Using Air Movement to Improve Energy Efficiency

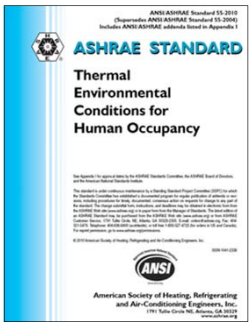
BIG ASS FANS

Overview

- Benefits of air movement
- Thermal comfort & ASHRAE Standard 55
- Energy savings: cooling & heating
- Product overview
- Application examples

Thermal Comfort

ASHRAE Standard 55-2010: Thermal Comfort



"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**

What is Thermal Comfort?

Definition:
"That condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation."

ANSI/ASHRAE Standard 55-2010, Section 3

It Is All A Matter Of Perspective

Thermal Comfort – what affects it?

Thermal Comfort Variables:

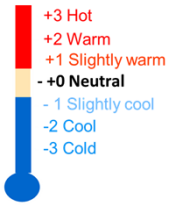
Environmental Factors
- Air temperature (°F)
- Humidity (% RH)
- Radiant temperature (°F)
- Air speed (fpm)

Personal Factors
- Clothing insulation (clo)
- Metabolic rate (met)

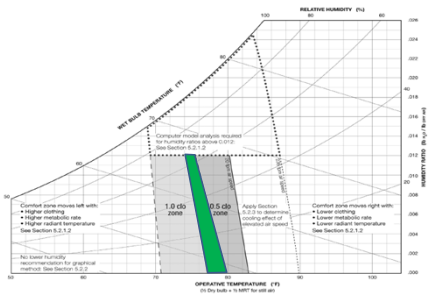
Definitions

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

Comfort Zone
- **PMV: -0.5 to +0.5**
- **PPD < 10%**

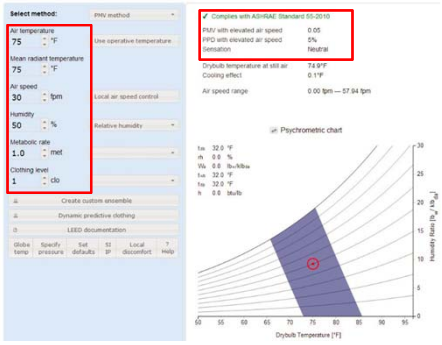


Operative Temperature - Graphical Method



Operative Temperature (what people feel) = Air Temp +/- Radiant Effects – Air Speed Cooling Effect

Comfort Zone - Computer Model Method



Source: CBE Thermal Comfort Tool

Air Movement in Conditioned and Non-Conditioned Spaces

Temperature vs. Productivity & Accuracy

TEMPERATURE	PRODUCTIVITY LOSS
77°F	0.0%
80°F	-3.2%
85°F	-8.8%
90°F	-14.3%
95°F	-19.9%
100°F	-25.4%
105°F	-31.0%

** Source: Seppänen, O., Fisk, W. J. and Lei, Q. H. (2006)*

Benefits of Large Overhead Fans
Cooling Applications

Designing for Thermal Comfort - Cooling

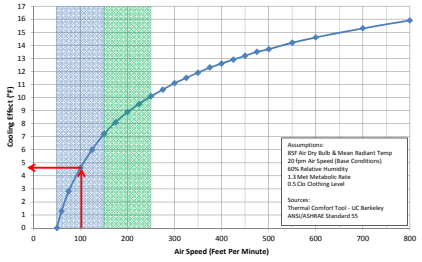
Typical School Cooling Values

- 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

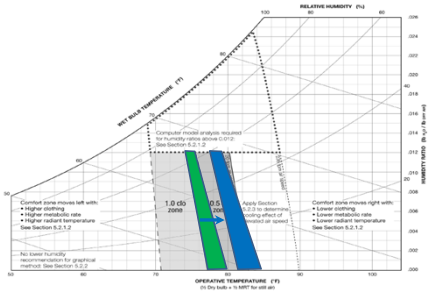
Cooling Effect From Elevated Air Speed



100 - 350 fpm best cooling per Watt

ASHRAE Thermal Comfort Tool

Graphical Method - Shifting the Comfort Zone

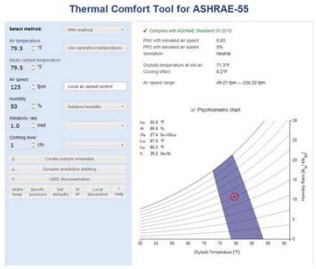


Operative Temperature (what people feel) = Air Temp +/- Radiant Effects – Air Speed Cooling Effect

