Welcome to Webinar Wednesday

Varitec Technical Institute - 2023

Presenter: Dan Hahne
(Varitec: Director of High-Performance HVAC Solutions)

Program Coordinator: Kellie Huff
(Varitec: Marketing Manager)

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SHAPING THE FUTURE OF HVAC

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(New Horizons Launch, January 9, 2006)

Mission:

To provide an educational platform for continued learning in the HVAC industry with a focus on high performance buildings and innovative technologies for a better built environment.

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March 22nd : Fundamentals of HVAC

- Session #1: Fundamentals of HVAC Systems

April 19th: Fundamentals of HVAC

- Session #2: Toward Healthier Buildings, Humidification

May 10th: Fundamentals of HVAC

- Session #3: Psychrometrics Deconstructed Part 1

June 14th : Fundamentals of HVAC

- Session #4: Psychrometrics Deconstructed Part 2

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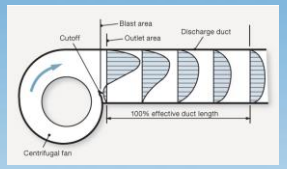
July 12th: Fundamentals of HVAC

- Session #5: Fan System Effect & The Physics of Air Flow



September 13th: 100% Outside Air Systems

- The Importance of Ventilation & Building Design Considerations

October 11th: Thermally Stratified Environments

November 8th: Underfloor Air Systems

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IEQ, Net Zero & HVAC | February 2023

TODAY'S DEVELOPMENTS FOR TOMORROW'S WORLD

What you need to read this month

Developing global and national initiatives will impact how buildings are designed in the future. In 2021, the Department of Energy (DOE) issued a determination ASHRAE Standard 90.1-2019 will be adopted into State commercial building codes to meet or exceed the standard. In 2022, ASHRAE initiated its Task Force for Building Decarbonization to reduce operational carbon emissions by increasing building efficiency. On another front, the pandemic demonstrated the need to reduce a building's risk of infection resulting in federal initiatives to supply better indoor air quality (IAQ). In October of 2022, the White House instituted its "Clean Air in Buildings Challenge" to provide a range of resources and recommendations for improving IAQ followed in December by ASHRAE's expressed commitment to writing an IAQ Pathogen Mitigation Standard. Consequently, what appear to be conflicting pressures, creating better IAQ and improving building energy efficiency, have posed a dilemma to design groups and building owners.

In response to this ever-changing market dynamic, Varitec's Technical Institute will be writing a monthly newsletter to inform building owners and industry professionals on:

- ASHRAE developments toward electrification, decarbonization, and enhanced IAQ.
- Federal initiatives and directives for net-zero carbon and increased operational efficiency
- Government initiatives to create healthier environments through superior IAQ.
- Technological developments that impact the built environment
- Design concepts and promising technology that will span the divide between superior IAQ and greater energy efficiency.

Varitec; supporting our community for a better tomorrow.

Want to submit an article for next month? Click Here

Introducing the Inflation Reduction Act Guidebook

This guidebook provides an overview of the clean energy, climate mitigation and resilience, agriculture, and conservation-related tax incentives and investment programs in the Inflation Reduction Act, including who is eligible to apply for funding and for what activities. The Administration is working quickly to design, develop, and implement these programs; as such, the information in this guidebook is current as of publication. In the coming weeks and months, we will publish new developments on www.CleanEnergy.gov to keep stakeholders and potential beneficiaries of these programs up to date on the latest deadlines and details. This guidebook does not cover the Inflation Reduction Act's health care provisions or certain corporate tax reforms.

