Environmental Benefits of Use of Circulating Fans

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AHR EXPO Atlanta FEB 6-8

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Session Moderator

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- Responsible for development of AMCA's education programs; staff liaison for the Education & Training Committee
- Projects include webinars, online education modules, presentations at trade shows, AMCA Speakers Network and many other items.

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Christian Taber

Principal Engineer – Codes and Standards
Big Ass Fans

- Over 23 years experience in the industry
- B.S. in chemical engineering & M.S. in mechanical engineering from Iowa State University; M.S. in biological/biosystems engineering from the University of Kentucky
- His articles on air movement and energy efficiency have been published in multiple publications, and he has presented at AMCA, ASHRAE and AIA conferences nationally.
- ASHRAE certified High-Performance Building Design Professional and Certified Energy Manager; LEED Gold Big Ass Solutions Research & Design Facility & mentors coworkers studying for LEED accreditation exams.
- Chair of AMCA North America Air Movement Advocacy Committee; serving on AMCA committees 230, 214, 211, 208, 11 and others, as well as ASHRAE Standard 90.1

David Rose

Sr. Manager, Technical Strategy + Innovation
Big Ass Fans

- Been with Big Ass Fans for over 7 years; started as Application Engineer / Sales Engineer
- Co-authored the 2022 AMCA inmotion Magazine article *“Reducing Climate Change Induced Heat Strain and HVAC Performance Loss with Circulating Fans”*
- Member of AMCA 230 committee & a voting member of ASHRAE Standard 55, as well as President of the ASHRAE Bluegrass Chapter
- Earned a Bachelor of Science in Mechanical Engineering from the University of Kentucky

Environmental Benefits of Use of Circulating Fans

Purpose and Learning Objectives

The purpose of this presentation is to explore the use of circulating fans to reduce building energy use, increase thermal comfort, and provide improved comfort during extreme events.

At the end of this presentation, you will be able to:

1. Explain what a Large Diameter Ceiling Fan (LDCF) is and its typical characteristics.
2. Outline how LDCFs contribute to thermal comfort and building energy savings.
3. Lists the ways LDCFs increase resilience to extreme events and climate change.
4. Identify the organizations that are involved in establishing LDCF specifications.

Presentation Outline

- LDCF Fan Basics
- Thermal Comfort
- Energy Savings
- Increasing Resilience
- Specifications to Achieve Project Goals

Large Diameter Ceiling Fans 101

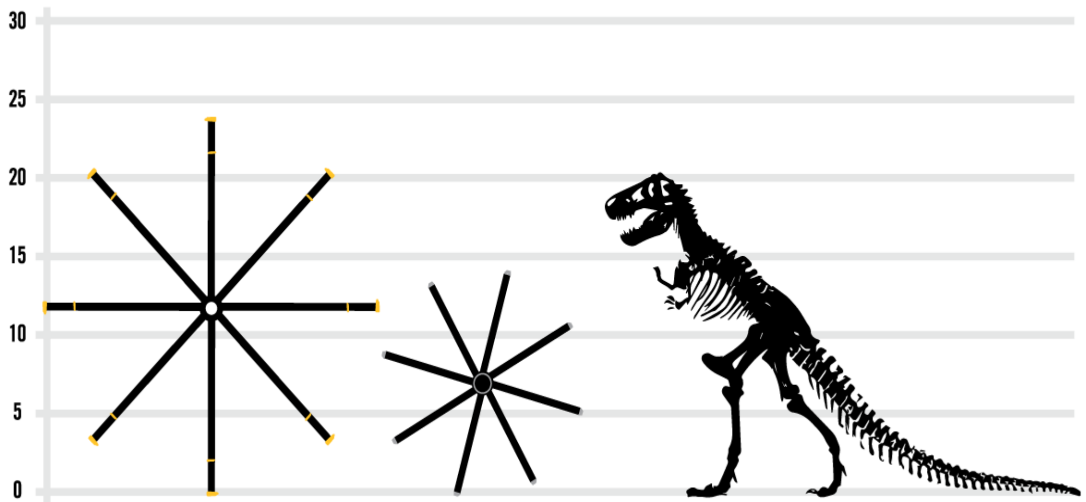
Defining Large-Diameter Ceiling Fans (LDCF)

- Ceiling fan - "a non portable device that is suspended from a ceiling for circulating air via the rotation of fan blades."

  - 42 U.S.C § 6291.Definitions

- Large-diameter ceiling fan – "a ceiling fan that is greater than seven feet in diameter."

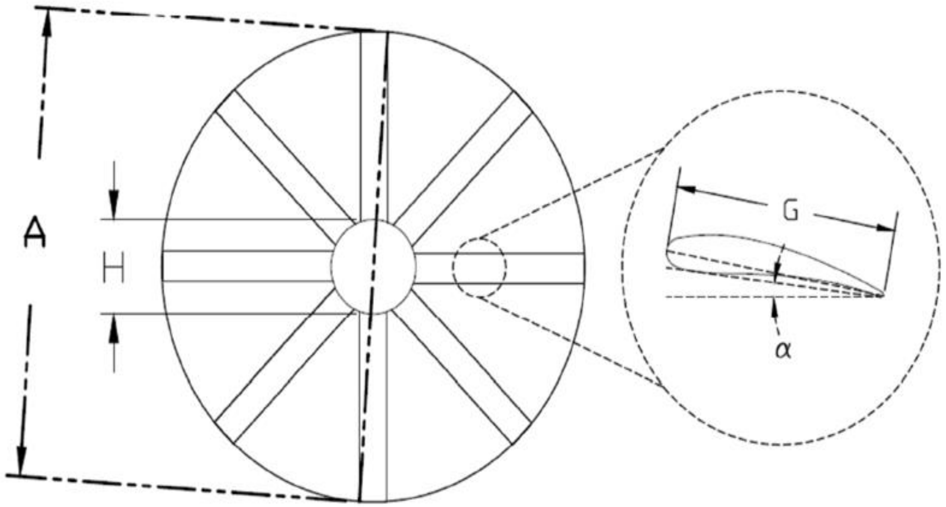
  - 10 CFR 430, Appendix U to Subpart B



Design Standards / Typical Characteristics

- 42 U.S. Code § 6295.Energy conservation standards (ff)
  - Fan speed control separate from lighting control
  - Adjustable speed control
  - Capability of reversible fan action*

- Typical Characteristics
  - Impeller diameter 7-24 ft (2.1-7.3m)
  - Airfoil shaped blades
  - 2 to 8 blades
  - Tip speeds 1100-5500 fpm (5-28m/s)

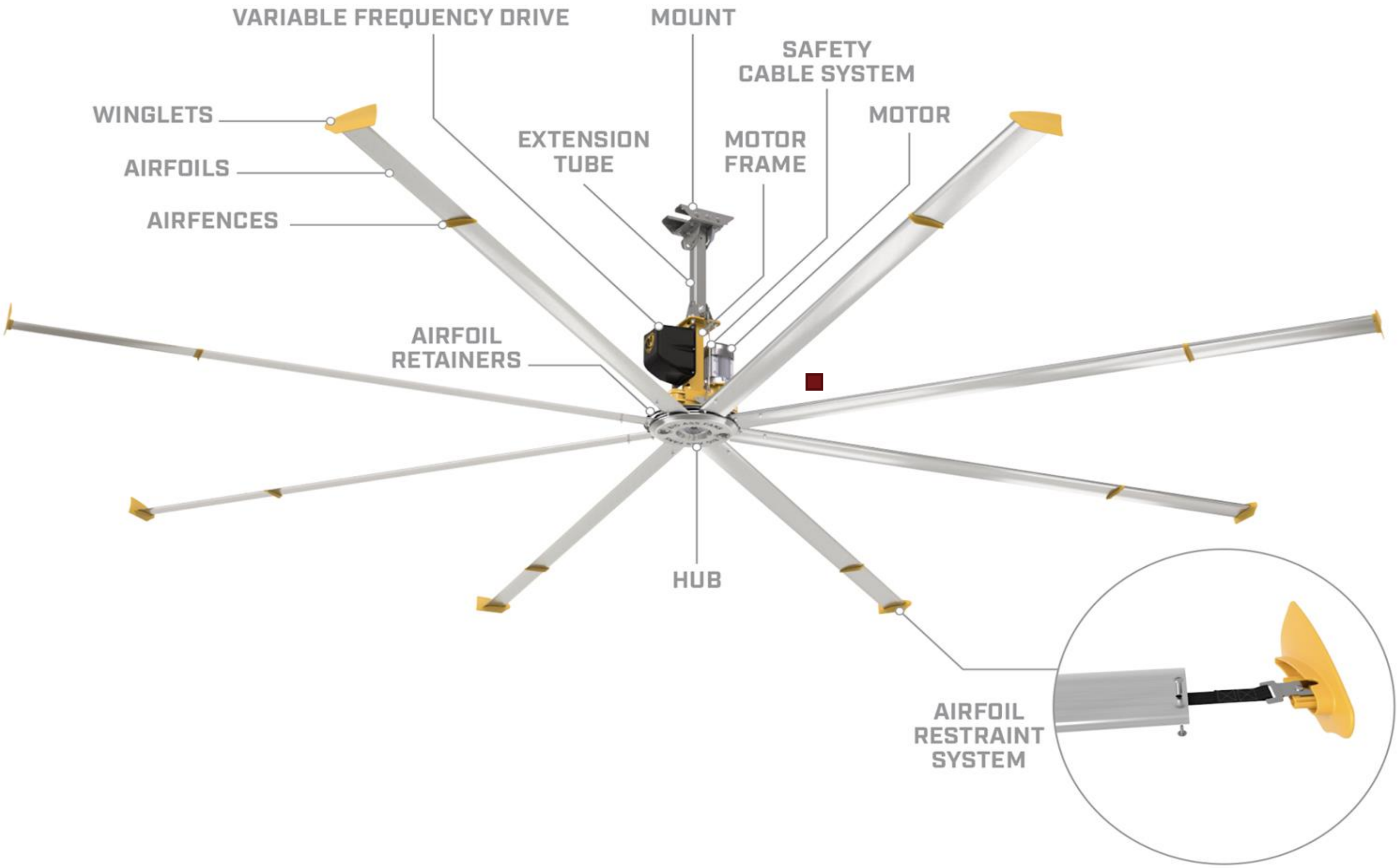


A	Impeller Diameter
H	Hub Diameter
G	Blade Width at Tip
α	Pitch Angle at Tip or at a Designated Radius
N	Number of Blades

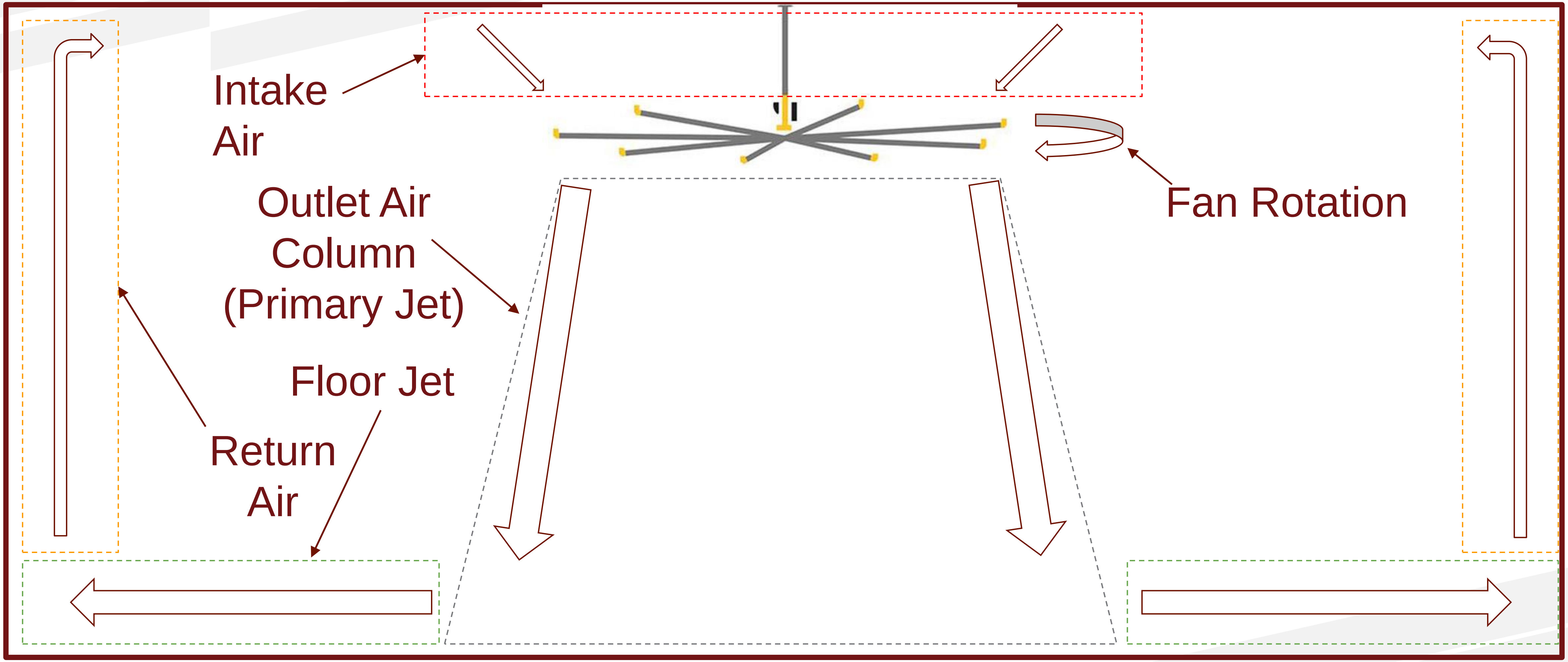
Figure A.37 AMCA 211-13 (Rev. 10-18)