Designing for Thermal Comfort

Alternate Office Cooling Values

- *Air temperature (79.5 °F)*
- Humidity (50% RH)
- Metabolic rate (1 met)
- Radiant temperature (79.5 °F)
- Clothing insulation (0.5 to 1.0 clo)
- *Air speed (125 fpm)*



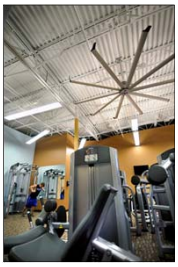
	Alternate
PPD	5%
PMV	-0.05

Savings from Airflow to Offset Temperature Increase

- According to the U.S. EPA and D.O.E. Energy Savings Calculator*, each degree of this 4.5°F thermostat offset saves 3% to 6% of cooling energy.
- This gives a total saving of 13% to 27% of cooling energy.

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

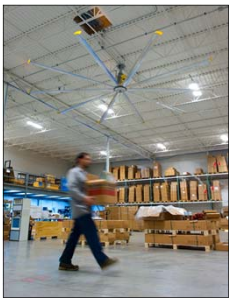
Airflow in Non-Sensitive Spaces



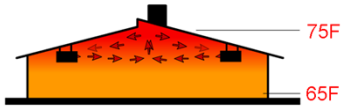
Reductions of **10-20%** in cooling energy

Benefits of Large Overhead Fans
Heating Applications

Air Movement for Winter Energy Efficiency



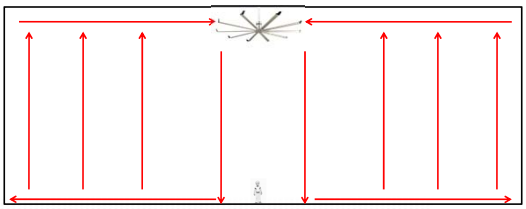
Stratification in Heating Mode



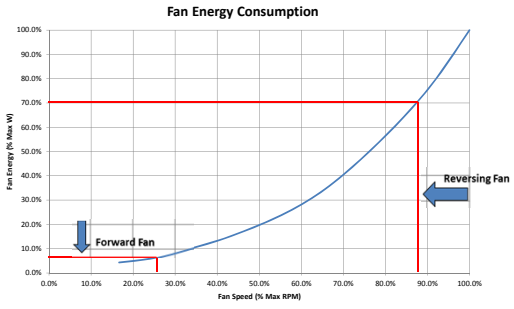
- Difficult to balance heating and cooling requirements with one distribution system
- Warmer air rises towards the ceiling
- Stratification of 0.5 – 1.0 F°/ft.
- Higher average space temperature, heat loss, equipment runtime, discomfort

Fan Jet Requirement

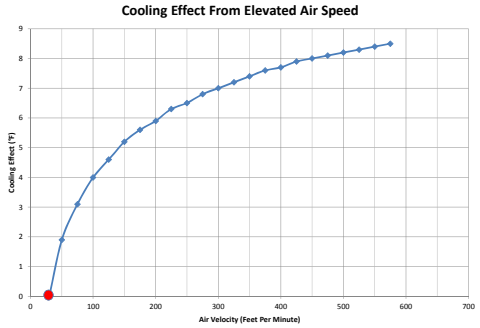
- **Jet that reaches floor**
  - **Minimum fan size**
  - **Open areas**



Forward Operation (No Reverse)

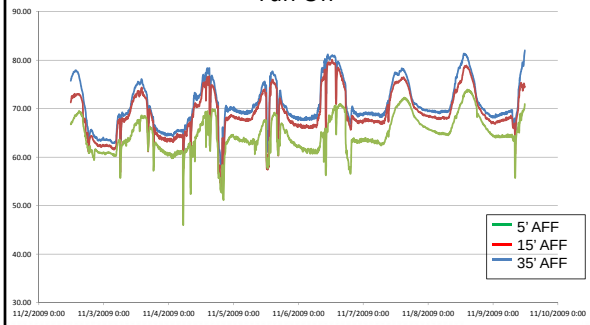


No Drafts



Destratification Fan Results

Fan Off

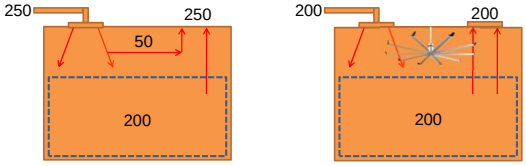


Destratification Fan Results

Fan On

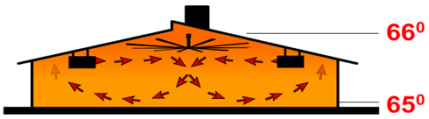
ASHRAE Std 62.1 & Overhead Heating

	Office
Zone Floor Area - (ft2)	2000
Zone Population - (people)	16
Breathing Zone Outdoor Airflow (cfm)	200
Typical Zone Air Distribution Effectiveness (Ez)	0.8
Outdoor Air Intake Flow (cfm)	250



