



Air Movement for Energy-Efficient Comfort in Conditioned Spaces



ASHRAE Standard 55-2010: Thermal Comfort

ANSUASHRAE Standard 55-2010 (Supercedes ANSI/ASHRAE Standard SS-2004) Includes ANSI ASHRAE addends listed in Appendix I



ASHRAE STANDARD

Thermal Environmental Conditions for Human Occupancy

Date Appendix I for approval lighter by the ADMANE Distriction Controlline, the ADMANE Shared at Scientists. por the Assess on Robinson Therefore Involves.

The absoluted is profer continuous continuous by a Standing Standard Project Controlled (SSPC) for which For Standards Susteeding has established a discovered program for regular published of additions or norsoro, including providure for lands, documented, consensus action on requests for disapprist any part of the dentest. The charge submitted from posturbone, and desilven may be obtained an electronic hore from No ASSESSE With the loves automating or in paper hore him the Manager of Florefulls. The black soften of as ASHAE Standard may be purchased from the KSHAE Well site (save automorp) or from ASHAE Continue Service, 1797 Taller Steller, ME. Albeits, GA 50079-0005. Evenally arrived Registering Flor; 459. 271 MTE. Tringhous: 454-C80 MED (auchieute), or fell than 1 600 GET 4755 No crotes in 155 and Caracter. For report purchases, yet in annual front organizations.

#2011 Resource Toronty of Healing Religiousing and the Conditioning Singineers, Inc.





American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

1791 Yulia Circle NE, Adamia, GA 30329





ANSI/ASHRAE Standard 55-2013

(Supersedes ANSI/ASHRAE Standard 55-2010) Includes ANSI/ASHRAE addenda listed in Appendix M

Thermal **Environmental** Conditions for **Human Occupancy**

See Appendix M for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely. documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tutte Circle, NE, Atlanta, GA 30329-2305. E-mail: orderscitashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrse.org/permasions.

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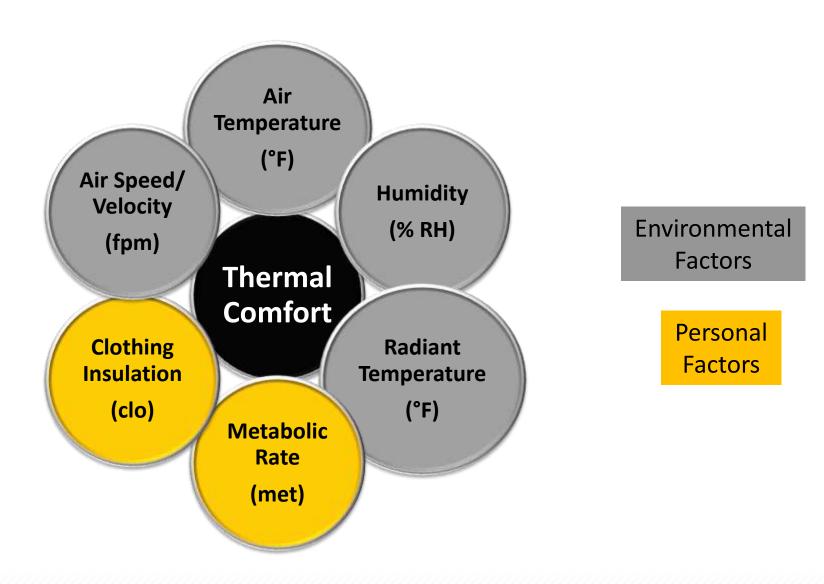
"Specify the combination of indoor thermal environmental factors and personal factors that will produce thermal environmental conditions acceptable to a majority of the occupants..."

Said another way:

Quantify comfort for most



Thermal Comfort: What Affects It?



Definitions

Predicted Percentage of Dissatisfied (PPD)
Predicted Mean Vote (PMV)
Operative Temperature

