Low and Net Zero Energy Design Strategies for High Performance Sustainable Buildings

NASA Goddard Space Flight Center's Building 34

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The Exploration Sciences Building – B34

Background

- Goddard Space Flight Center's Building 34 is the first NASA sustainable facility with a major lab component.
- B34 is 200,000 gross sqft, 3 story office; 2 story laboratory facility, containing both research laboratories as well as office spaces.
- Laboratory space types range from "dry" electronics to "wet" chemistry functions.
- The lab block also contains 2,500 sqft of class 10,000 clean rooms.
- A centralized laboratory hazardous exhaust system allows for large variety of lab exhausting requirements to be met with a common system distributed throughout the lab block.
- Laboratory space accounts for a third of the building program.

LEED Gold Certification

B34 LEED points cover site development, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality.

- Site: Highly reflective coatings; storm water management; alternate parking (carpooling); site development capped an existing landfill with new parking lot.
- Water – Low flow; no irrigation, The signed LEED Letter Template and calculations demonstrate water use has been reduced by 21.47% through the use of low-flush water closets, low-flow lavatories and a low-flow kitchen sink.

LEED Gold Certification

- Energy and Atmosphere – The signed LEED Letter Template, summary tables, and energy modeling output demonstrated a 19.3% savings between the budget and design cases in comparison with ASHRAE 90.1-1999. Energy efficiency measures include a thermally efficient envelope, efficient lighting, high efficiency motors, fan speed control, low pressure loss HVAC design, and demand control ventilation.
- Materials and Resources – Regional materials, waste management, recycled materials.
- Indoor Environmental Quality – Low VOC's, increased airflow. Increased focus was placed on VOC's for the clean room airflows.
- Innovation in Design – Received two innovation of design points. Energy Efficient Convertible Lab Systems and Building Effluents Safety and Risk Management.

Saving Energy

Reuse of Conditioned Air

- B34 was energy modeled to show a 19.3% reduction in energy usage. This demonstrated a 19.3% savings between the budget and design cases in comparison with ASHRAE 90.1-1999.
- Non-Hazardous laboratory air is returned to air handlers and reused as supply air to hazardous areas that don't allow recycling of the air stream; (such as the wet chemistry areas).

Revise Air Change Rates for Hazardous Labs.

- Risk was assessed and ventilation rates optimized to conserve energy. This measure resulted in significant fan energy savings, plus the heating and cooling energy savings associated with conditioning less outside air.

Saving Energy

Low Pressure Loss HVAC Ductwork:

- Fan pressure is directly related to energy consumption. Oversized ductwork means less friction loss which translates into reduced energy usage. A major challenge of this is the coordination of the larger sized ductwork with the many other utilities within the building envelope.

Building Effluents Safety and Risk Management

- B34 project submitted a LEED innovation credit for Building Effluents Safety and Risk Management. The credit proposal required wind tunnel testing for the building and surrounding environment to analyze potential health and safety impacts on building occupants and neighboring areas.

Building Effluents Safety and Risk Management

- The team conducted wind tunnel testing of a 1:240 scale model of the building and surroundings within a 1,360 foot radius. Exhaust sources, both building generated and vehicle generated, were modeled under varying wind conditions. While most of the study sources posed no adverse conditions, four areas were noted as potential problem areas. The report presented recommendations for mitigation of the identified risks. Based on the findings of the wind-tunnel study, the laboratory exhaust stacks were increased to 25 feet. One air handling unit was relocated to the roof to avoid entrainment of diesel exhaust from the loading dock into the air intake.

Building Effluents Safety and Risk Management

- The documentation presented by the design team indicated a comprehensive design and analysis approach with measurable environmental and safety benefit, making this approach eligible for the award of an innovation point.

Centralized Hazardous Exhaust System

- This system allows for large quantity of lab exhausting requirements to be met within the lab block. Having individual exhaust systems for 70 lab spaces would not fit within the given building envelope and roof areas. A large centralized system common to all of the lab spaces allows for the best utilization of building space and the ultimate flexibly for the ever changing science operations in the buildings. The B34 system utilizes four large rooftop fans and is N+1 redundant by design. In practice due to the specific capacities of the equipment installed and fine tuning of the controls, enabled this system to operate at an N+2 redundancy. It's far less maintenance intensive to operate the four B34 fans verses multiple individual fans. This is the first system of its kind at GSFC. Project team worked with the customer group and Safety to determine the suitability and safety of this type of system for scientific research.

Centralized Hazardous Exhaust System

- The hazardous exhaust fan stacks were modeled for occupational safety and potential reduced energy use. This fan system was also designed for low pressure loss to maximize energy savings. The site, building, and its exhaust were “wind” modeled to ensure proper rooftop personnel safety and to determine the required exhaust airflow. This exhaust system was not designed to a set standard high velocity. The ability of the exhaust plume to leave the building envelope is a function of both mass and speed. The centralized system can allow for adequate mass to reduce the stack velocity. It’s the momentum of the air that’s allows the exhaust air stream to safely exit the exterior building space.

Centralized Hazardous Exhaust System

- LEED - The project submitted a narrative and additional energy modeling documentation that supported a $29,532 annual energy cost savings from the laboratory exhaust system. The documentation demonstrated a 5% energy cost reduction in comparison to the regulated design energy cost and therefore, warranted the award of an innovation point.

Equipment Accessibility

- Design must consider and require equipment accessibility. Building support equipment cannot be maintained or repaired if it is not safely accessible. Equipment access space needs to be identified on the construction documents. Open space disappears quickly in a construction environment. Access space requirements need to be clearly identified and required.