Ez = 0.8 Ez = 1.0

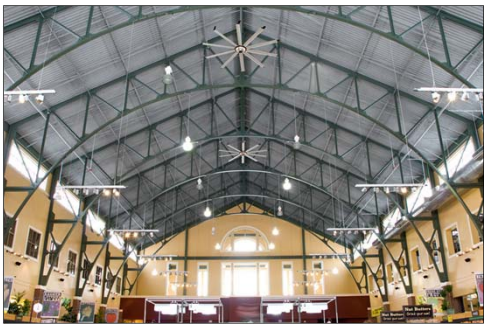
Winter Destratification - Review



1. Uniform distribution
2. Reduce heating energy*
3. Reduce outdoor air intake requirements

*No change in thermostat setpoint

Reclaim the Ceiling



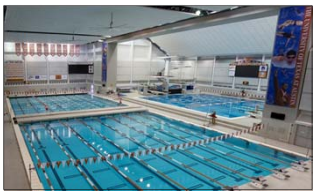
Ductwork Minimization

Condensation Mitigation

- **Problem:**
  - Moist air + cold surface = condensation
    - Corrosion of metal
    - Loss of product
    - Safety

- **Solution:**
  - BAF mitigate condensation by:
    - Disturbing stagnant air film
    - Increasing surface temperature
    - Increasing air temperature near floor

Improving IAQ

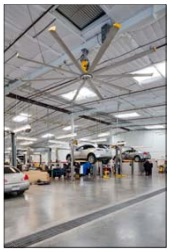


Applications

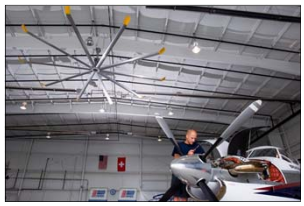
Industrial Applications (Factories, DC, & Service Centers)



Auto Dealerships – Showrooms and Service Centers

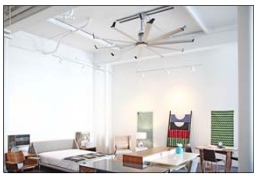



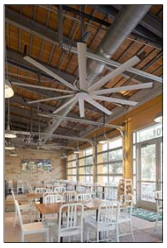

Aircraft Hangars & Terminals




Government & Military

Retail & Commercial Spaces



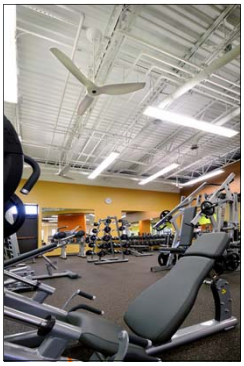


Furniture Row

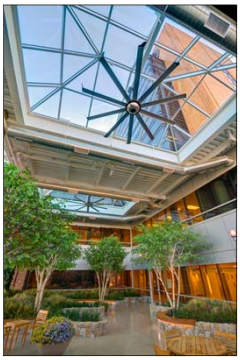
IKEA

Public Spaces

Health Clubs & Recreation Centers



Healthcare & Physical Therapy



Schools – K-12 & Universities

Churches and Shopping Malls

Outdoor Covered Areas

Residential Spaces

Large Diameter Fans and Energy Efficiency

LEED & Large Diameter Fans

Where fans can help:

- Energy & Atmosphere
  - Reduce Energy Use
- Indoor Environmental Quality
  - Increase Thermal Comfort
  - Reduce Ventilation Intake
- Innovation & Design Process
  - Materials Reduction, etc…

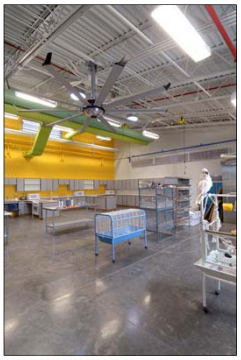
LEED Details
http://www.bigassfans.com/page/leed_pts

Big Ass Fans Testing Laboratory

Oakland Unified School District

Oakland Unified School District

Locust Trace



Locust Trace

Summary - Benefits of Large Diameter Fans

- Improve thermal comfort
- Summer and winter energy savings
- Improve air distribution
- Reduce condensation

Contact information:
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