What is an HVLS Fan

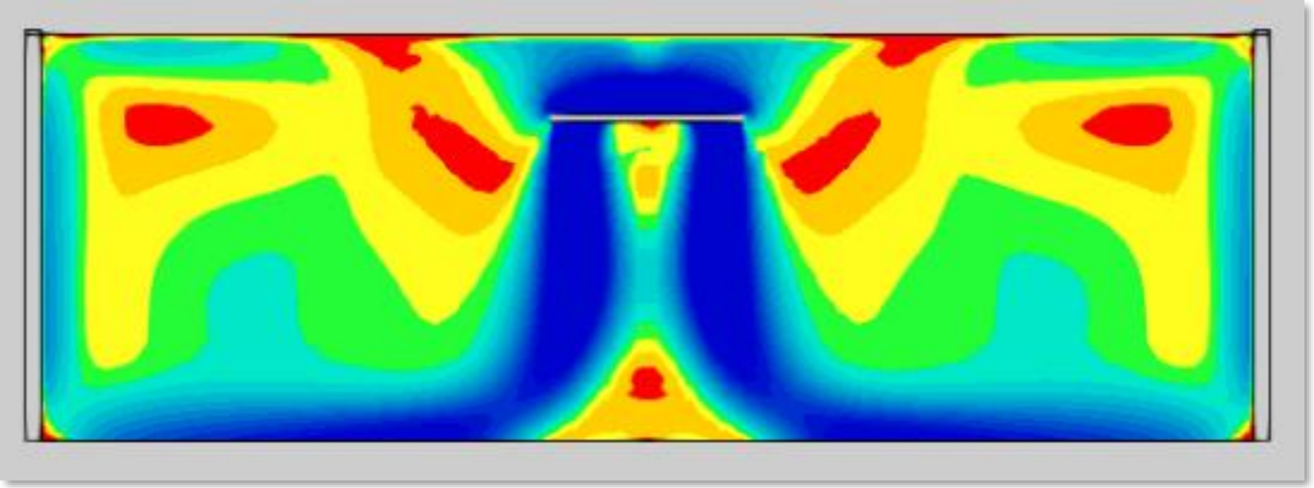
- Air circulating fan
  - Ceiling fan
- Large = >7’ (2.1m) Diameter
- Low RPM - 24’ (7.3m) Fan ~60 RPM
- Low HP - ≤2.5 hp (1.85kW) motor
- 2 to 8 blades
- Tip speeds 1,100-5,500 fpm (5.6-28m/s)

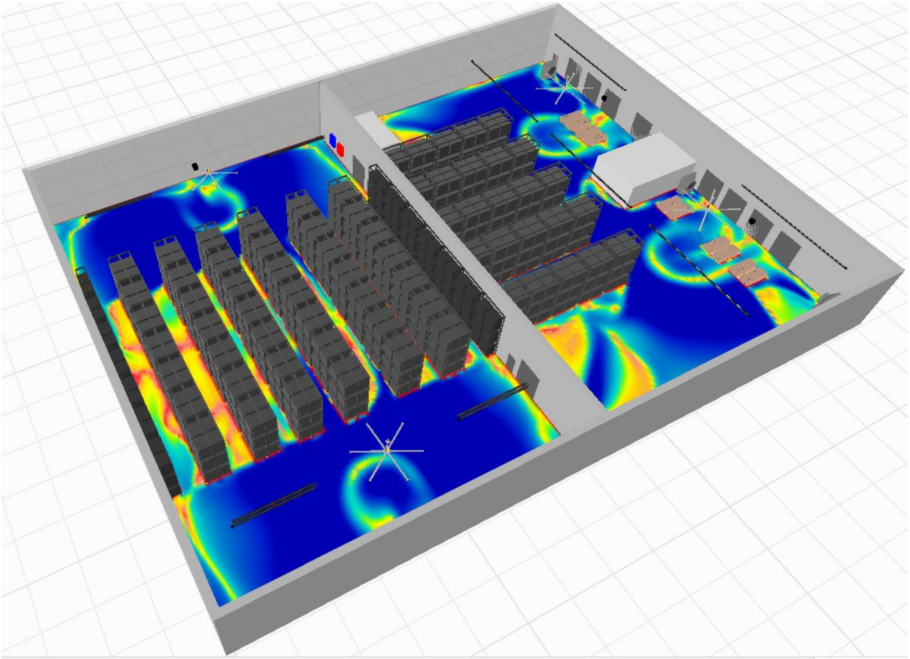


What Does an HVLS Fan Do?



Visualizing LDCF/HVLS Fan Performance





North Storage *(Airflow measured at Standing height)*

PRIMARY USE	INDOOR SUMMER TEMP	INDOOR HUMIDITY
Warehouse	80 °F	60%

	No Fans	With Fans
AVERAGE AIR VELOCITY	20ft/min	224.05ft/min
AVERAGE AIR TEMP	80 °F	80 °F
COOLING EFFECT	0 °F	9.79 °F
COOLING COVERAGE	0%	100%

With Fans PMV = 0.12
No Fans PMV = 1.24

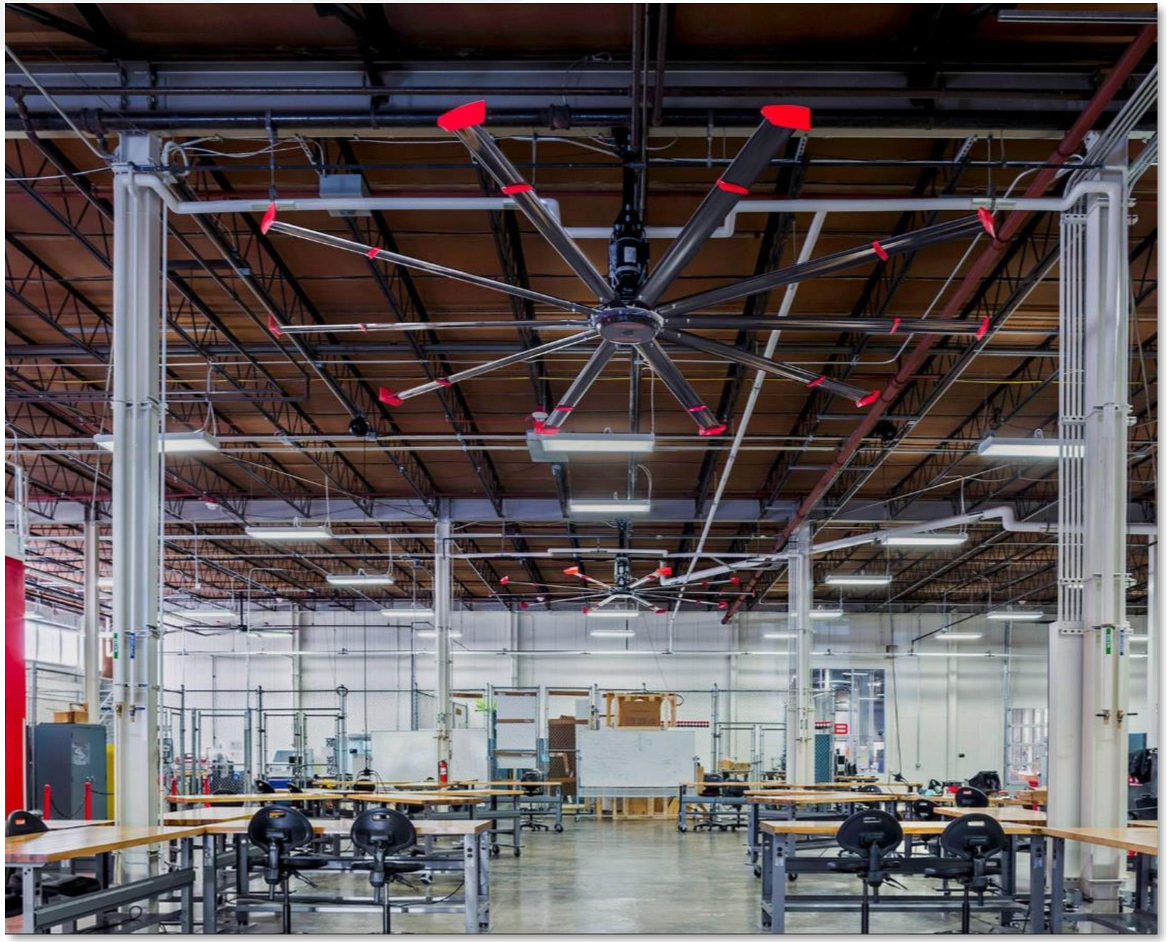
Cold (-3)	Cool	Slightly Cool	Neutral (0)	Slightly Warm	Warm	Hot (+3)

LDCF Applications Overview

- Indoor Environmental Quality
  - Occupant thermal comfort
  - Indoor air quality (IAQ)
  - Acoustical performance

- Energy savings
  - Heating
  - Cooling
  - Innovative HVAC Systems

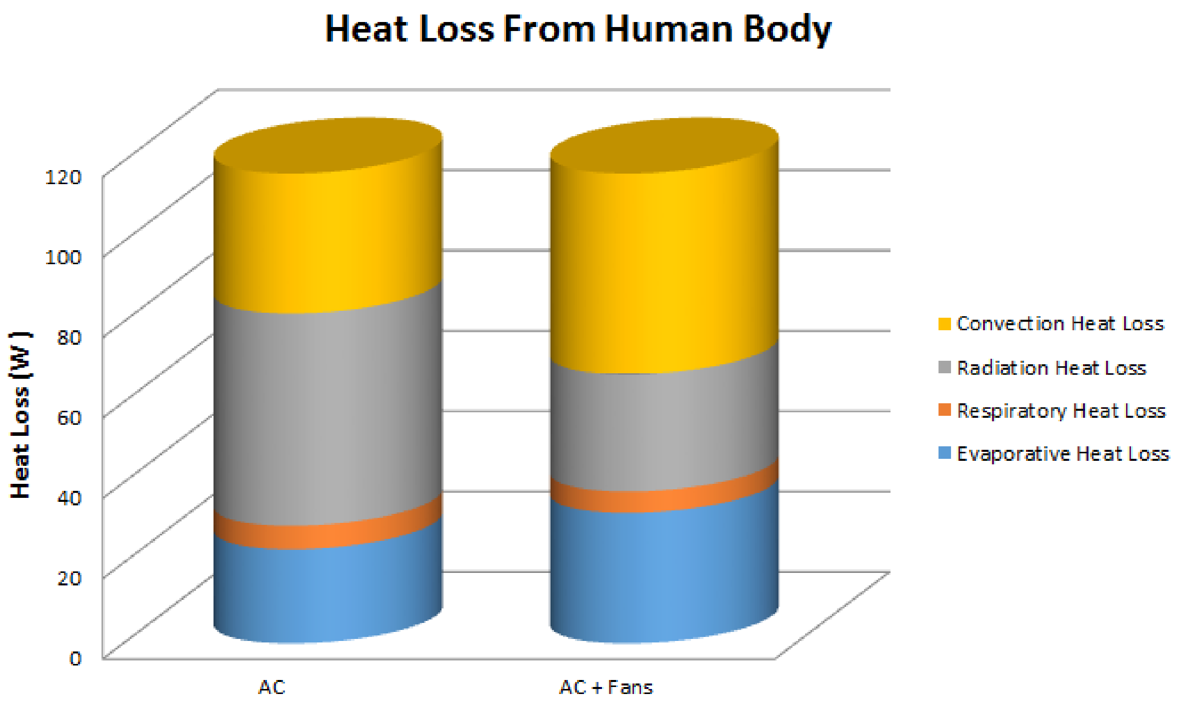
Common Real-World Applications



Using LDCF to:
Improve Thermal Comfort

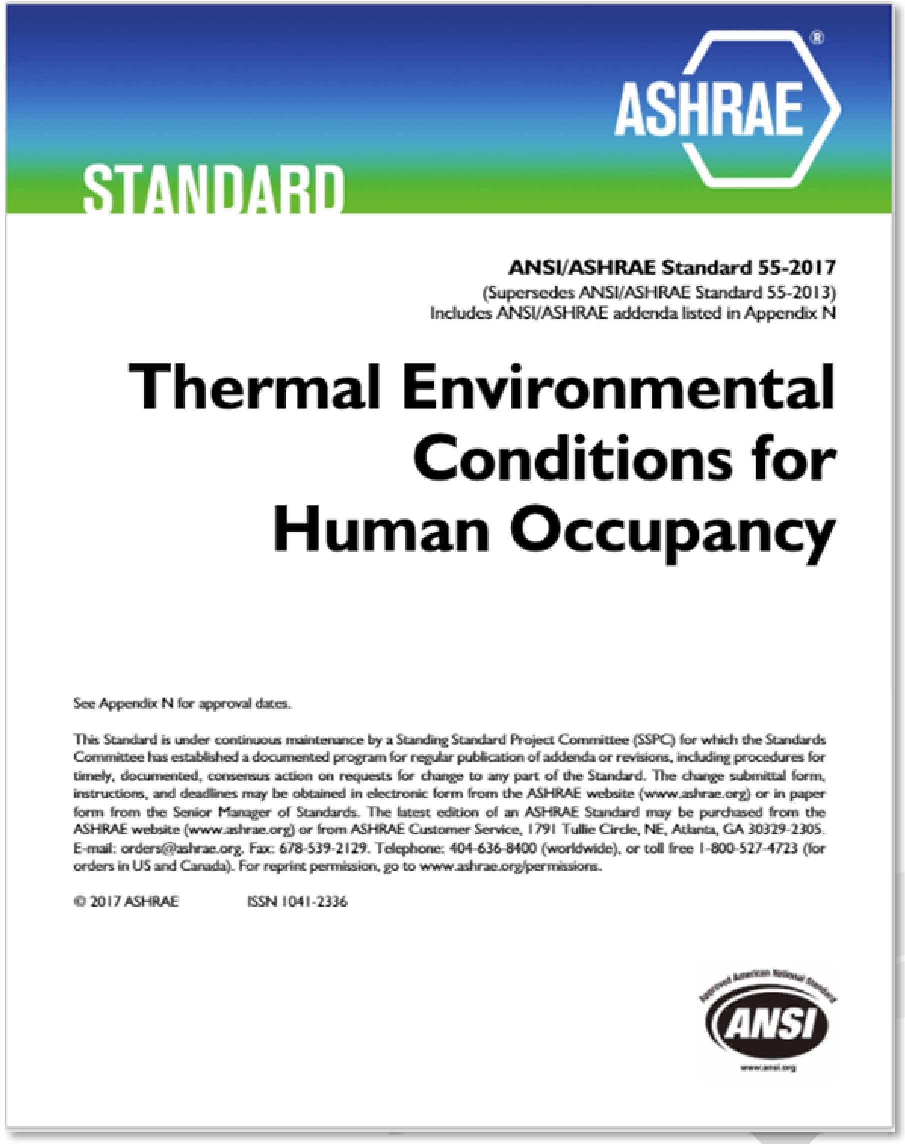
Thermal Comfort – Elevated Air Speed

- Most common comfort application for fans
- Increased heat transfer from the human body
- Sensible & latent heat transfer
  - Sensible at < ~99 °F (37 °C)
  - Latent at < 100% RH



