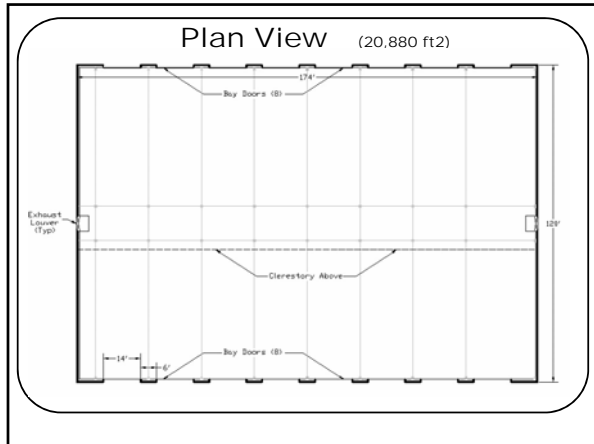

Designing Maintenance Garages for Energy Savings

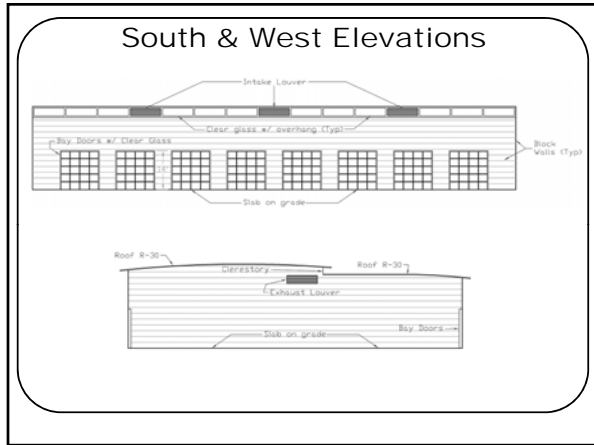
Overview

- Typical H&V design for a maintenance garage
- Discuss problems associated with the typical system and what led to another approach
- Modified design approach
- Advantages
- Energy savings
- Design considerations
- Additional Energy Saving Options

West Ox Bus Operations Center

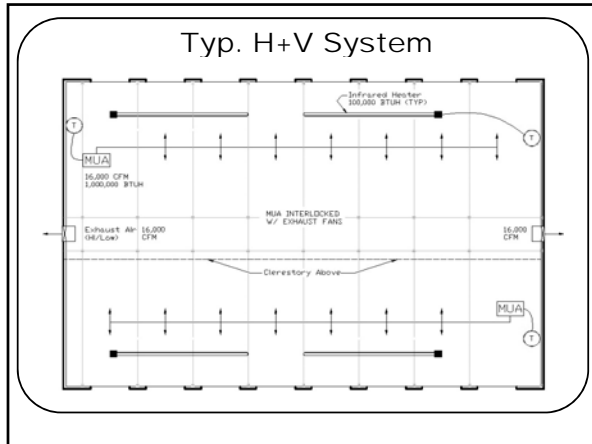






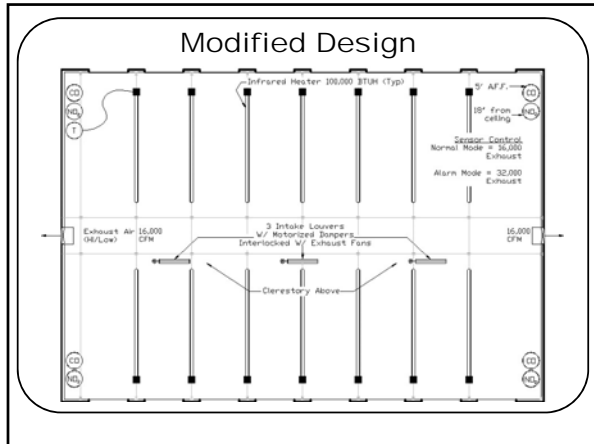
Typical H&V System - Heat Loss Calculations

- Design Temps = 70°F inside, 14°F outside
- Skin Heat loss (walls, roof, glass) = **200,000 BTUH**
- Ventilation heat loss = **1,935,000 BTUH**
(1.5 cfm/ft² = 32,000cfm)
- Total Heat Loss = **2,135,000 BTUH**



- ### Problems- Typical H&V Design
1. **Comfort:** Occupants continually uncomfortable
 - Occupants must raise temperature set-points for MUAs units
 - Limited infrared heat coverage (load calculations)
 2. **Reliability:** MUAs units fail, replacement costs very high
 3. **Energy Costs**
 - Large quantities of fresh air being heated and exhausted
 - Higher required air temperatures (70-75 °F)
 - Stratification of hot air
 - Fan energy costs (MUA units 2-25 hp motors, high runtime)

