



### DoD Executive Agent

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(Installations and  
Environment)

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

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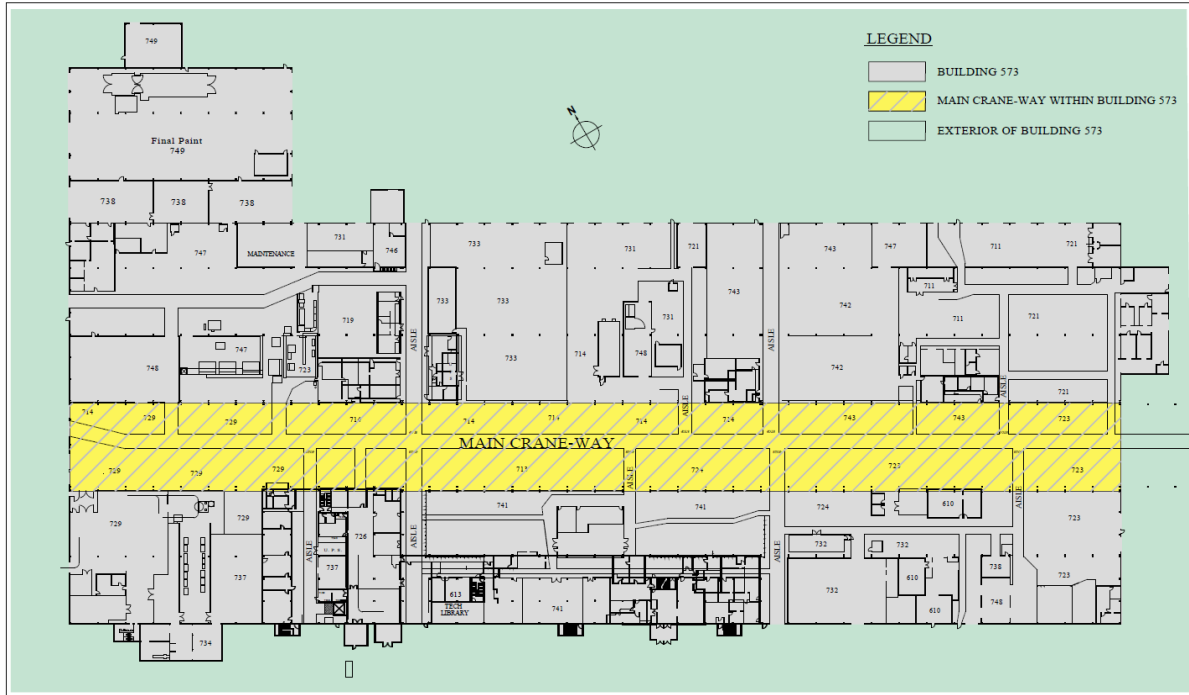
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# Maintenance Center Barstow (MCB) Facts

- 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.

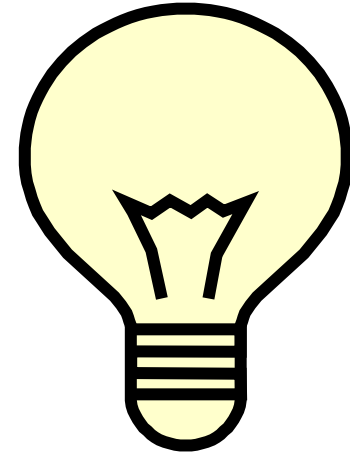
# Main Crane Way at MCB



Main Crane Way (MCW) is a 60 foot high, 1,000 foot long corridor in Building 573 with two bridge cranes that transport tactical vehicles to repair shops within MCB.

# 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

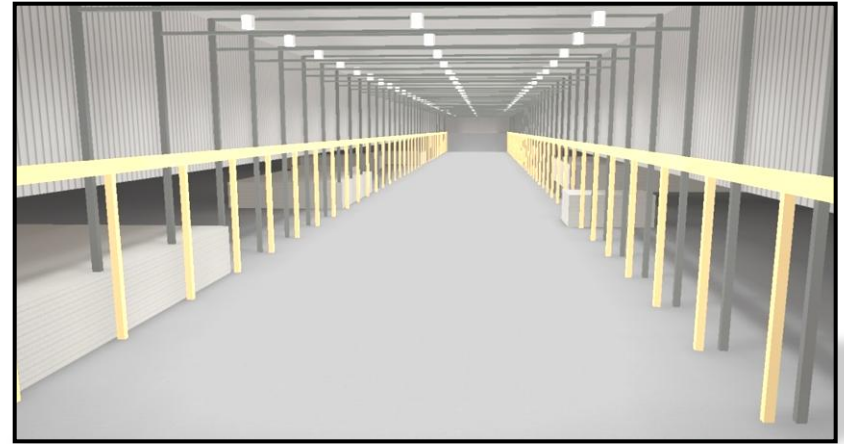
- Performed site visits to collect data
- Collected additional data via industrial hygiene surveys, building and energy information
- Performed baseline assessment of facility
  - Summary of existing indoor environment and energy use data for the MCW within Building 573
  - Gap analysis that identifies 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 CO<sub>2</sub>, 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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