Thermal Comfort – Average Air Speed

- ANSI/ASHRAE Standard 55-2020
  - Average air speed
    - Seated – 4”, 24”, and 43” AFF (0.1, 0.6, and 1.1m)
    - Standing – 4”, 43”, and 67” AFF (0.1, 1.1, and 1.7m)
  - Standard Effective Temperature (SET)
  - Cooling effect calculated using average air speed
  - CBE Thermal Comfort Tool
    - Quantify comfort impact
    - Determine target average air speeds
    - Evaluate different design scenarios


STANDARD

ASHRAE

ANSI/ASHRAE Standard 55-2017
(Supersedes ANSI/ASHRAE Standard 55-2013)
Includes ANSI/ASHRAE addenda listed in Appendix N

Thermal Environmental Conditions for Human Occupancy

See Appendix N for approval dates.

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 website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.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.ashrae.org/permissions.

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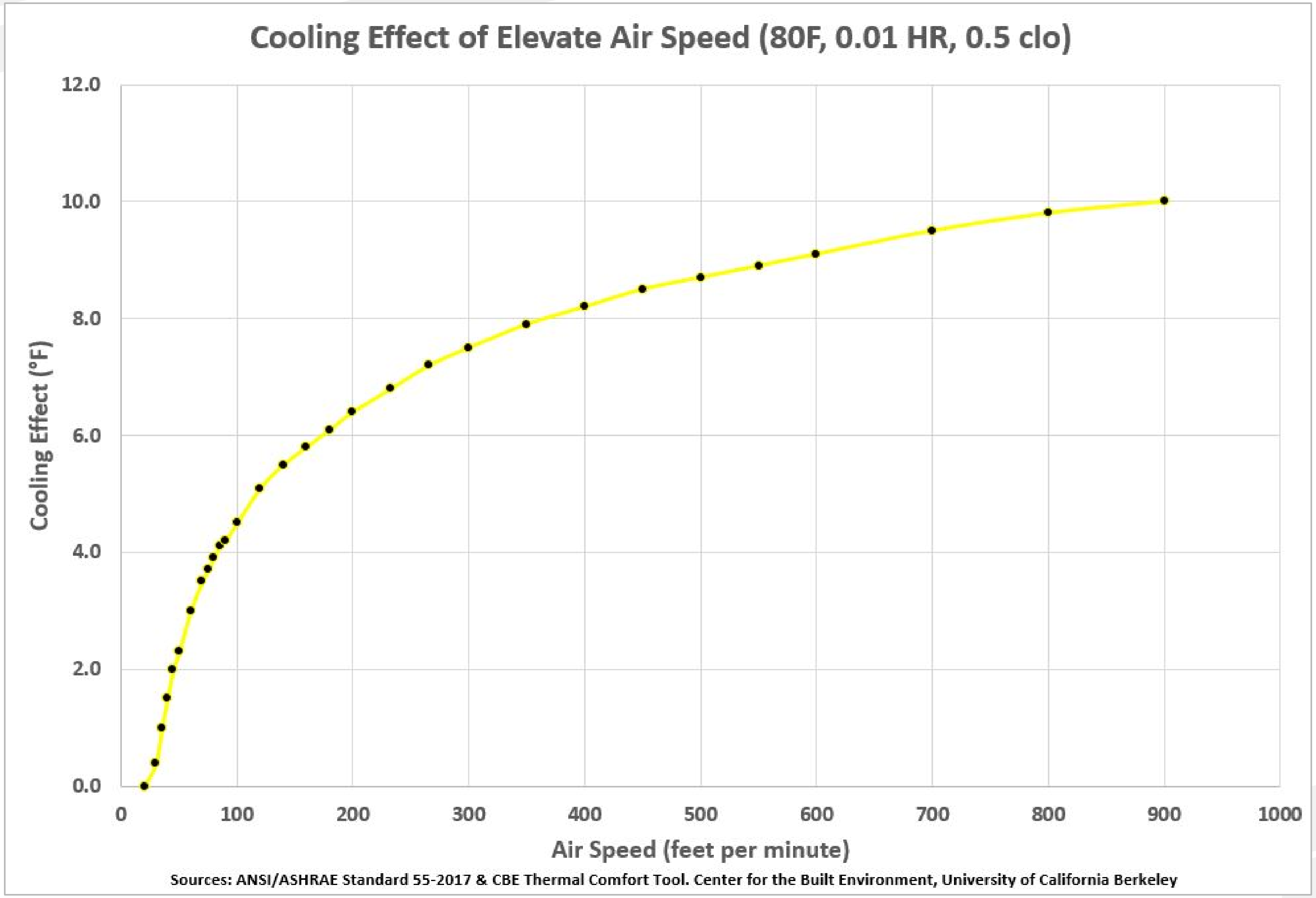
ANSI

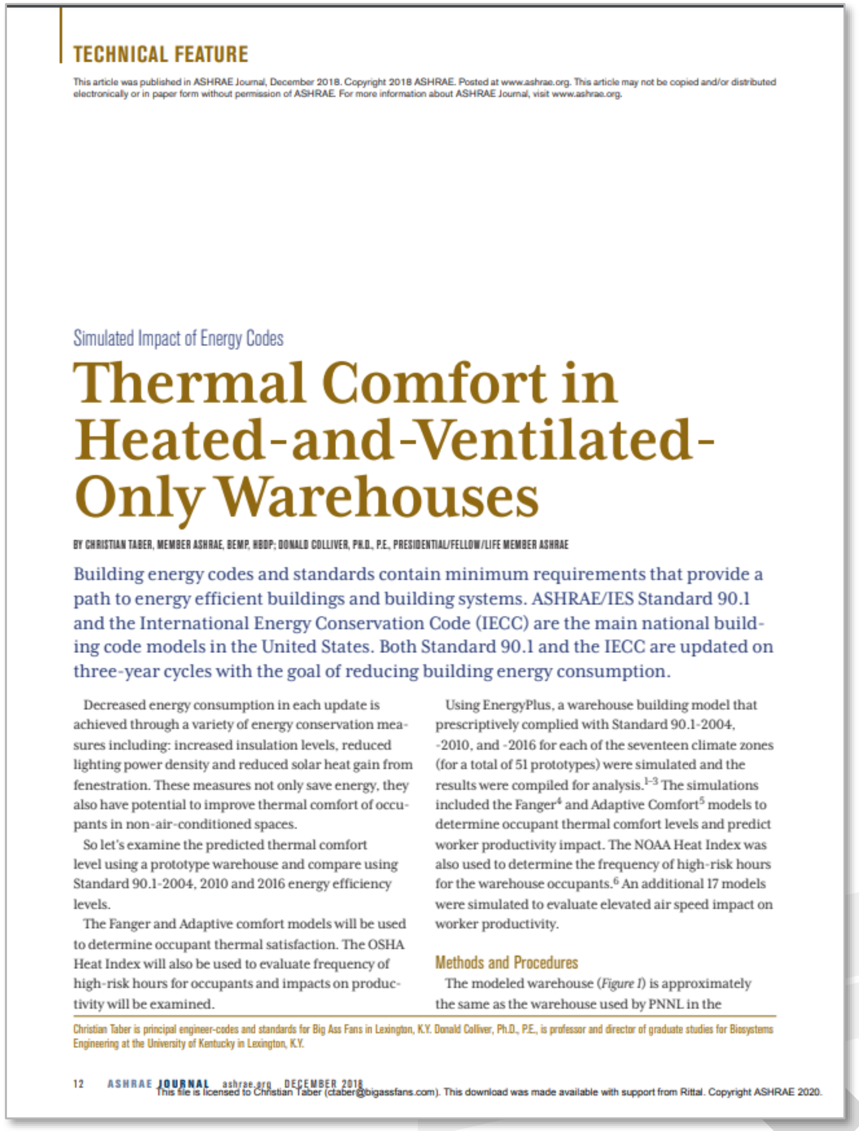
Cooling Effect of Elevated Air Speed



Note: 100 fpm = 0.5 m/s

Thermal Comfort – Additional Information

- ANSI/ASHRAE Standard 55-2020
- *Thermal Comfort in Heated-and-Ventilated-Only Warehouses*,
  - ASHRAE Journal, Dec 2018
- Center for the Built Environment
  - Numerous Publications



TECHNICAL FEATURE

Simulated Impact of Energy Codes

Thermal Comfort in Heated-and-Ventilated-Only Warehouses

BY CHRISTIAN TABER, MEMBER ASHRAE, BEMP, HBDP; DONALD COLLIVER, PH.D., P.E., PRESIDENTIAL/FELLOW/LIFE MEMBER ASHRAE

Building energy codes and standards contain minimum requirements that provide a path to energy efficient buildings and building systems. ASHRAE/IES Standard 90.1 and the International Energy Conservation Code (IECC) are the main national building code models in the United States. Both Standard 90.1 and the IECC are updated on three-year cycles with the goal of reducing building energy consumption.

Decreased energy consumption in each update is achieved through a variety of energy conservation measures including: increased insulation levels, reduced lighting power density and reduced solar heat gain from fenestration. These measures not only save energy, they also have potential to improve thermal comfort of occupants in non-air-conditioned spaces.

So let's examine the predicted thermal comfort level using a prototype warehouse and compare using Standard 90.1-2004, 2010 and 2016 energy efficiency levels.

The Fanger and Adaptive comfort models will be used to determine occupant thermal satisfaction. The OSHA Heat Index will also be used to evaluate frequency of high-risk hours for occupants and impacts on productivity will be examined.

Using EnergyPlus, a warehouse building model that prescriptively complied with Standard 90.1-2004, -2010, and -2016 for each of the seventeen climate zones (for a total of 51 prototypes) were simulated and the results were compiled for analysis.[1–3] The simulations included the Fanger[4] and Adaptive Comfort[5] models to determine occupant thermal comfort levels and predict worker productivity impact. The NOAA Heat Index was also used to determine the frequency of high-risk hours for the warehouse occupants.[6] An additional 17 models were simulated to evaluate elevated air speed impact on worker productivity.

Methods and Procedures

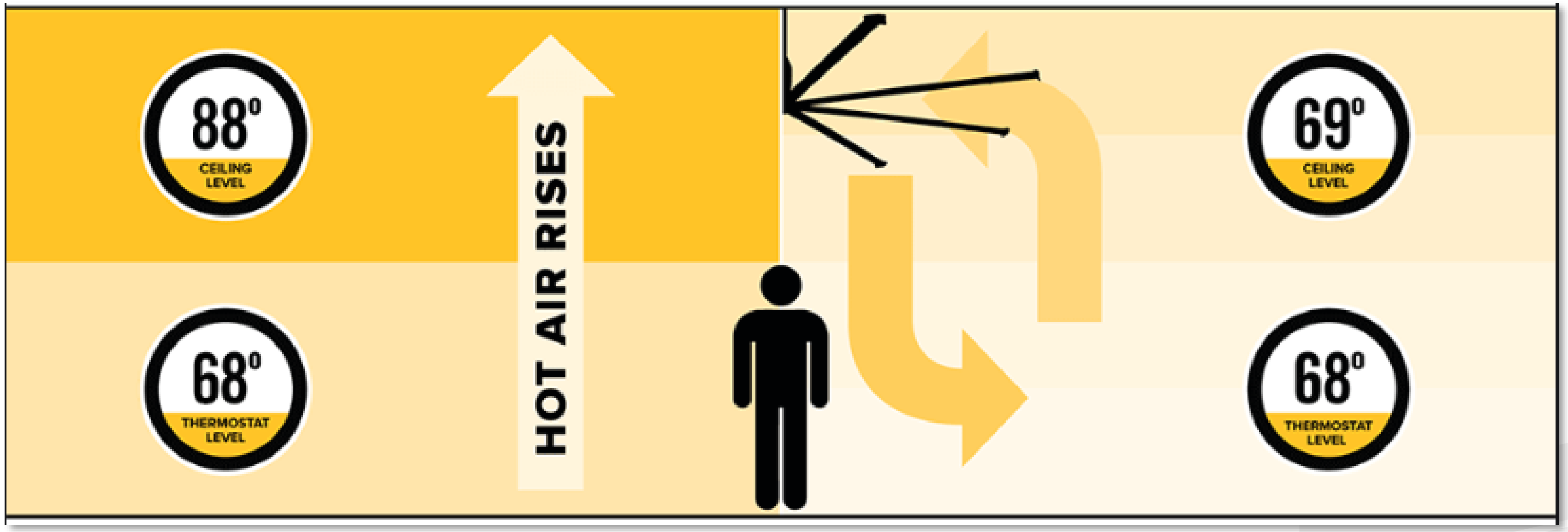
The modeled warehouse (*Figure 1*) is approximately the same as the warehouse used by PNNL in the

Christian Taber is principal engineer-codes and standards for Big Ass Fans in Lexington, K.Y. Donald Colliver, Ph.D., P.E., is professor and director of graduate studies for Biosystems Engineering at the University of Kentucky in Lexington, K.Y.