- ### Is there a Better Way?
- | | |
|--|--|
| <ul style="list-style-type: none"> • How can we: <ul style="list-style-type: none"> • Increase comfort levels? • Increase system reliability? • Reduce Energy Costs? | <ul style="list-style-type: none"> • Solution: <ul style="list-style-type: none"> • More infrared heat coverage • Infrared heat extremely reliable • cut exhaust quantities • Reduce stratification • Lower indoor air temps |
|--|--|



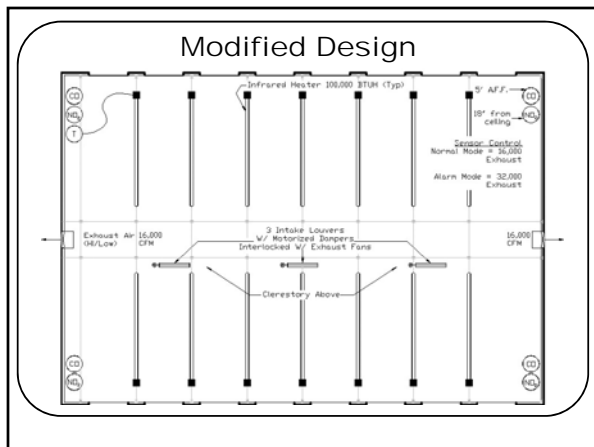
Infrared Heat Sizing

Design Temps = 65 °F inside, 14 °F outside

	Normal Mode (one Exhaust Fan)	Alarm Mode (two Exhaust Fans)
Skin Heat Loss	180,000 BTUH	180,000 BTUH
Ventilation Heat Loss	880,000 BTUH	1,760,000 BTUH
Total Heat Loss	1,060,000 BTUH	1,940,000 BTUH

Infrared heater sizing a judgment call, we have typically split the difference between normal and alarm mode = **1,500,000 BTUH**

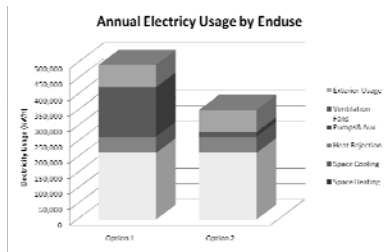
On a design day, both fans running in alarm mode, the indoor temperature could reach as low as 52 degrees.



Advantages

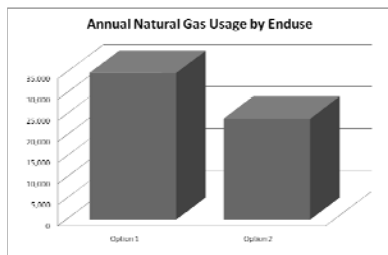
1. Increased comfort, full infrared coverage
2. Increased reliability, infrared heaters last, very low maintenance
3. Lower energy costs:
 - Lower Indoor temperatures (70 °F vs 60-65 °F)
 - No Air Stratification
 - Less fan costs (50HP)
 - Normal operation mode reduces ventilation load by 50%

Energy Savings Using DOE 2.2 Building Simulation



Building Simulation prepared by EMO Energy Solutions

Energy Savings Using DOE 2.2 Building Simulation



Building Simulation prepared by EMO Energy Solutions

Energy Savings Using DOE 2.2 Building Simulation

Model	Annual Electricity (Kwh/yr)	Co-incident Peak Demand (KW)	Annual Natural Gas (therms)	Annual Energy Cost *	% Energy Cost Savings
Option 1	494,117	90	34,959	\$123,061	
Option 2	352,064	58	24,049	\$86,479	30%

* Assumes Natural Gas \$1.40/therm, electricity \$0.15/kwh

Building Simulation prepared by EMO Energy Solutions

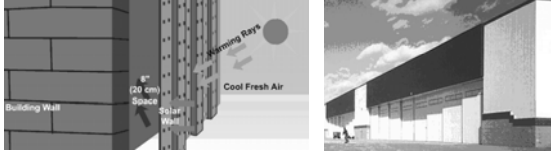
Key Design Considerations

- Avoid freeze-ups using raw MUA
- Invest time with Building Operations staff to fully understand the system
- Perform periodic calibration and testing of sensors
- Work with Local Code Officials
 - 2006 IMC requires 1.5cfm/ft2 exhaust
 - (Code of Virginia lowers to 0.75cfm/ft2)
 - 2009 IMC lowers exhaust requirements to 0.75cfm/ft2

Additional Energy Saving Options

- Heat recovery between exhaust and Intake to preheat MUA
- Transpired wall system (Solar Wall) to preheat incoming air

Transpired Wall System



Additional Energy Saving Options

- Heat recovery between exhaust and Intake to preheat MUA
- Transpired wall system (Solar Wall) to preheat incoming air
- Landfill gas to infrared burners
- Waste Oil heaters for heating water and preheating MUA

Questions?