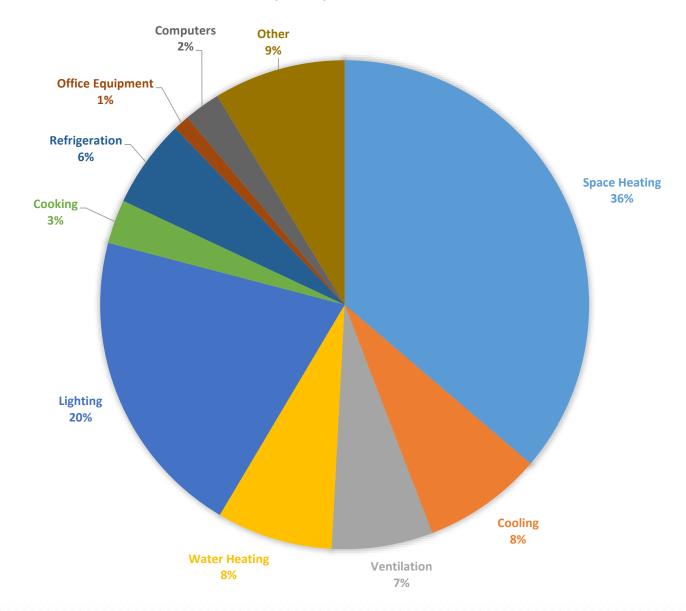
Comfort Zone

PMV: -0.5 to +0.5

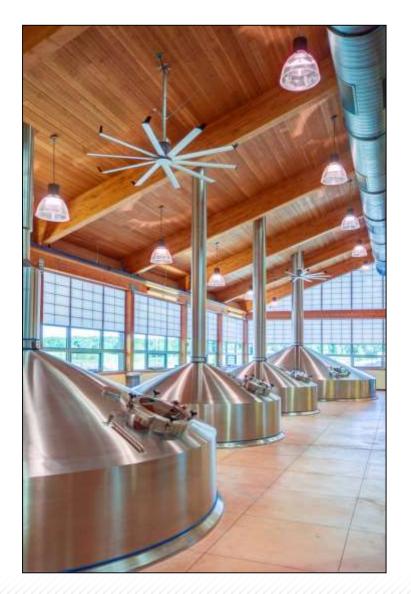
PPD < 10%

+3 Hot +2 Warm +1 Slightly warm - +0 Neutral - 1 Slightly cool -2 Cool -3 Cold

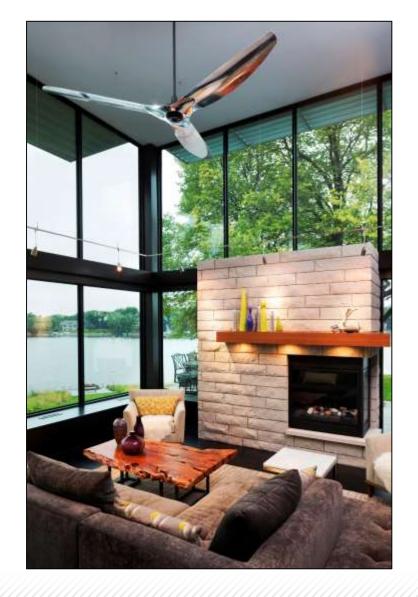
MAJOR FUEL CONSUMPTION (BTU) BY END USE FOR ALL BUILDINGS, 2003



Air Movement for Summer Cooling







Designing for Thermal Comfort: Cooling

Typical Cooling Values

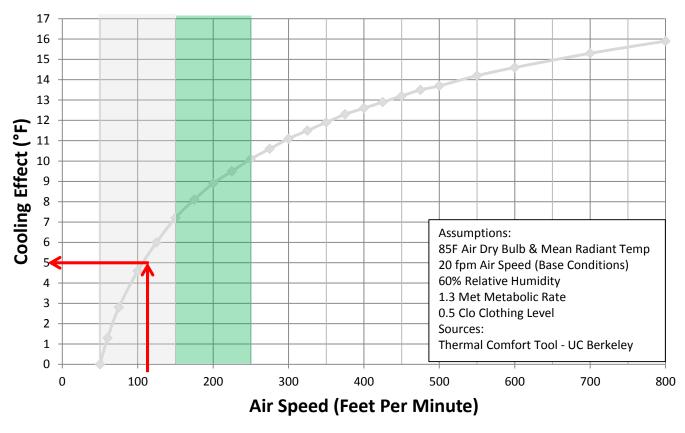
- Air temperature (75 °F)
- Humidity (50% RH)
- Metabolic rate (1 met)
- Radiant temperature (75 °F)
- Clothing insulation (0.5 to 1.0 clo)
- Air speed (40 fpm or less)

	Typical
PPD	8%
PMV	-0.39



Air Speed and Thermostat Offset

Cooling Effect From Elevated Air Speed

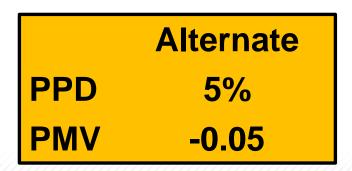


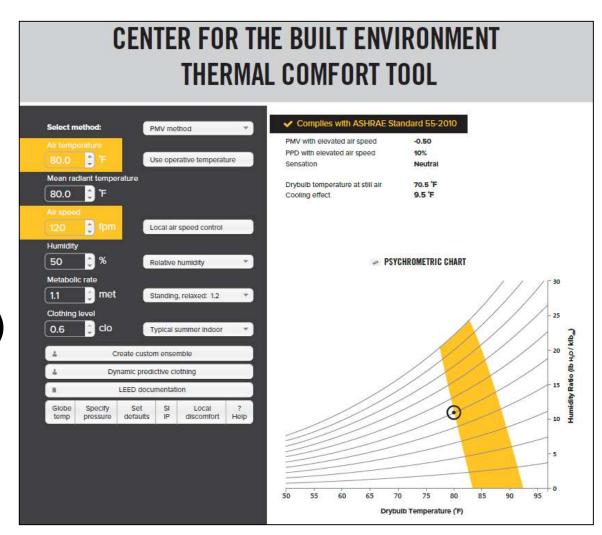
100 - 250 fpm best cooling per Watt

Designing for Thermal Comfort: Cooling

Alternate Cooling Values

- Air temperature (80 °F)
- Humidity (50% RH)
- Metabolic rate (1.1 met)
- Radiant temperature (80 °F)
- Clothing insulation (0.5 to 1.0 clo)
- Air speed (120 fpm)





Savings from Temperature Offset

According to the U.S. EPA and D.O.E. Energy Savings Calculator*, each degree of this thermostat offset saves 3% to 6% of cooling energy.