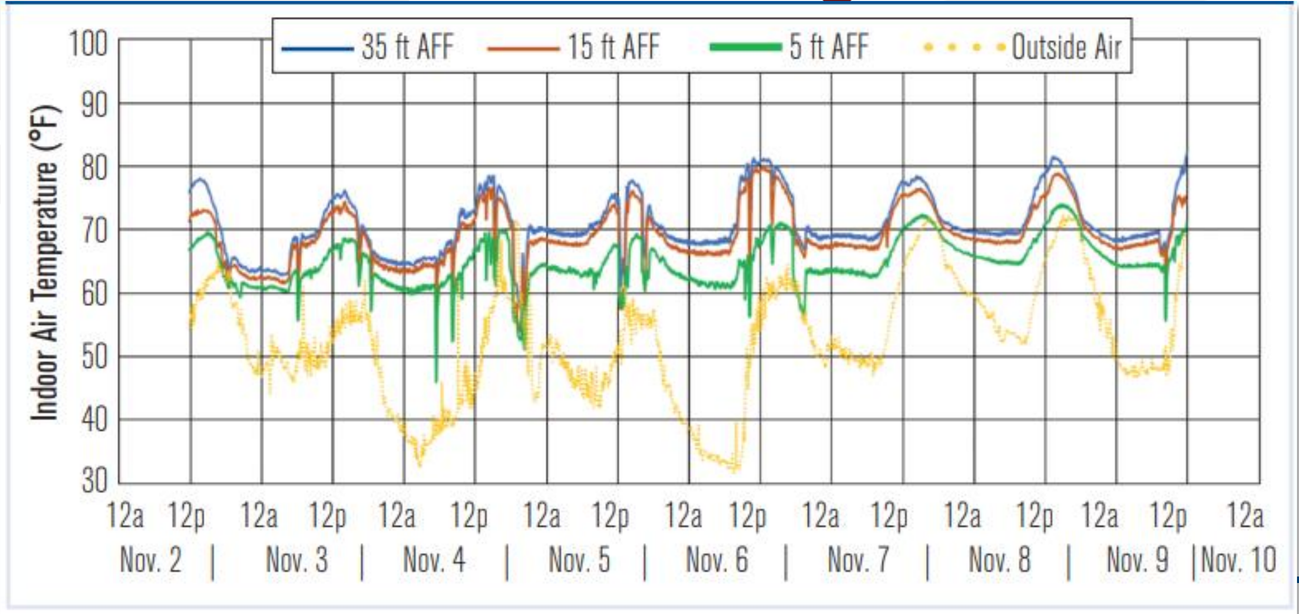
Using LDCF to:
Decrease Building Energy Use

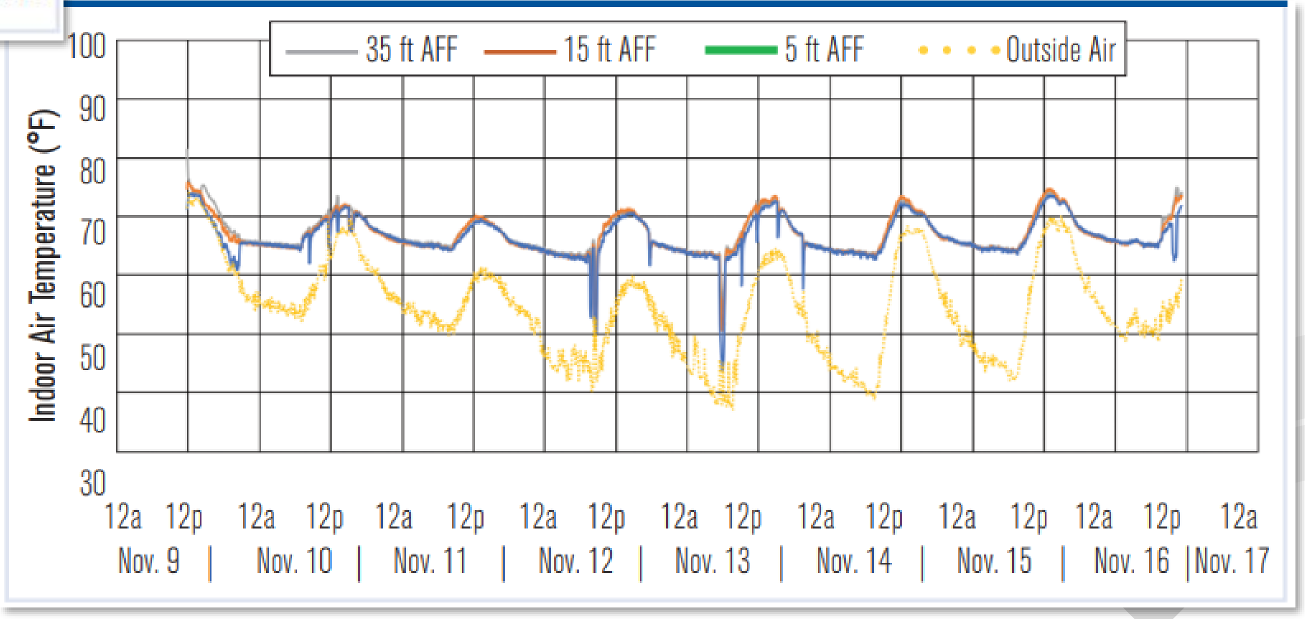
Thermal Mixing (Destratification)

- Most common energy saving application
- Mixing stratified layers of air
- High ceilings, overhead supply/return ideal



Thermal Mixing – Floor to Ceiling Temps





Impact of HVLS Fans on Airplane Hangar Air Destratification, ASHRAE Journal, April 2020

Heating Savings - Additional Information

- *Impact of HVLS Fans on Airplane Hangar Air Destratification*
  - ASHRAE Journal, April 2020

- *Optimizing Winter Heating: Is reversing the direction of your ceiling fan the best way to achieve thermal destratification?,*
  - Sonya Milonova, Harvard School of Public Health

TECHNICAL FEATURE

Impact of HVLS Fans On Airplane Hangar Air Destratification

BY CHRISTIAN TABER, BEMP, HBDP, MEMBER ASHRAE; BRANDON A. STEELE, STUDENT MEMBER ASHRAE

Thermal air stratification results when heated air rises due to its having a lower density relative to ambient air, which results in a thermal gradient from floor to ceiling. The heated air typically stagnates at the ceiling of large facilities due to a lack of air circulation.[1,2] Air stratification presents an important consideration in facility energy savings for buildings with tall ceilings; elevated air temperature at the ceiling level increases the rate of heat loss through the building envelope. A substantial opportunity to reduce annual heating costs for facilities is available by reducing floor-to-ceiling stratification.

Airports present a tremendous air destratification energy savings opportunity because many of the buildings have large, open spaces with high ceilings. Heating airport hangars to meet comfort temperature requirements often consumes large amounts of energy and produces an excessive amount of emissions. Like many other areas of industry,[3] airports are now under pressure to use energy-efficient systems and comply with increasingly stringent regulations while still providing occupant thermal comfort, all in an effort to reduce operating costs and reduce carbon footprint.

High volume, low speed (HVLS) fans are a prominent and practical means for reducing the floor-to-ceiling temperature gradient in large spaces. Large-diameter, HVLS fans are operated in the downward direction at low speeds during winter to mix warm air at the ceiling with cooler air at the floor, all while not creating the sensation of unwanted cooling across an occupant's skin. Fans can be operated in the upward direction to destratify air, but this typically requires higher operating speeds and costs, as the fan has to push the heated air along the ceiling and down a vertical surface to reach the thermostat level. The fans lower the average space temperature by minimizing excess heat at the ceiling, which reduces HVAC system use. The study presented in this article seeks to quantify the effects on energy cost and consumption from use of an HVLS fan for air destratification in an airport hangar.

Methods

The test building is 15,000 ft^2 (1,400 m^2), has a peak ceiling height of 40 ft (12 m) and height of 20 ft (6 m) at

Christian Taber, BEMP, HBDP, is principal engineer-codes and standards for Big Ass Fans in Lexington, Ky. Brandon A. Steele is Big Ass Fans' sustainability engineering intern and a student at the University of Kentucky.

Cooling Energy Savings

- What does it do
  - Increase convective & evaporative heat loss
  - Distribution and mixing
- What is the design criteria
  - Spaces with AC - 100 fpm to 200 fpm
- What is the result
  - Equal comfort at higher dry bulb temperatures
  - Reduced cooling energy use
  - Reduced duct work
  - Redundancy for increased resiliency
  - Reduced AC capacity OR
  - Excess capacity for future climate

CEC - EPIC Project 16-013

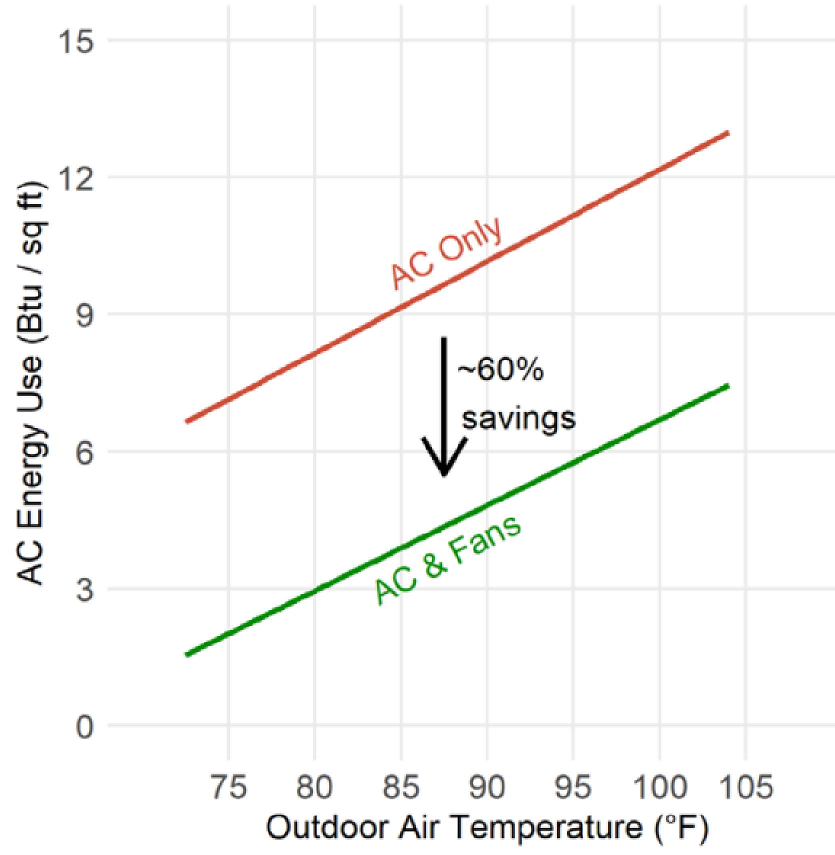
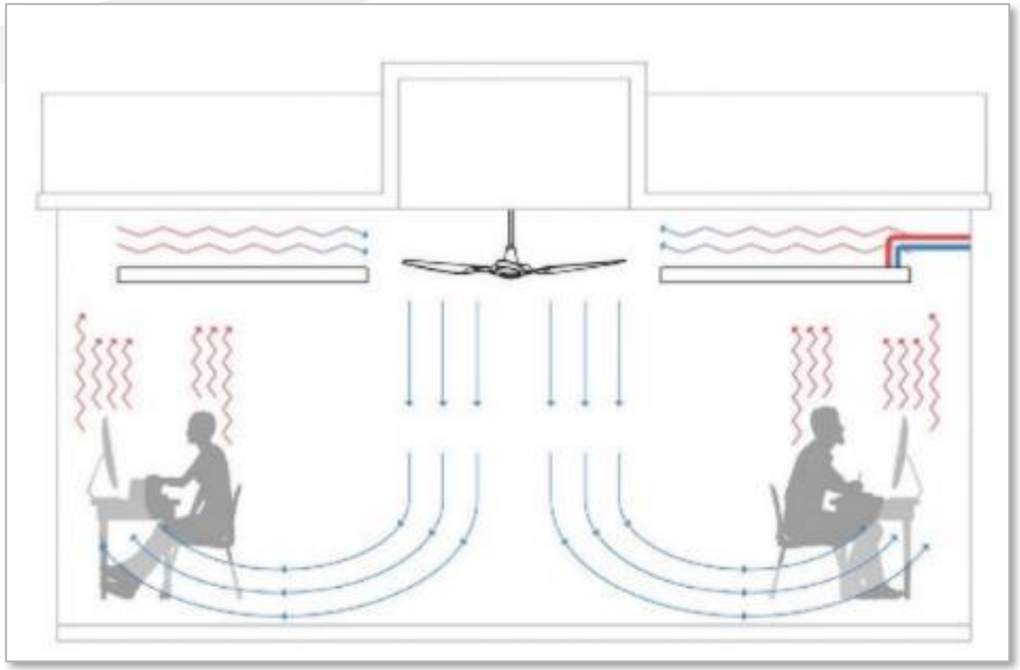