BUILDING A CLEAN ENERGY ECONOMY:

A GUIDEBOOK TO THE INFLATION REDUCTION ACT'S INVESTMENTS IN CLEAN ENERGY AND CLIMATE ACTION

Read More

Varitec's Newsletter:

Today's Developments for Tomorrow's World

- Recent actions and programs from the Federal Government
- Developments in the Green Building movement
- AIA's 2030 Commitment
- HVAC solutions for healthier more efficient buildings

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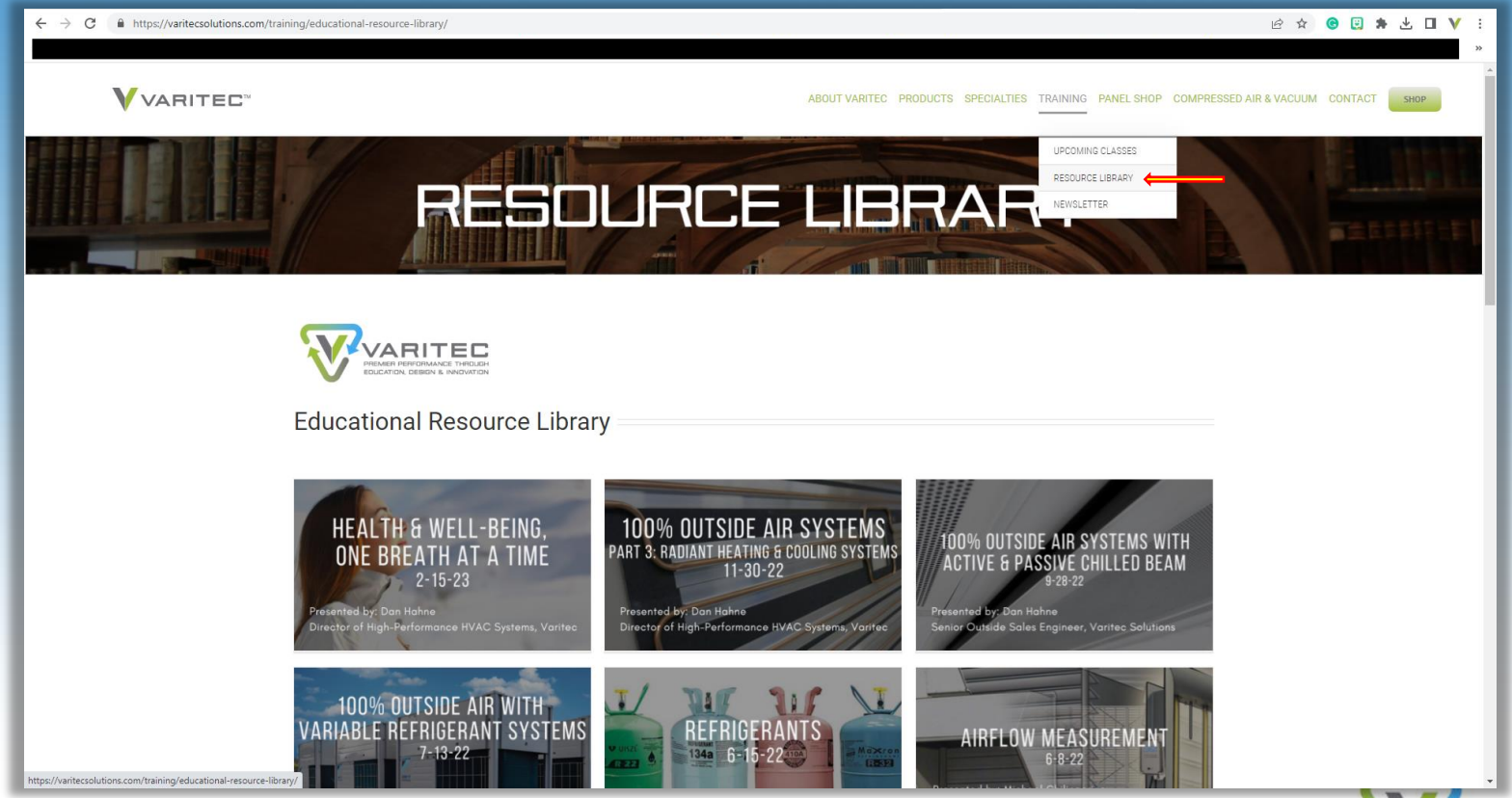

