
- Developed a recycling plan for construction materials, including concrete, wood, steel, duct work, copper pipe, and paper. Milled and reused asphalt paving material as fill onsite.
- Avoided CFC-based refrigerants in building systems.
- Used low-VOC carpets, paints, adhesives, flooring, sealants, and furnishings.
- Accommodated storage and collection of recyclables (e.g., paper, glass, plastics) during occupancy.

E.O. 13149—Greening the Government Through Federal Fleet and Transportation Efficiency

- Provided electric vehicle recharging stations.

E.O. 13123—Greening the Government Through Efficient Energy Management

- Used energy-efficient lighting, including motion-detector lights, and energy-efficient T-5,T-8, and halogen lamps.
- Reduced the need for electric lighting by designing a high-ceiling, open-bay office with clerestory windows.
- Installed energy-efficient heating and cooling systems, including VAV ventilation systems for offices and laboratories, programmable thermostats, occupancy sensors, variable-speed drives on HVAC equipment, and VAV fume hoods.
- Installed ENERGY STAR® reflective roofing to reduce the cooling load for the building.
- Installed a rooftop rainwater recovery system.
- Installed low-flow plumbing fixtures in bathrooms.
- Used native landscaping/xeriscaping.

E.O. 13150—Federal Workforce Transportation

- Sited building close to Metro bus service.
- Designed car pool stations and designated car pool parking.
- Provided bike racks and shower facilities for commuters.

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