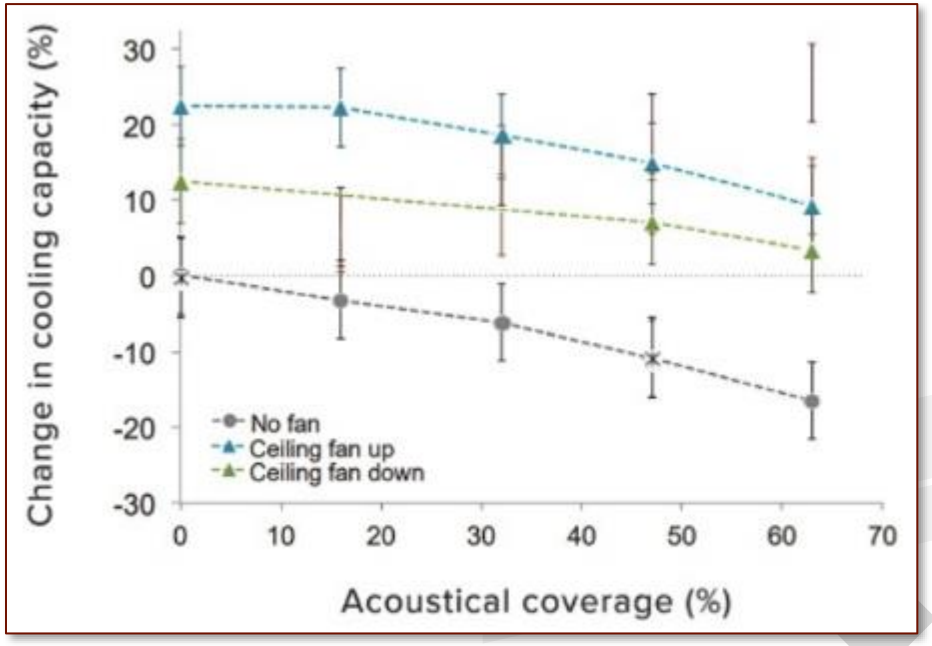
Figure 1. HVAC energy use in the common room was reduced by 60% by raising setpoints and using fans to cool occupants when the temperature was above 74 °F.

Note: 100 fpm = 0.5 m/s

Innovative HVAC Systems

- What does it do
  - Reduce required materials
  - Increases heat transfer
- What is the design criteria
  - Increased air speed
- What is the result
  - Instant cooling of occupants (forward)
  - Increased system capacity (forward and reverse)
  - Increased air distribution (forward and reverse)





Example System: Overhead Radiant + Fans

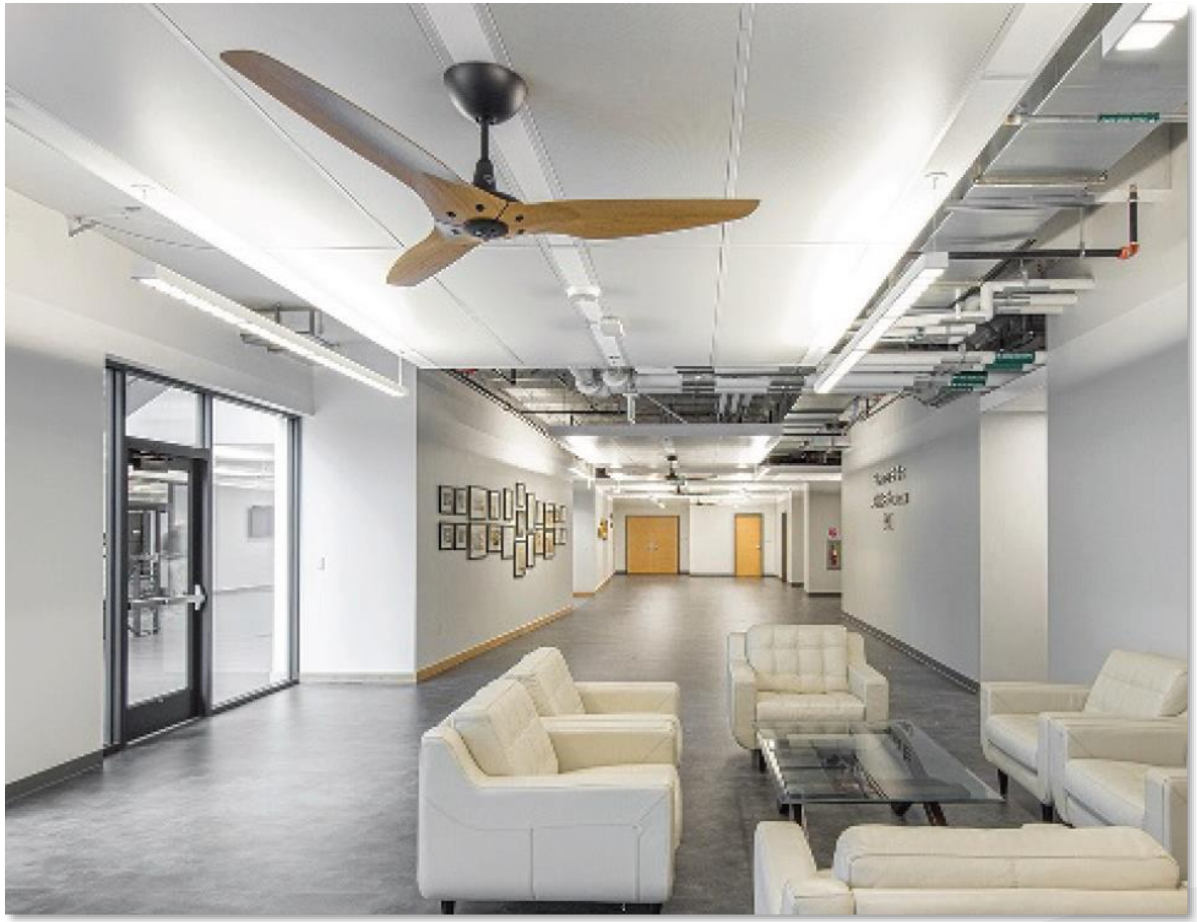


Image Source: ASHRAE GLOBAL HEADQUARTERS TRANSFORMING BUILDINGS FOR A SUSTAINABLE FUTURE

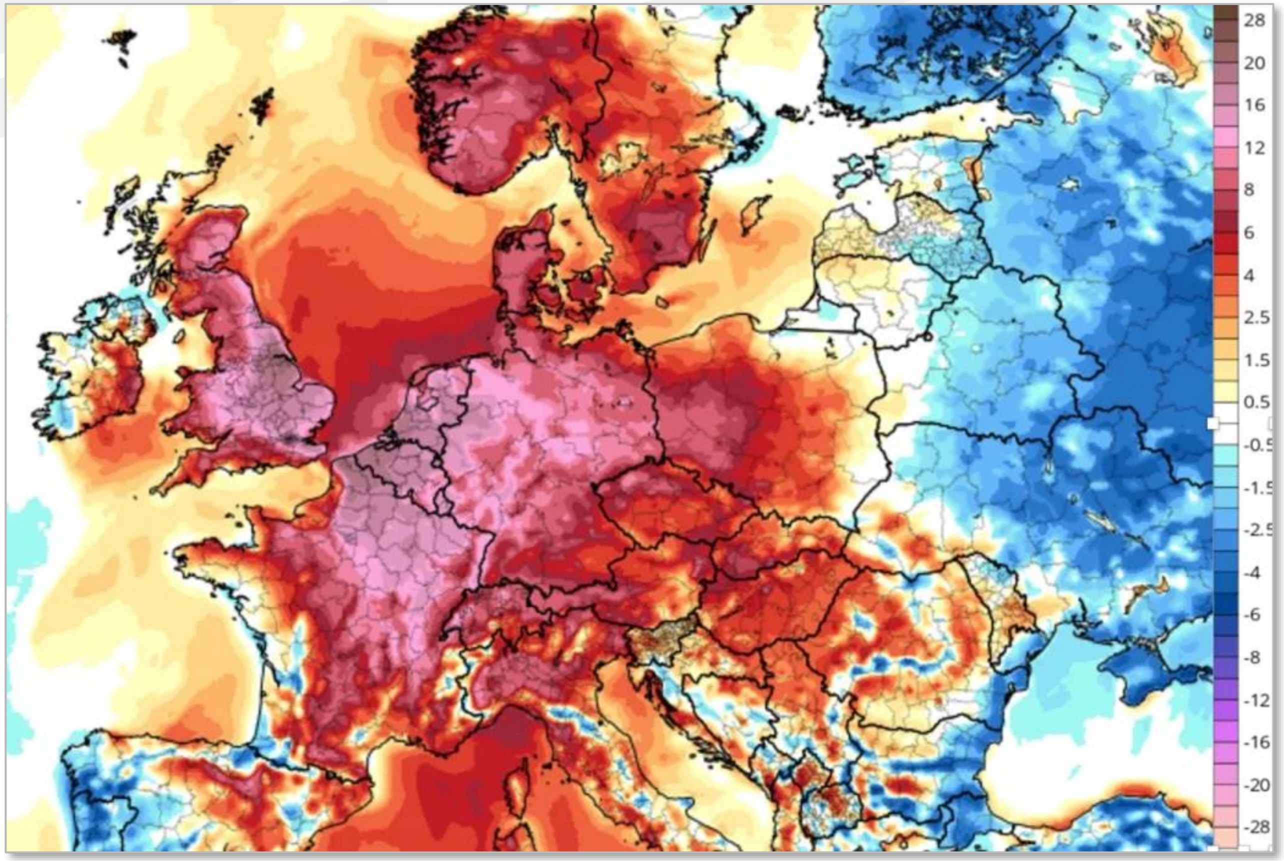
Additional Information

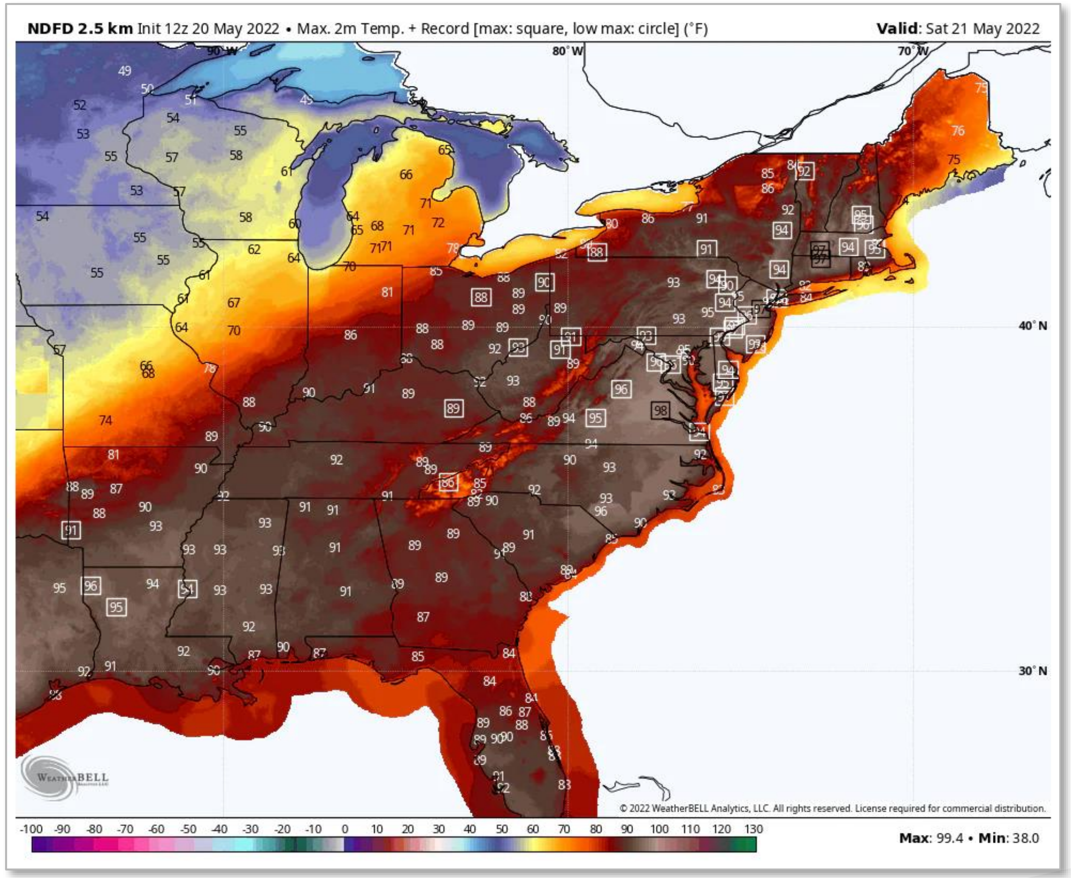
- ANSI/ASHRAE Standard 55-2020
- Center for the Built Environment Case Studies
- Integrating Smart Ceiling Fans and Communicating Thermostats to Provide Energy-Efficient Comfort
  - CEC Final Report
- ASHRAE Global Headquarters
  - Transforming Buildings for a Sustainable Future

Using LDCF to:

Increase Resilience During Extreme Events

Local Extreme Events – Heatwave Examples





Heat waves: increasing in frequency, magnitude, and often the most memorable and wide-spread resilience events, more than 15,000 deaths in 2022 attributed to heat (1)

Image Source: Yale Climate Connections, The Washington Post

(1) SOURCE: World Health Organization: Statement – Climate change is already killing us, but strong action now can prevent more deaths

