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Integrated Energy and Indoor Environmental Assessment of the Maintenance Center Barstow Main Crane Way

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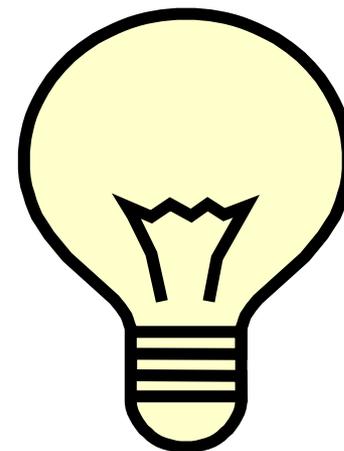
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Maintenance Center Barstow (MCB) Facts

- Began operation in late 1950s
- Located on the outskirts of the Mojave Desert
 - Temperatures can range from 25°F to 113°F
 - Santa Ana winds: variable and windy
- MCB is a 440,000 square foot industrial complex where military equipment, weapons, and supplies are repaired and remanufactured.
- Two 40-ton cranes, one 30-ton crane, one 20-ton crane, two 10-ton cranes, and numerous other smaller cranes service the shops throughout the building.
- 1,200 personnel work in the MCB facility over two shifts.

Energy Statistics for the United States

- In the US, buildings account for:
 - 36% of total energy use
 - 65% of electricity consumption
 - 30% of greenhouse gas emissions.
- In 2005, the DoE estimated that 40% of the energy used to heat and cool an average building was lost to air leaks in the building envelope.
 - This means that nearly 15% of total US energy usage is leaked right out of buildings.



Energy Use at MCW in Barstow, CA

- Building not air tight
- Energy isn't leaking – it's hemorrhaging
- Overhead doors are kept open all day in warm weather for multiple reasons:
 - Function: Allowing cranes and equipment to move inside/outside the door
 - Temperature and humidity control
 - Lighting
 - Fresh air



Open Door at end of Main Crane Way

Indoor Environmental Quality

- Indoor environmental quality (IEQ) refers to quality of air and environment inside buildings, including:
 - Thermal conditions
 - Lighting conditions
 - Ergonomics
 - Contaminant levels and sources.
- IEQ stressors include the following types of hazards:
 - Physical (noise, heat, and light)
 - Chemical (particulates, gases, and vapors)
 - Biological (bacteria and fungi).
- To evaluate and control indoor environment stressors requires an understanding of factors affecting IEQ, worker health, comfort, and productivity.

Background IEQ for MCB

- Activities in the MCB that may generate physical, chemical, and biological IEQ stressors in and around the MCW include:
 - Engine testing
 - Degreasing
 - Welding and soldering
 - Abrasive blasting.
- Potential hazards impacting IEQ, worker health, comfort, and productivity in the MCW include:
 - Hazardous noise levels
 - Hazardous metal particulates/fumes
 - Hazardous vapors
 - Dust and particulates.

Background IEQ for MCB (continued)

- Industrial hygiene, environmental health, and safety personnel at MCB evaluate and recommend controls for some of the IEQ stressors in the MCW.
- Based on the nature of the industrial processes within the MCW, additional data are needed to complete an IEQ baseline assessment within the MCW:
 - Light levels
 - Air movement
 - Temperature and humidity levels
 - Carbon dioxide, carbon monoxide, and other contaminant levels.

Challenges in the MCW - Heating

- No centralized HVAC system
- Various heating systems in operation:
 - Horizontal hot water unit heaters mounted 16 feet above the shop floor
 - No automatic temperature controls
 - Maintenance and energy intensive.
 - Vertical hot water unit heaters mounted in ceiling 22 feet above shop floor
- Ventilation system:
 - 34 five-foot wall-mounted exhaust fans installed approximately 55 feet above the shop floor
 - Energy intensive
 - Major source of noise (>90 dB)