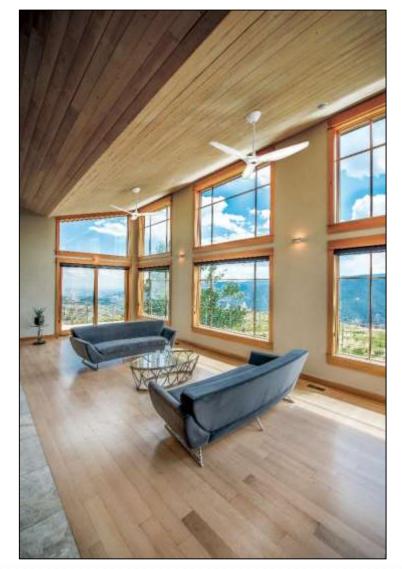




*U.S. EPA and D.O.E. Energy Savings Calculator

Shifting the Concept of Thermal Comfort

- \$18.6 billion on residential AC in the US
- 63% rise in the cost of electricity since 2003
- The energy consumed by residential AC in the US doubled between 1993 and 2003



Shifting the Concept of Thermal Comfort

If every home in the US raised its thermostat setpoint 6F, we would eliminate 78 billion pounds of carbon



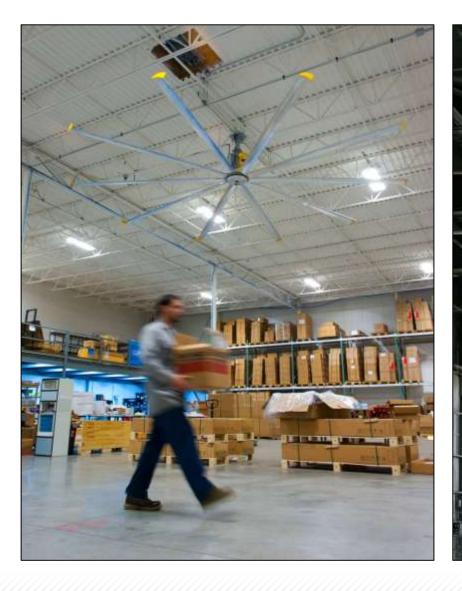
Switch 925 million incandescent lamps to CFL bulbs

9 coal-fired power plants for a year



Carbon sequestered by 29 million acres of US forests in one year

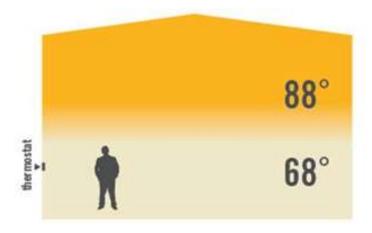
Air Movement for Winter Energy Efficiency

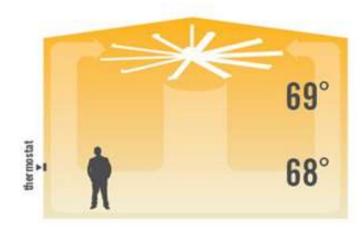




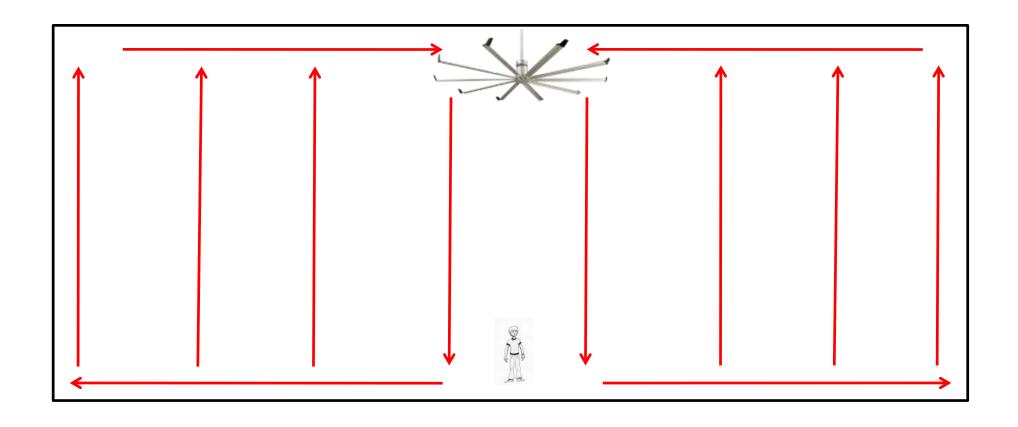
Stratification in Heating Mode

- Hot air rises
- Difficult to get uniformity
- Stratification of 0.5 1.0°F/ft.
- Higher average space temperature, heat loss, equipment runtime