Global Climatic Changes

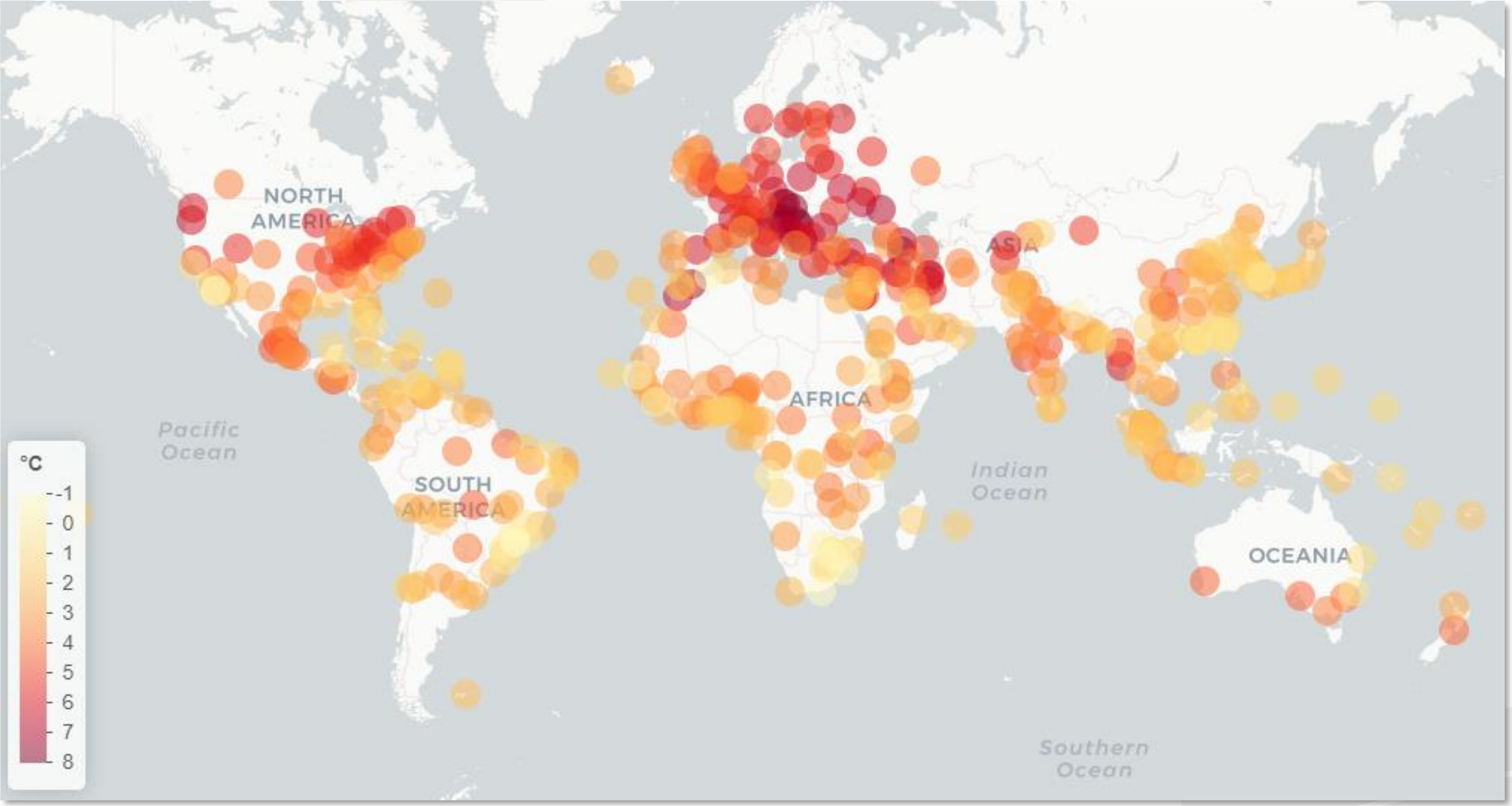
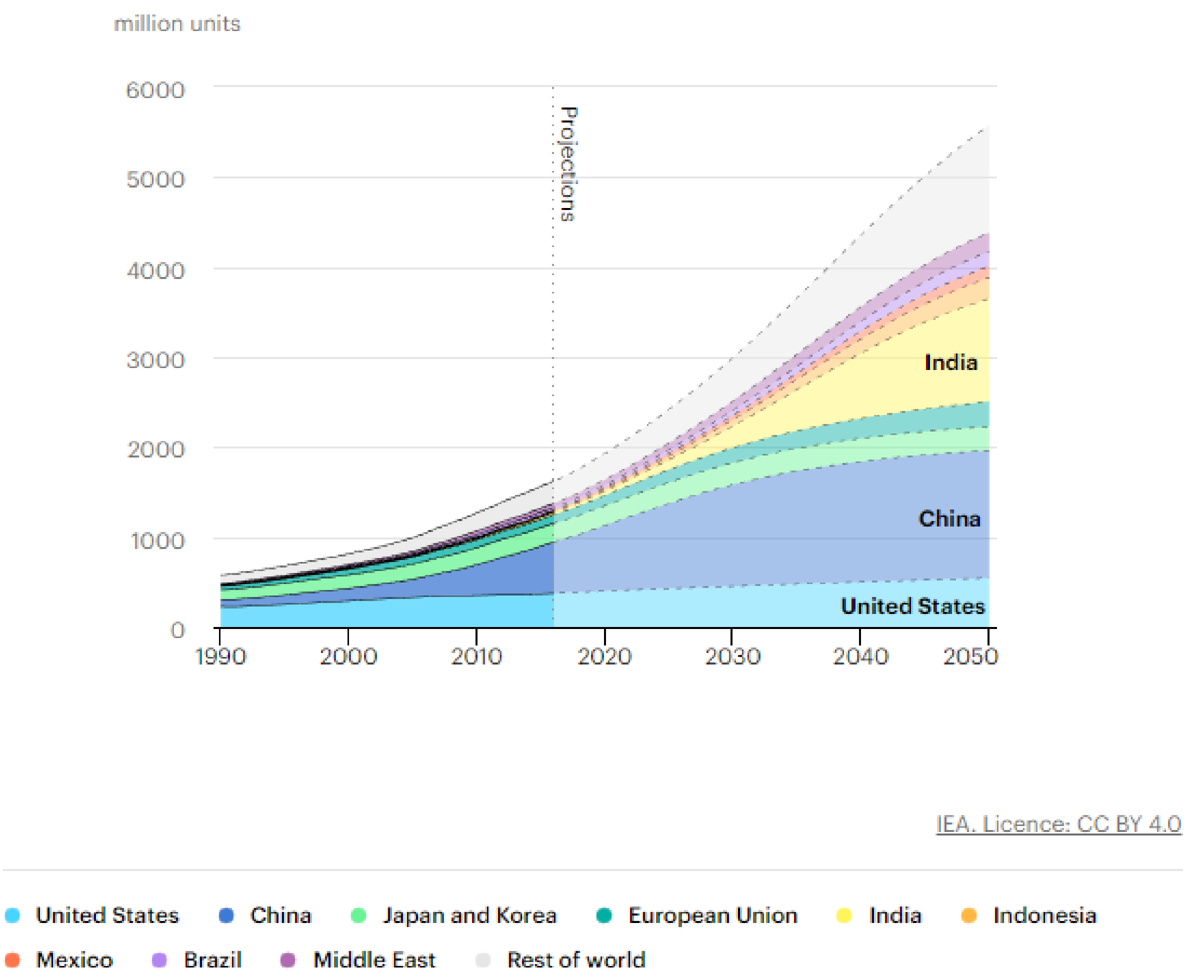


Image Source: ETH Zurich, Crowther Lab: Cities of the Future, Visualizing Climate Change to Inspire Action

Demand for Cooling, Industry Changes

Global air conditioner stock, 1990-2050

Open



ENVIRONMENT

Seattle is no longer the U.S.'s least air conditioned big city

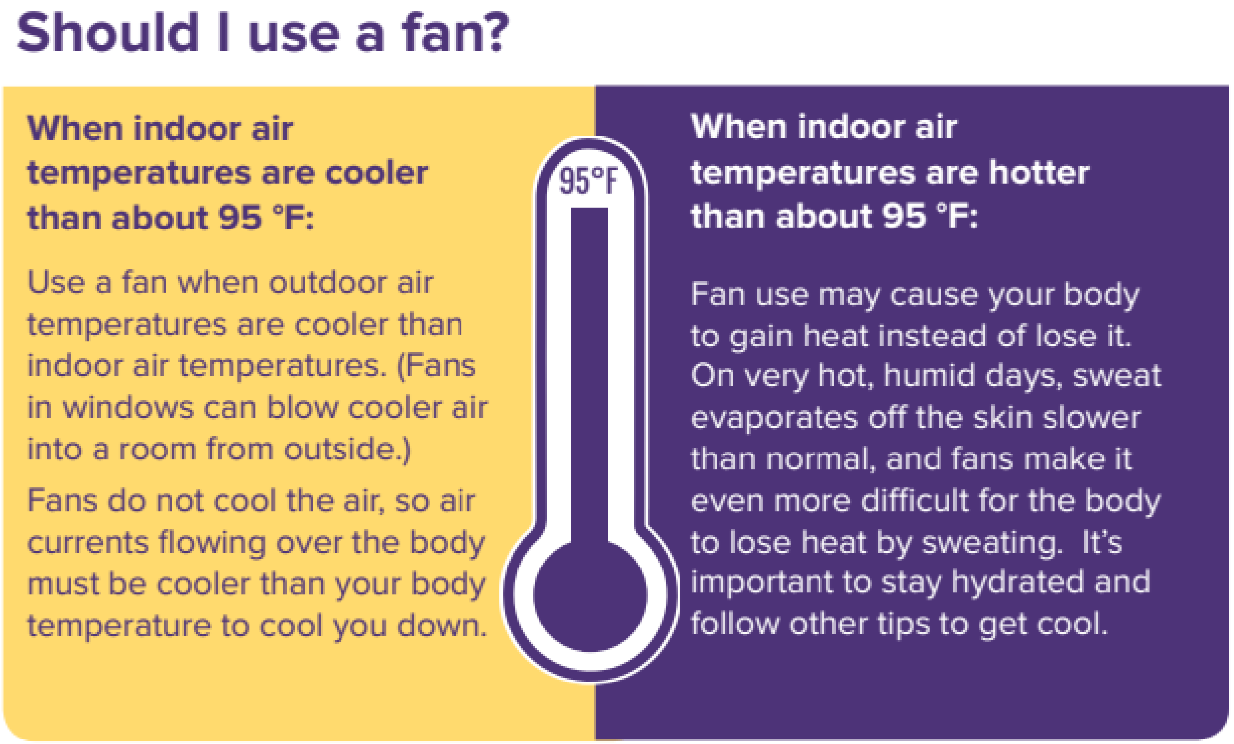
After years of lethal heat waves, Seattleites are embracing A/C as a necessity rather than a luxury.

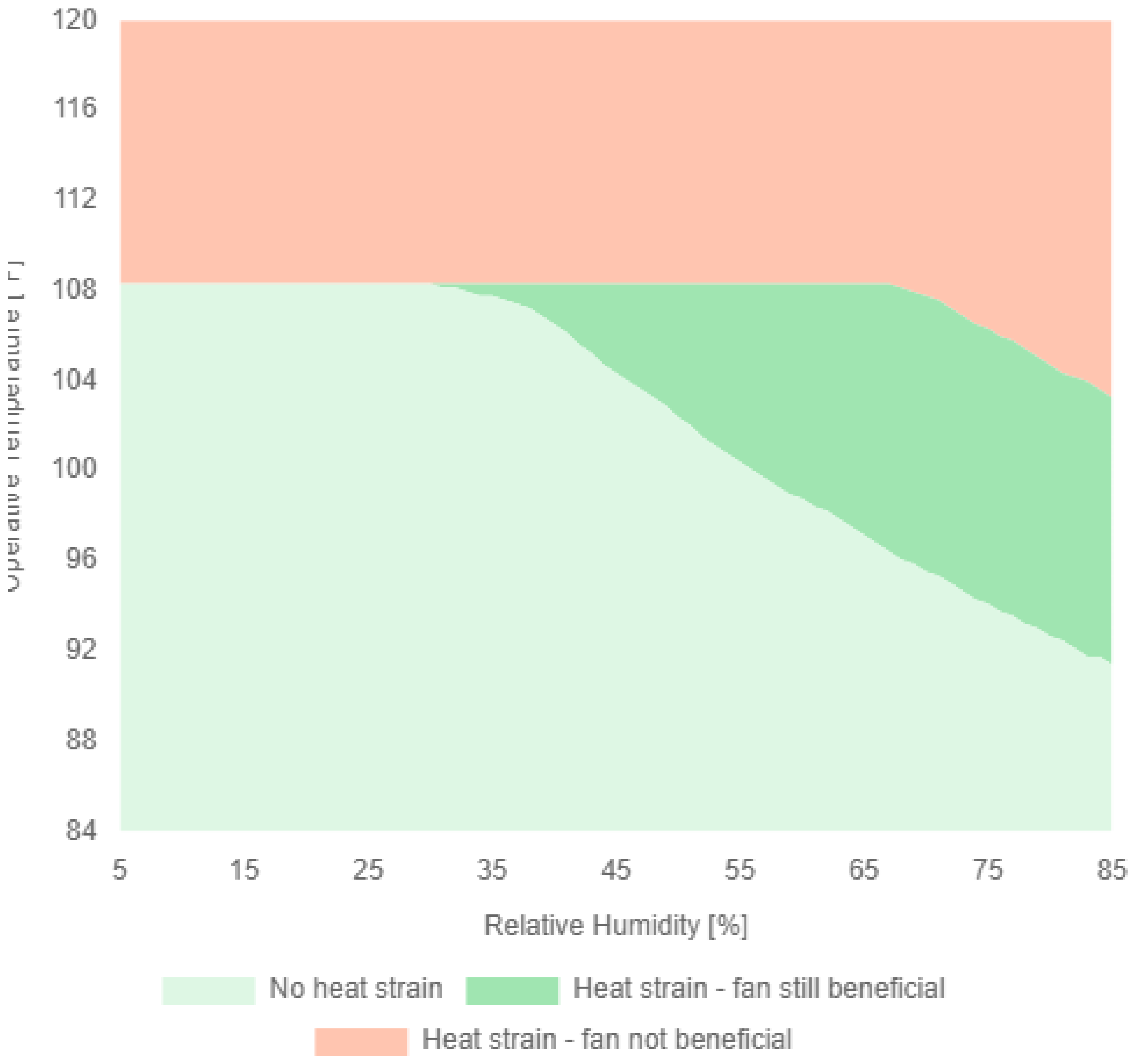
by Hannah Weinberger / December 29, 2022

When Fred Woo and his family moved from San Diego to Seattle a decade ago, they brought their portable air conditioning unit with them, thinking it wouldn't be necessary in our historically temperate climate. They were right — for a while.