Hot Water Unit Heater

Challenges in the MCW - Cooling

- Various cooling “systems” in operation:
 - Overhead doors opened in warm months
 - No filtration
 - Inadequate temperature or humidity control
 - Cooling provided by portable evaporative coolers (swamp coolers)
 - Take up floor space
 - Potential source of biological hazards
 - Wall-mounted exhaust fans and portable fans also used for cooling/ventilation



Swamp cooler used for portable cooling

Challenges in the MCW - Various

- 400 Watt high pressure sodium luminaires prevalent in MCW
 - Energy intensive
 - Installed near the high ceiling and do not provide sufficient light for detailed work
- Compressed air leaks affect noise and air flow
- Indoor and outdoor particulates, gases, and vapors
- Natural environment of Barstow, CA
- Building age
- Original building design did not allow for system integration or energy conservation

Challenges in the MCW - Example

- Systems are not integrated and impact each other.
 - For example, personnel leave the high bay door open.
 - This reduces IEQ by altering air flow, introducing new contaminants from the exterior environment, and exposing workers to hot air from outside.
 - In turn, workers need to cool their workspaces and turn on the portable evaporative coolers and fans.
 - Exhaust fans are turned on and off by personnel because of noise or they don't appear to be working.
 - This alters the flow of air.
 - All of these factors alter the temperature and humidity of the indoor air, affecting comfort levels and air quality.

Approach

- Goal: integrate IEQ and energy efficiency in the industrial setting of the MCW
- Prior to any large capital investments, MCB wanted to perform a comprehensive evaluation of available technical equipment and complete an Indoor Air Quality model.
- To accomplish this:
 - Compile information about MCW Barstow
 - Evaluate energy options for MCW Barstow
 - Develop a baseline model
 - Demonstrate the model using selected improvements
 - Technology transfer and fielding

Completed Activities

- Performed site visits to collect data
- Collected additional data via industrial hygiene surveys, building and energy information
- Performed baseline assessment of facility
 - Summary of existing indoor environment and energy use data for the MCW within Building 573
 - Gap analysis that identifies additional data required to accurately model indoor environment and energy use
 - Development of a list of technology and process improvements that could help reduce energy use and improve indoor environmental conditions

Completed and Current Activities

- Identified high priority technology/process improvements
 - Roof-mounted HVAC system to service MCW
 - Lighting redesign and replacement / add natural lighting
- Gathering site specific data with purchased equipment
 - Outdoor data logger to collect temperature and humidity
 - Indoor data loggers to monitor and collect temperature, light, and humidity information for several locations within MCW

Additional Tasks

- Collect more indoor environment data
- Build model
 - Create baseline computer simulation model for future project comparisons
- Prepare a demonstration plan using model and selected process improvements
 - Provide comparison of cost and performance for selected energy efficiency and IEQ improvement projects
 - Create user's operating manual for model
 - Summarize in final report



MCW rendering of existing lighting

Energy Modeling

- Input parameters include:
 - Publicly available weather data files for nearby Daggett, CA
 - Building envelope parameters
 - Occupancy information such as number of people and their schedules
 - Lighting parameters
 - Specific information about permanent or non-permanent equipment that could contribute heat
 - Information about HVAC systems such as types, sizes, efficiencies, power requirements, etc.
 - Economic parameters such as utility rates, structures, and increases, life and condition of existing equipment and systems, and maintenance costs and schedules.

IEQ Modeling

- Input parameters include:
 - Existing light levels from luminaires
 - Existing natural light levels and operational profile of bay doors' openings and closings
 - Existing CO₂, CO, and other contaminant levels
 - Source locations for potential contaminants such as:
 - Vehicle exhausts
 - Engine testing
 - Degreasing
 - Welding and soldering
 - Abrasive blasting.

Path Forward

- Evaluate whether all proposed equipment upgrades are compatible to challenges facing the MCB and the other depots
- Identify anticipated life cycle costs and performance of proposed equipment
- Validate measures to reduce energy consumption and improve indoor environmental quality
- Establish a baseline and methodology for analysis for consistent comparisons of proposed future projects



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