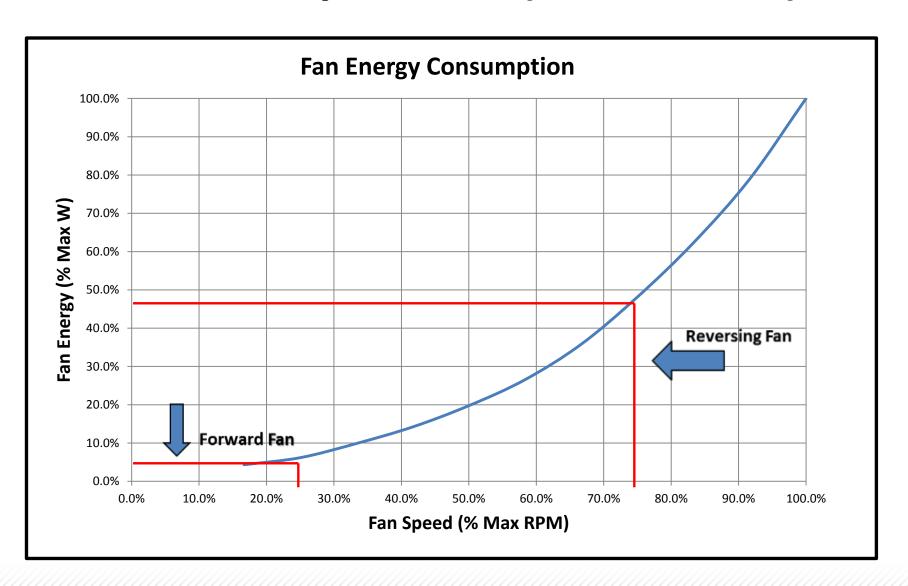




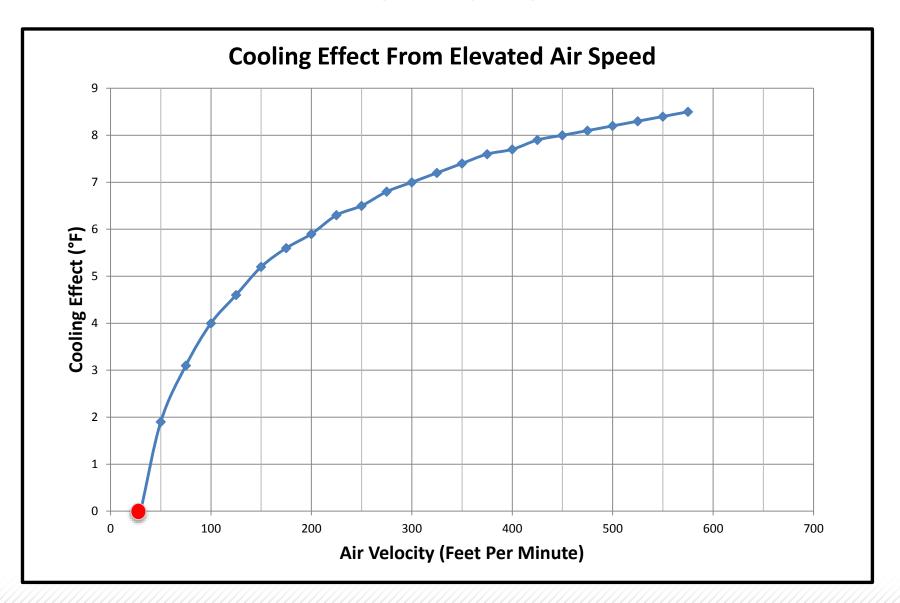
Fan Jet Requirement



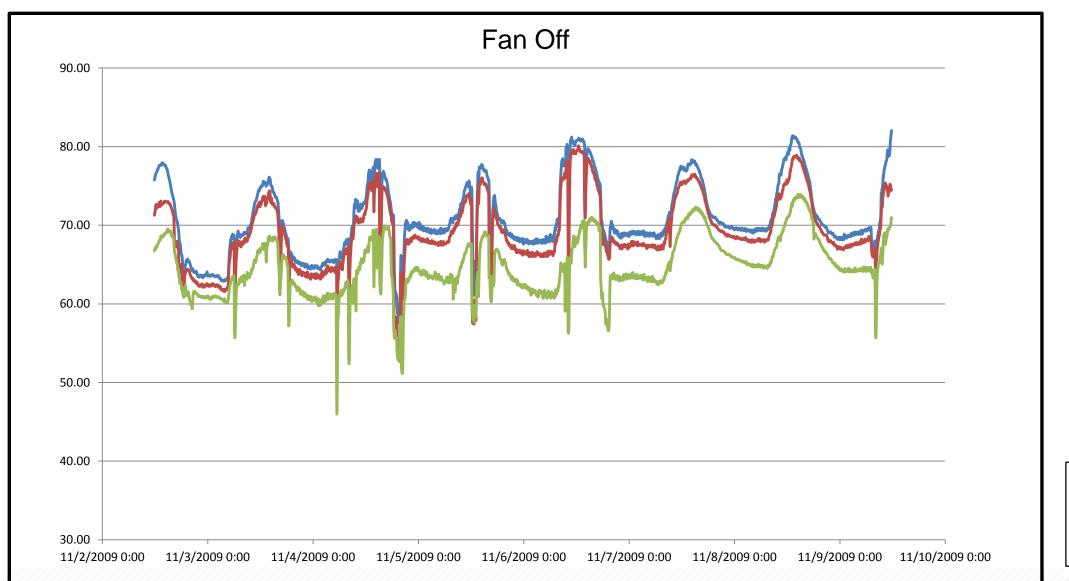
Forward Operation (No Reverse)