Image Source: IEA, Crosscut - Hannah Weinberger

Fans and Heat – Common Misconceptions





Above: an example of **<u>incorrect</u>** heat stress mitigation guidance from a health department.

Right: CBE research showing fans provide beneficial heat rejection at operative temperatures up to 104 deg F regardless of humidity conditions *(0.5 Clo, 1.2 Met, 150 fpm)* (1)

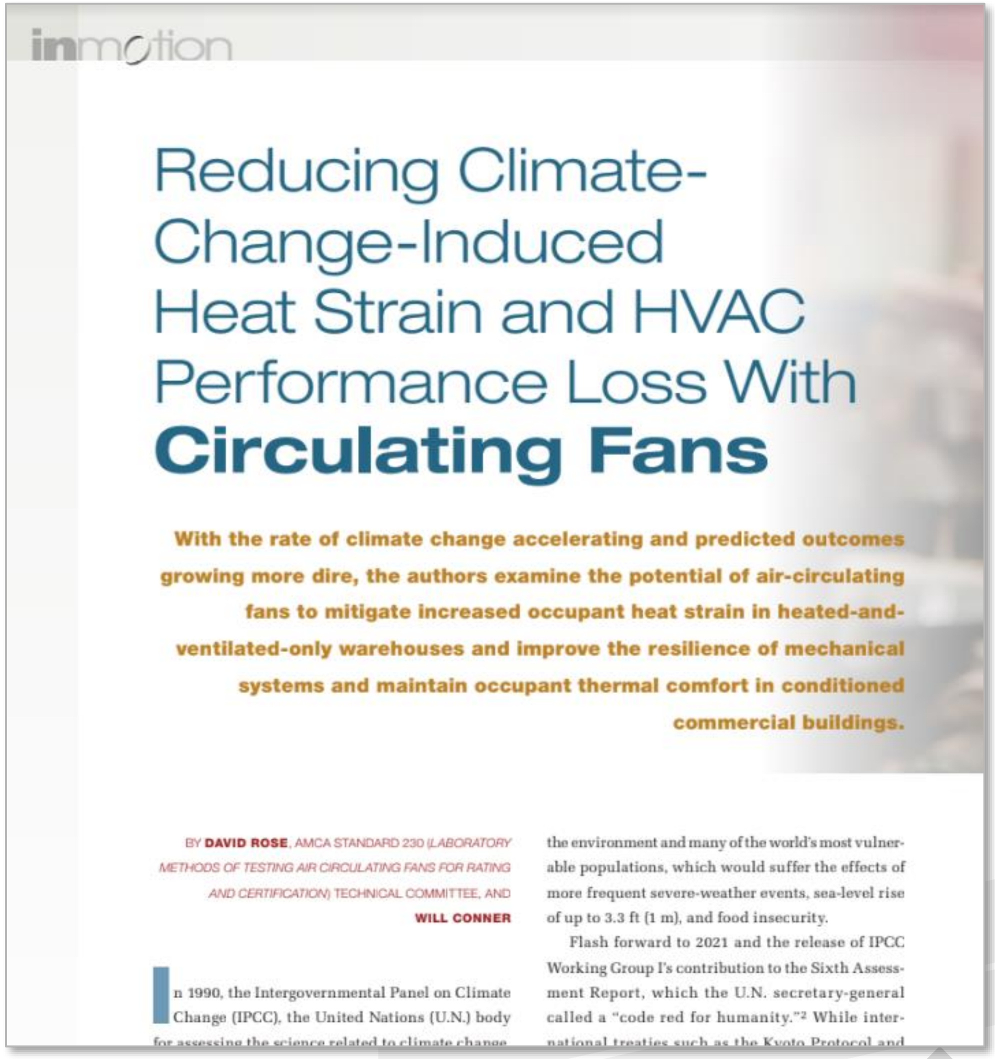
(1) Tartarini, F., Schiavon, S., Cheung, T., Hoyt, T., 2020. CBE Thermal Comfort Tool : online tool for thermal comfort calculations and visualizations. SoftwareX 12, 100563. https://doi.org/10.1016/j.softx.2020.100563

Image Source: NY State Dept of Health, Center for the Built Environment, UC Berkley

Mitigating Effects of Climate Change with Fans

- **Unconditioned Warehouse Environment**
  - ***Can fans mitigate occupant heat stress increases in future conditions?***
  - **Methods:** Energy modeling and analysis of a DOE warehouse reference building
  - **Tools:** Commercially available building energy simulation software, TMY3 data, CBE Python thermal comfort code, NWS heat index tool.

- **Conditioned Office Environment**
  - ***Can fans mitigate increase in peak cooling load and energy use in future conditions?***
  - **Methods:** Energy modeling and analysis of a DOE medium office reference building
  - **Tools:** Commercially available building energy simulation software, TMY3 data, CBE Python thermal comfort code.


inmotion

Reducing Climate-Change-Induced Heat Strain and HVAC Performance Loss With **Circulating Fans**

With the rate of climate change accelerating and predicted outcomes growing more dire, the authors examine the potential of air-circulating fans to mitigate increased occupant heat strain in heated-and-ventilated-only warehouses and improve the resilience of mechanical systems and maintain occupant thermal comfort in conditioned commercial buildings.

BY **DAVID ROSE**, AMCA STANDARD 230 (*LABORATORY METHODS OF TESTING AIR CIRCULATING FANS FOR RATING AND CERTIFICATION*) TECHNICAL COMMITTEE, AND **WILL CONNER**

In 1990, the Intergovernmental Panel on Climate Change (IPCC), the United Nations (U.N.) body

the environment and many of the world's most vulnerable populations, which would suffer the effects of more frequent severe-weather events, sea-level rise of up to 3.3 ft (1 m), and food insecurity.

Flash forward to 2021 and the release of IPCC Working Group I's contribution to the Sixth Assessment Report, which the U.N. secretary-general called a "code red for humanity."[2] While inter-

Image Source: AMCA In-Motion 2022, Reducing Climate Change … With Circulating Fans

Heat Stress Resilience – Typical Warehouse

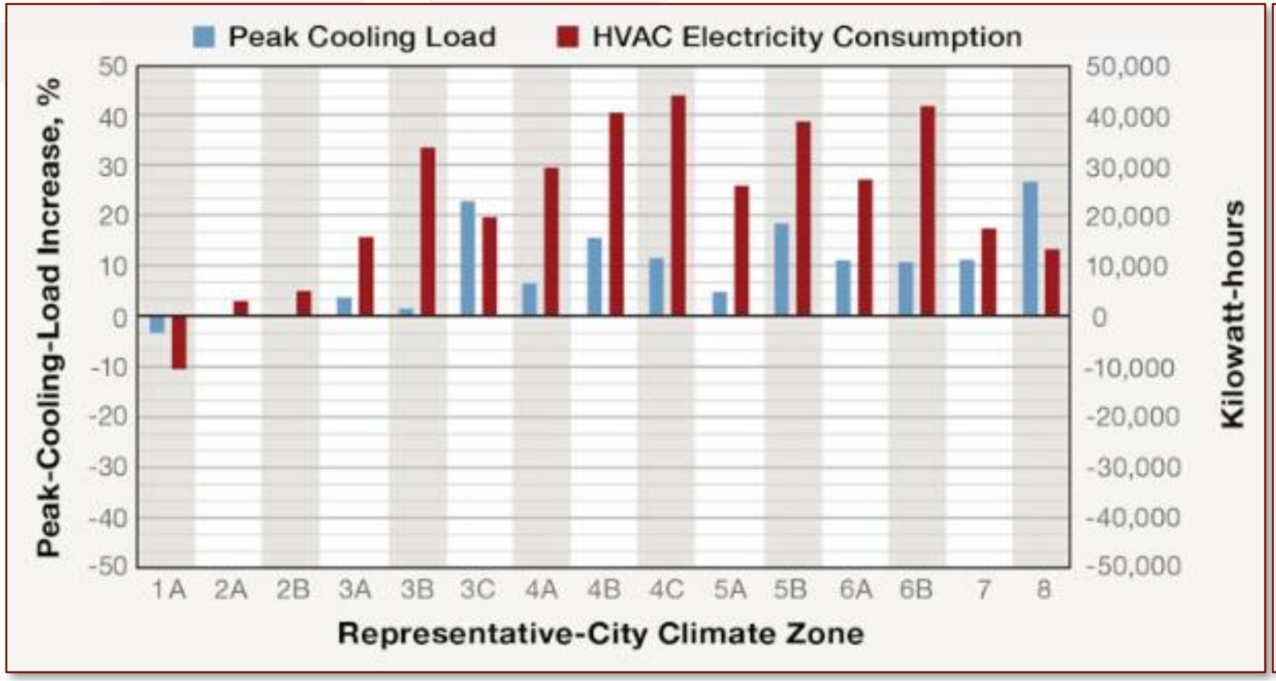
Representative City	CZ	Current Weather				Dangerous Hours
		Neutral	Very Warm	Hot	Very Hot	
Miami, Fla.	1A	1,709	2,348	2,991	1,712	4,703
Houston, Texas	2A	3,775	1,551	2,312	1,122	3,434
Phoenix, Ariz.	2B	3,184	1,783	2,639	1,154	3,793
Atlanta, Ga.	3A	4,854	1,604	1,804	498	2,302
Las Vegas, Nev.	3B	4,482	1,179	2,653	446	3,099
San Francisco, Calif.	3C	8,465	295	0	0	0
Baltimore, Md.	4A	5,866	1,595	1,275	24	1,299
Albuquerque, N.M.	4B	5,337	1,868	1,548	7	1,555
Seattle, Wash.	4C	8,261	494	5	0	5
Chicago, Ill.	5A	6,214	1,916	622	8	630
Boulder, Colo.	5B	6,319	1,922	519	0	519
Minneapolis, Minn.	6A	6,711	1,582	466	1	467
Helena, Mont.	6B	7,175	1,371	214	0	214
Duluth, Minn.	7	7,958	786	16	0	16
Fairbanks, Alaska	8	8,175	585	0	0	0

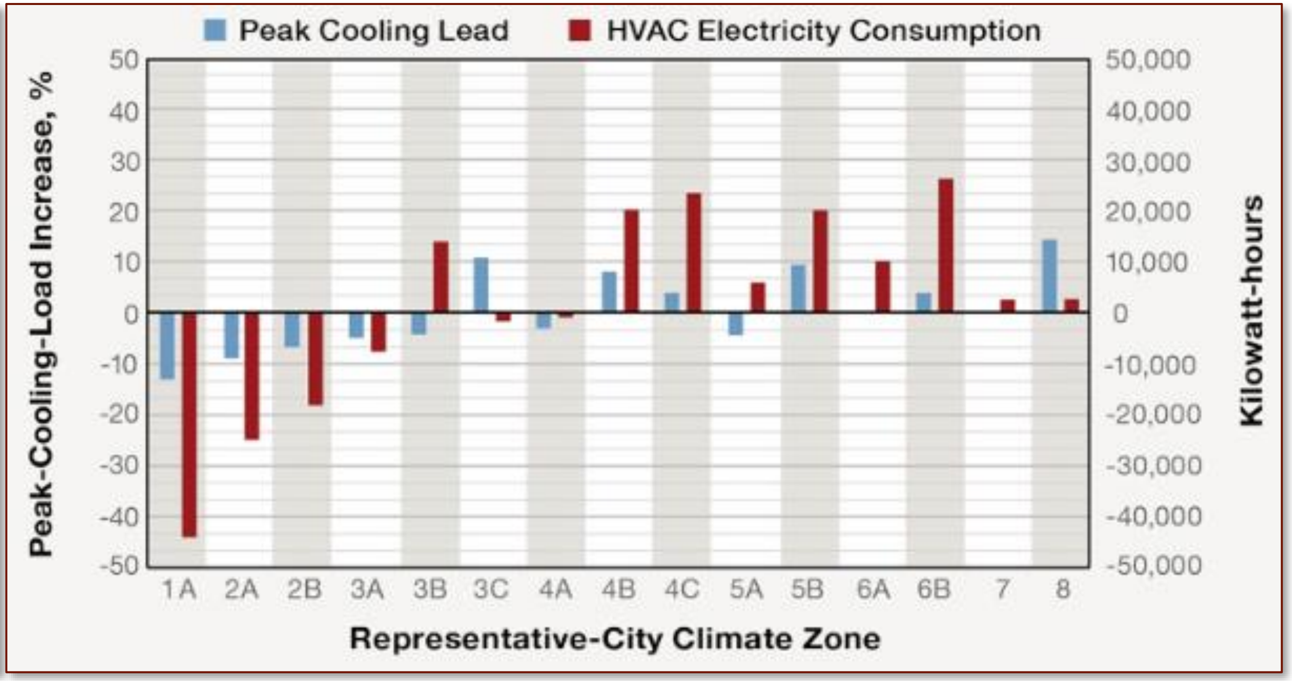
Future City Analog	Future Weather				Change in Dangerous Hours vs. Current
	Neutral	Very Warm	Hot	Very Hot	
Rio de Janeiro, Brazil	467	3,147	4,039	1,107	443 (9%)
Jacksonville, Fla.	3,853	1,895	2,416	596	-422 (-12%)
Kuwait City, Kuwait	2,594	1,594	3,511	1,061	779 (21%)
Memphis, Tenn.	4,858	1,485	1,953	464	115 (5%)
Phoenix, Ariz.	3,184	1,783	2,639	1,154	694 (22%)
Lisbon, Portugal	6,098	2,472	190	0	190 (NL)
Nashville, Tenn.	4,856	1,611	1,937	356	994 (77%)
El Paso, Texas	4,342	1,380	2,900	138	1,483 (95%)
San Francisco, Calif.	8,465	295	0	0	-5 (-100%)
St. Louis, Mo.	5,688	1,294	1,660	118	1,148 (182%)
Amarillo, Texas	5,883	1,438	1,421	18	920 (177%)
Kansas City, Mo.	5,791	1,283	1,640	46	1,219 (261%)
Salt Lake City, Utah	6,207	1,288	1,260	5	1,051 (491%)
Toledo, Ohio	6,341	1,930	489	0	473 (2,956%)
Winnipeg, Canada	7,289	1,145	326	0	326 (NL)

Future City Analog	Future Weather With Fans				Change in Dangerous Hours vs. Current
	Neutral	Very Warm	Hot	Very Hot	
Rio de Janeiro, Brazil	1,899	4,236	2,514	111	-2,078 (-44%)
Jacksonville, Fla.	5,085	1,895	1,748	32	-1,654 (-48%)
Kuwait City, Kuwait	3,388	1,590	3,749	33	-11 (0%)
Memphis, Tenn.	5,733	1,530	1,489	8	-805 (-35%)
Phoenix, Ariz.	4,103	1,668	2,890	99	-110 (-4%)
Lisbon, Portugal	7,560	1,200	0	0	0 (NL)
Nashville, Tenn.	5,652	1,982	1,114	12	-173 (-13%)
El Paso, Texas	4,926	2,085	1,749	0	194 (12%)
San Francisco, Calif.	8,754	6	0	0	-5 (-100%)
St. Louis, Mo.	6,271	1,908	581	0	-49 (-8%)
Amarillo, Texas	6,509	1,758	493	0	-26 (-5%)
Kansas City, Mo.	6,432	1,795	533	0	66 (14%)
Salt Lake City, Utah	6,686	1,738	336	0	122 (57%)
Toledo, Ohio	7,401	1,302	57	0	41 (256%)
Winnipeg, Canada	7,995	731	34	0	34 (NL)

Image Source: AMCA In-Motion 2022, Reducing Climate Change … With Circulating Fans

HVAC Performance Loss – Typical Office





Without fans: significant increases in both peak load and annual energy consumption.

With Fans: Reduced or significant mitigations in anticipated peak load and annual energy consumption

Image Source: AMCA In-Motion 2022, Reducing Climate Change … With Circulating Fans

Specifying LDCF for:
Thermal Comfort, Efficiency, & Resilience

Fan Safety Standards - UL 507 & CSA Standard 22.2 No. 113

- Third party safety standard for fans
  - Provides a minimum safety level, but does not cover industrial impact testing
  - Requires blades have smooth/rounded leading edges, safe electrical systems, etc.

- Designates ceiling fans into two categories
  - Safe to mount with blades ≥7 ft (2.1m) blade height - “Residential”
  - Safe to mount with blades ≥10 ft (3.05m) blade height - “Non-residential”
  - Classification based on blade thickness and tip speed

Table 90.1
Ceiling-suspended fans from 2.1 meters (7 feet) to less than 3.05 meters (10 feet) above floor

Air flow	Maximum speed at tip of blades,		Minimum thickness of edges of blades,	
	m/s	(feet per minute)	mm	(inch)
Downward	16.3	(3200)	3.2	(1/8)
Downward	20.3	(4000)	4.8	(3/16)
Upward	16.3	(3200)	4.8	(3/16)
Upward	12.2	(2400)	3.2	(1/8)

NFPA 13 (11.1.7 & 12.1.4) & 72

NFPA 13

11.1.7 High Volume Low Speed (HVLS) Fans. The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:

(1) The maximum fan diameter shall be 24 ft (7.3 m).

(2) The HVLS fan shall be centered approximately between four adjacent sprinklers.

(3) The vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of 3 ft (0.9 m).

(4) All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in accordance with the requirements of NFPA 72.

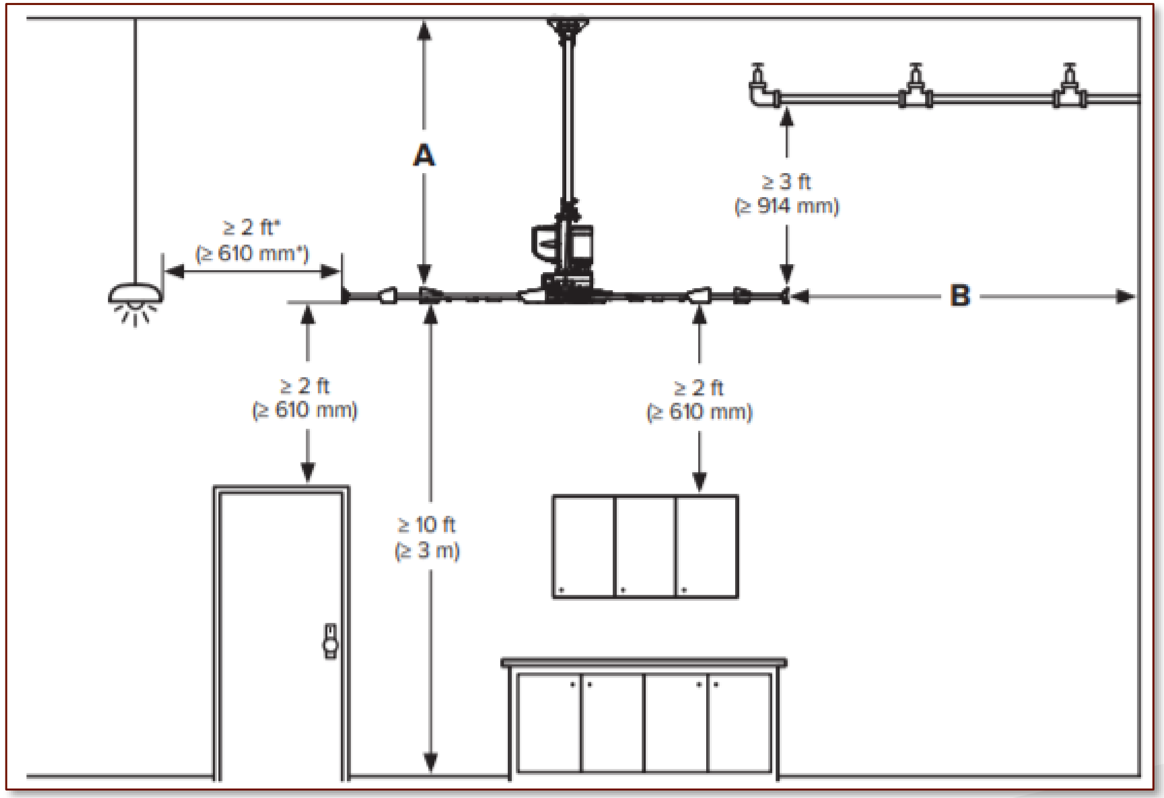
NFPA 72

Where required by NFPA 13, all HVLS large-diameter ceiling fans shall be interlocked to shut down upon actuation of a sprinkler waterflow switch that indicates waterflow in the area served by the fans.

Installation for Safety

- HVLS blade clearances
  - ≥ 2 ft (610mm) from objects
  - ≥ 3 ft (914mm) below sprinkler head
  - To wall ≥ diameter x 0.5
  - ≥ 2.5x diameter center to center
  - ~To ceiling ≥ diameter / 4 + 2 ft

- HVLS Blade Height
  - 10 ft above floor (UL 507)
  - ≥ diameter x 0.75



US DOE- Ceiling Fan Regulations

- 10 CFR Part 430, Appendix U to Subpart B
  - Product classes
  - Test procedures (AMCA 230 for LDCF)
  - Efficiency metric
  - Performance representations (CFM, W)
  - Effective 1/23/17, Updated 9/15/22

- 10 CFR 430.32 Energy and water conservation standards and their compliance dates
  - Minimum efficiency by product class
  - Effective 1/21/2020 (modified 12/27/2020)
  - Added to next revision of ASHRAE 90.1 and IECC

- 10 CFR Part 429 - Certification, compliance and enforcement
  - Requirements for submission of products to US DOE CCMS database

Air Movement and Control Association International (AMCA)

- Not-for-profit international association of the world's manufacturers of fans, louvers, dampers, air curtains, airflow measurement stations, acoustic attenuators, and other air system components.
  - Publishes and distributes standards, references, and application manuals
  - Provides third party certification of HVLS Fan performance
  - AMCA Publications 11 & 211 - Details of the Certified Ratings Program
  - AMCA 230 - Method of test for airflow and power
  - AMCA 208 - FEI (CFEI) efficiency metric
  - AMCA 340 - Method of test for sound performance (coming soon)

Additional Requirements - ASHRAE 90.1-2019

- Definition
  - ceiling fan, large-diameter: a ceiling fan that is greater than or equal to 84.5 inches (2.15 m) in diameter.

- Section 6 - 6 HEATING, VENTILATING, AND AIR CONDITIONING

  Section 6.4 - MANDATORY PROVISIONS

  6.4.1.3 Ceiling Fans

  Large-diameter ceiling fans shall be rated in accordance with 10 CFR 430 Appendix U or AMCA 230. The following data shall be provided:

  a. Blade span (blade tip diameter).

  b. Rated airflow and power consumption at the maximum speed.

  6.4.1.3.1 The data provided shall meet one of the following requirements:

  1. is determined by an independent laboratory; or
  2. is included in a database published by the U.S. DOE; or
  3. is certified under a program meeting the requirements of Section 6.4.1.5.

Additional Requirements - International Mechanical Code 2018 & 2021

- Definition
  - High-volume, large-diameter fans: a lowspeed ceiling fan that circulates large volumes of air and is greater than 7 feet (2134mm) in diameter.

- Section 929 High-Volume Large-Diameter Fans

  929.1 General

  When provided, high-volume large-diameter fans shall be tested and labeled in accordance with AMCA 230, listed and labeled in accordance with UL 507, and installed in accordance with the manufacturer's instructions.

Fan Specifications - Minimum Specifications

1. Ceiling fans greater than 7 feet in diameter shall be tested and performance data determined in accordance with 10 CFR Appendix U to Subpart B of Part 430 - Uniform Test Method for Measuring the Energy Consumption of Ceiling Fans and shall be listed in the US DOE Compliance Certification Management Ceiling (CCMS) Fan Database.
2. Ceiling fans greater than 7 feet in diameter shall exceed the US DOE minimum-efficiency requirement of CFEI 1.00 at high speed and CFEI 1.31 at 40 percent speed or the nearest speed that is not less than 40 percent speed.
3. Large-diameter ceiling fans must comply with AMCA Publication 211 and be certified to bear the AMCA Certified Ratings Program seal. They shall be tested for air performance in accordance with ANSI/AMCA Standard 230.
4. The fan assembly, as a system (with and without light kit), shall be Intertek/ETL-certified and built pursuant to the guidelines set forth by UL standard 507 and CSA standard 22.2 No. 113.
5. Large-diameter ceiling fans shall be installed per the requirements of NFPA 13 & NFPA 72.
6. Fans shall be installed in accordance with manufacturer's instructions.

Stated directly - LDCF shall comply with the relevant requirements found in the IMC, 90.1, and the US CFR.

Fan Specifications – Performance Based

- Ceiling fan sizing, placement, and performance shall be verified using computational fluid dynamics (CFD) analysis. At a minimum, the input data for the CFD analysis shall include the ceiling fan(s), significant obstructions to airflow at the floor level, and the actual space dimensions. As verification of cooling performance, the submittal shall include results of the CFD analysis including, at a minimum, the following performance metrics determined in accordance with ANSI/ASHRAE Standard 55: average air speed, average cooling effect from elevated air speed, Predicted Mean Vote, and Predicted Percentage Dissatisfied for seated and/or standing occupants in each occupied zone.

- Ceiling fan sizing, placement, and performance shall be verified using computational fluid dynamics (CFD) analysis. At a minimum, the input data for the CFD analysis shall include the ceiling fan(s), air speed at the floor level, and the actual space dimensions. As verification of destratification performance, the submittal shall include demonstration of the fan jet reaching the floor level and verification of a minimum of two air turnovers per hour at a fan operating speed that does not generate a draft over a significant portion of the occupied floor area.

Q & A

Survey QR Code:

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If you have any questions, please contact Lisa Cherney, Education Manager, at AMCA International (lcherney@amca.org).

NEXT SESSION- Tomorrow @ 9:00AM:

Minimizing & Troubleshooting Fan System Effects