No Drafts

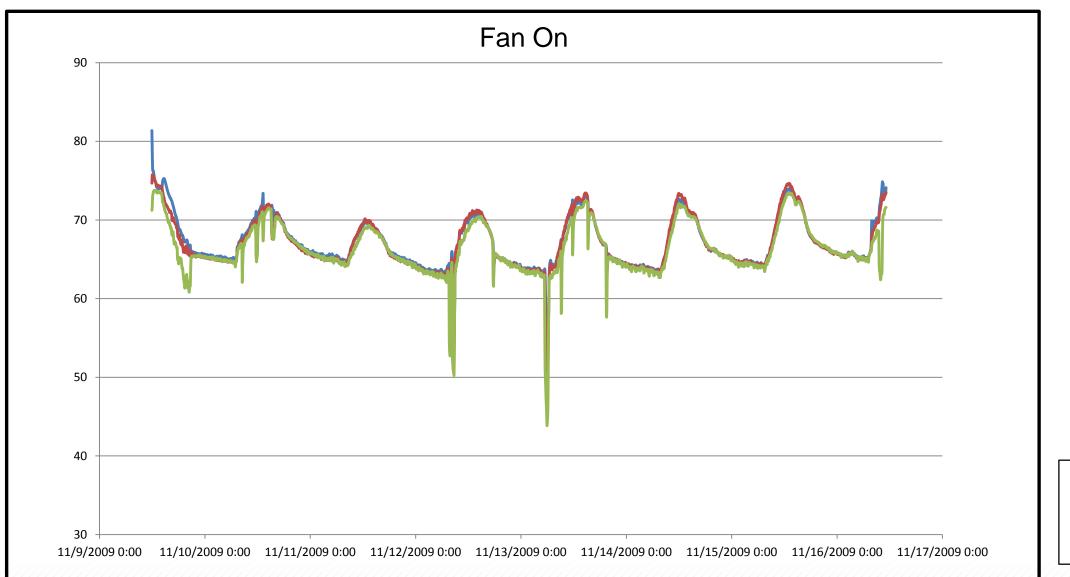


Destratification: Kentucky Guard Hangar





Destratification: Kentucky Guard Hangar





Destratification: Kentucky Guard Hangar

Gas savings: $272,247 \text{ ft}^3 = 272.2 \text{ MCF per year}$

Cost savings: \$2,714 per year

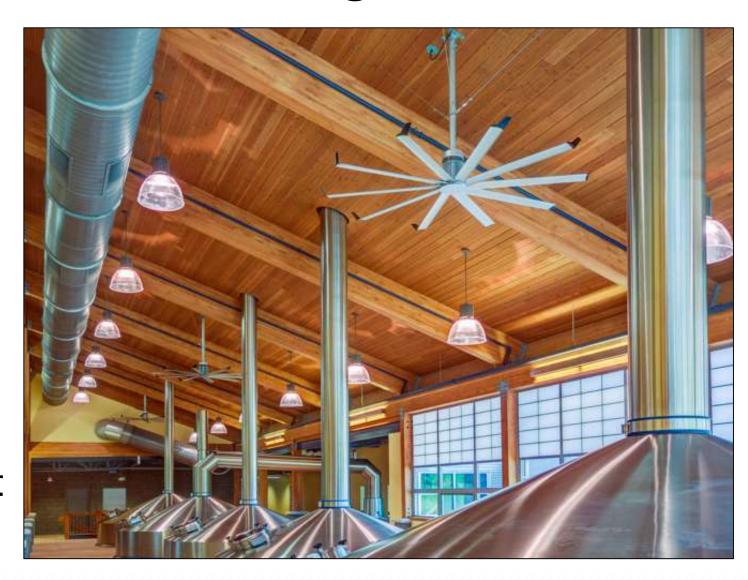
– Fan electricity: \$37

Net savings: \$2,677

Air Movement and Green Building Standards

LEED BD+C

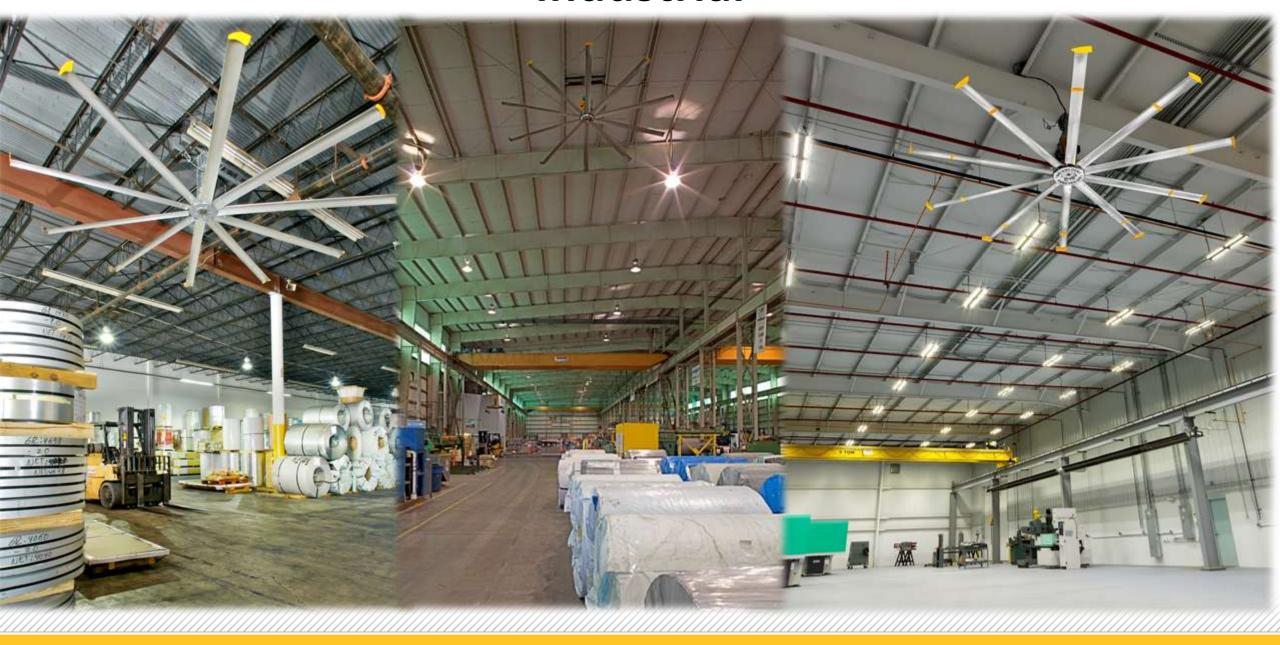
- EA Prereq 2 Minimum Energy Performance
- EA Credit 2 Optimize Energy Performance
- EA Credit 4 Demand Response
- EA Credit 6 Enhanced Refrigerant Management



Questions?

877-BIG-FANS

Industrial



Auto Dealerships



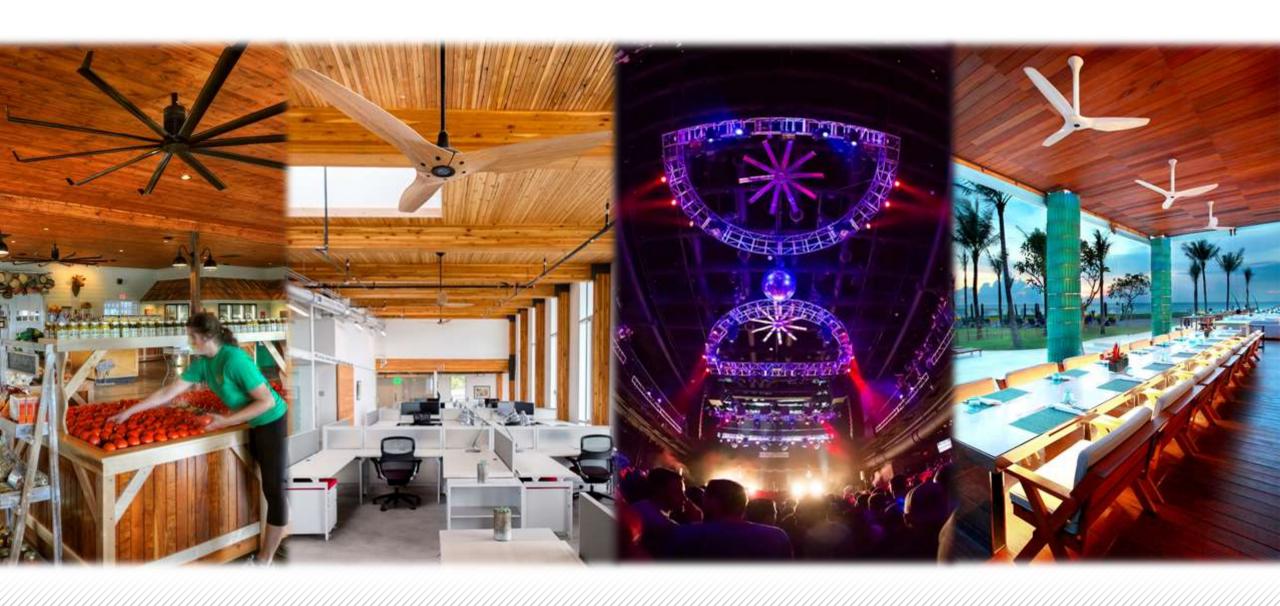
Aircraft Hangars and Terminals



Government and Military



Public Spaces



Health Club and Recreation Centers



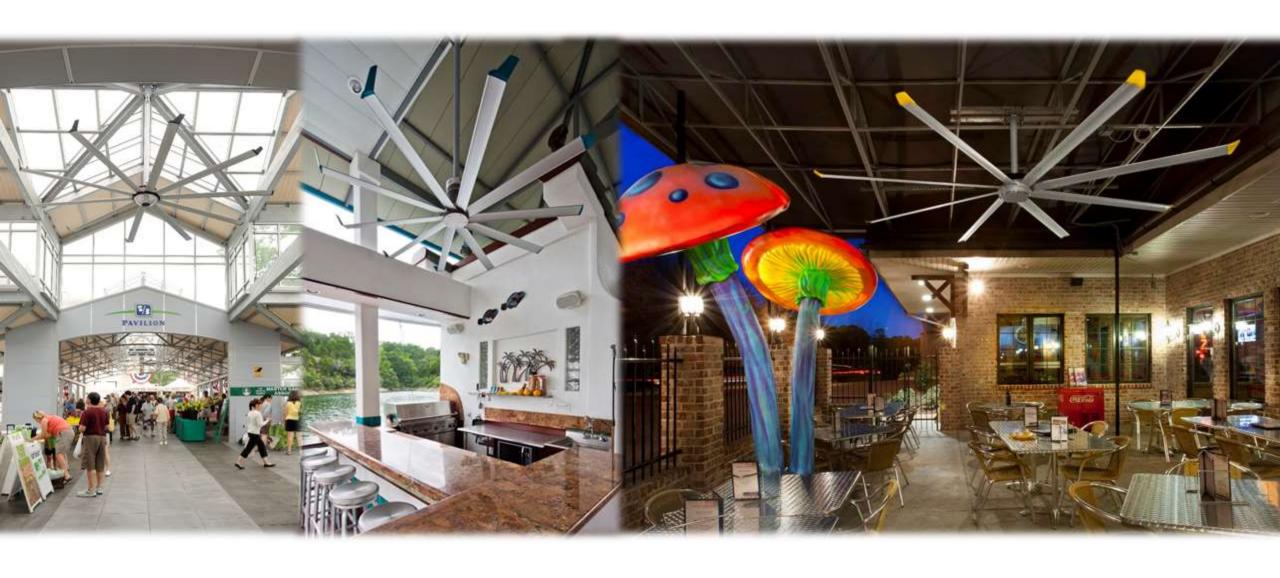
Schools: K-12 and Universities



Worship Facilities



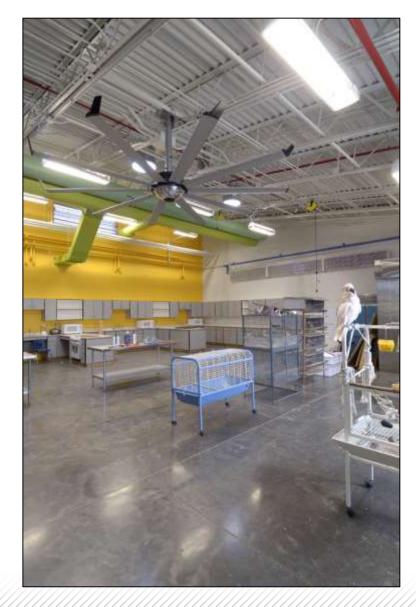
Outdoor Covered Areas



Residential Spaces

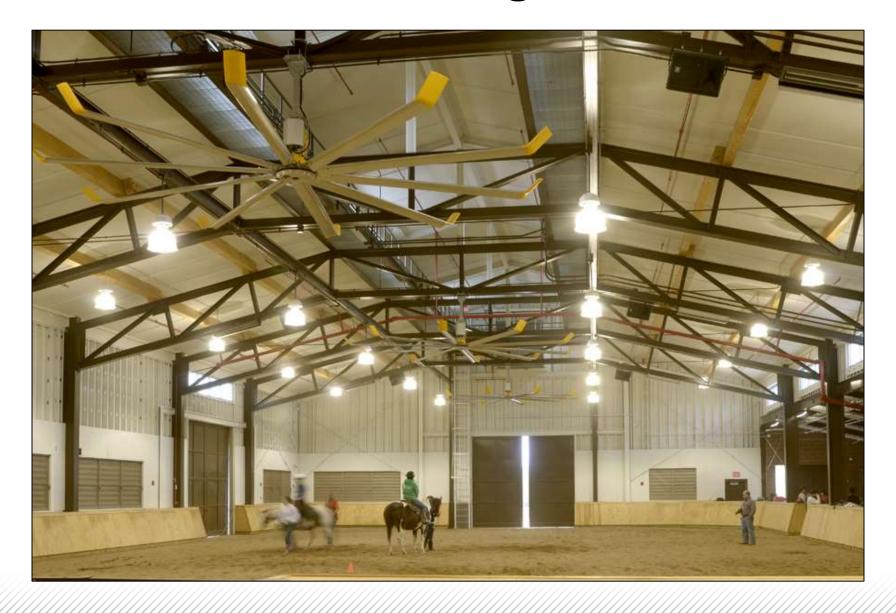


Locust Trace High School





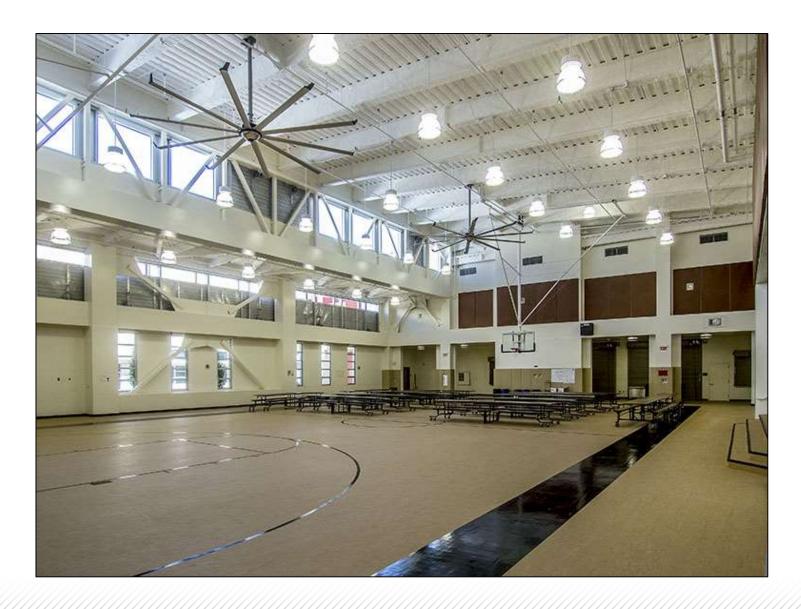
Locust Trace High School



Oakland Unified School District

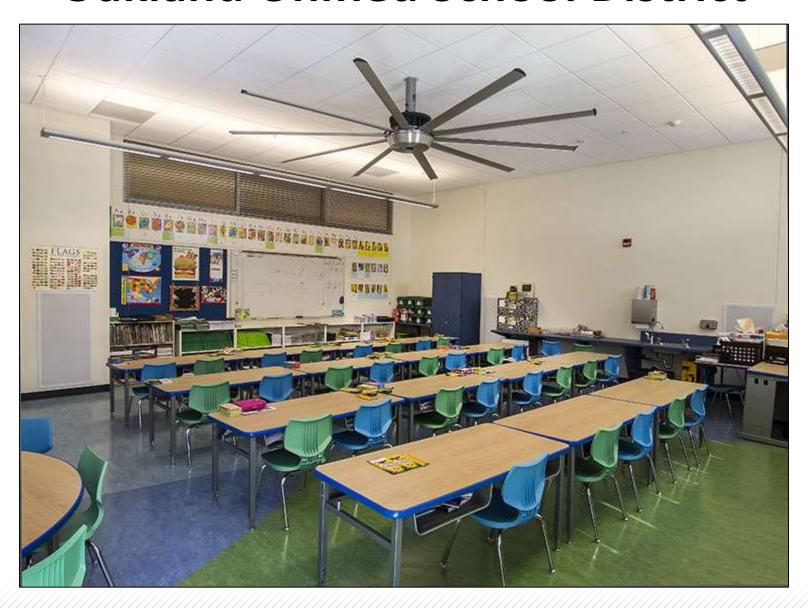


Oakland Unified School District



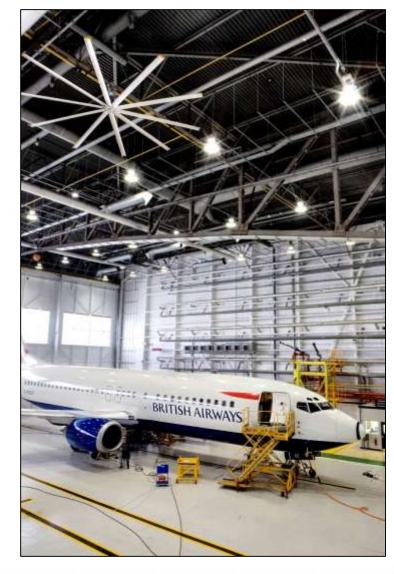


Oakland Unified School District



British Airways' Hangar 6





Big Ass Solutions Testing Facility