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Housekeeping Items:

- **We are recording this session**
- **Please ask questions in the chat**
- **If you need PDH or AIA credit, make sure your name is displayed correctly**

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Fundamentals of HVAC Systems: Thermal Comfort, Energy, Heat Transfer, and ASHRAE Standards

Presented by: Dan Hahne
Varitec: Director of High-Performance Building Solutions

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Introduction

- **Education:**
  - University of Arizona – Chemical Engineering
    - 1974 thru 1976
  - University College London – BFA Degree (Sculpture)
    - 1978 thru 1983
  - Boston University – MFA Degree (Sculpture)
    - 1983 thru 1985

- **Industry:**
  - **Norman S. Wright SW:** Estimator/Sales
    - 1985 thru 1999
  - **Air Specialty Products:** Outside Sales
    - 2000 thru 2008
  - **Air Specialty Products/ThermAir Systems:** Engineering Sales
    - 2009 thru 2016
  - **Varitec Solutions:**
    - Senior Sales Engineer
      - 2016 - 2022
    - Director of High-Performance HVAC Solutions/Educator
      - 2022 thru present

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Introduction

Publications:

- **July 2022: 100% Outside Air VRF Systems: A Sustainable, Hybrid Approach for Superior IEQ**
  - Dan Hahne
- **October 2021: Health Care Design: Beyond Code Minimum – Creating Healthier, More Efficient Environments**
  - (Co-Authored with Fletcher Clarcq P.E.)
- **June 2021: Health Care Design: ANSI/ASHRAE/ASHE Standard 170, and Beyond**
  - (Co-Authored with Fletcher Clarcq P.E.)
- **November 2019: Debunking the Myths of Active Chilled Beams: What You Thought You Knew But Were Wrong**
  - (Co-Authored with Eric Martin P.E., Fletcher Clarcq P.E. Steven Lamica, Engineer (Dadanco))
- **October 2019: Debunking the Myths of Active Chilled Beams: The Drip Test**
  - (Co-Authored with Eric Martin P.E., Fletcher Clarcq P.E., Steven Lamica, Engineer (Dadanco))

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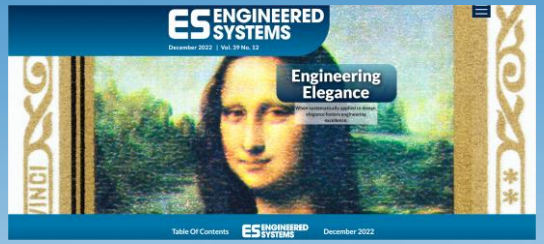
Introduction

ES Magazine: December 2022 Edition

- **100% Outside Air Systems – Passive Radiant Cooling & Heating Systems**
  - Co-Authors: Darren Alexander P.E. (Twa Panel Systems & Dan Hahne, Varitec)



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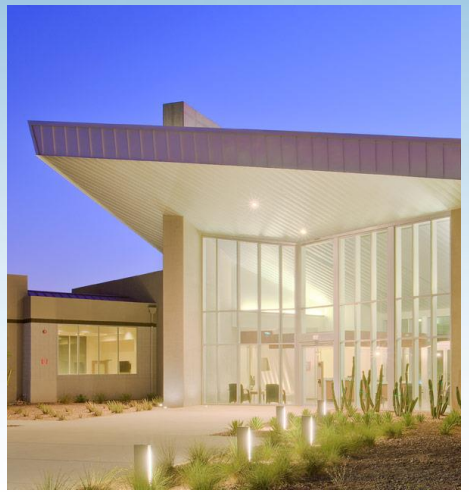
Varitec:
The HVAC System Solution Provider



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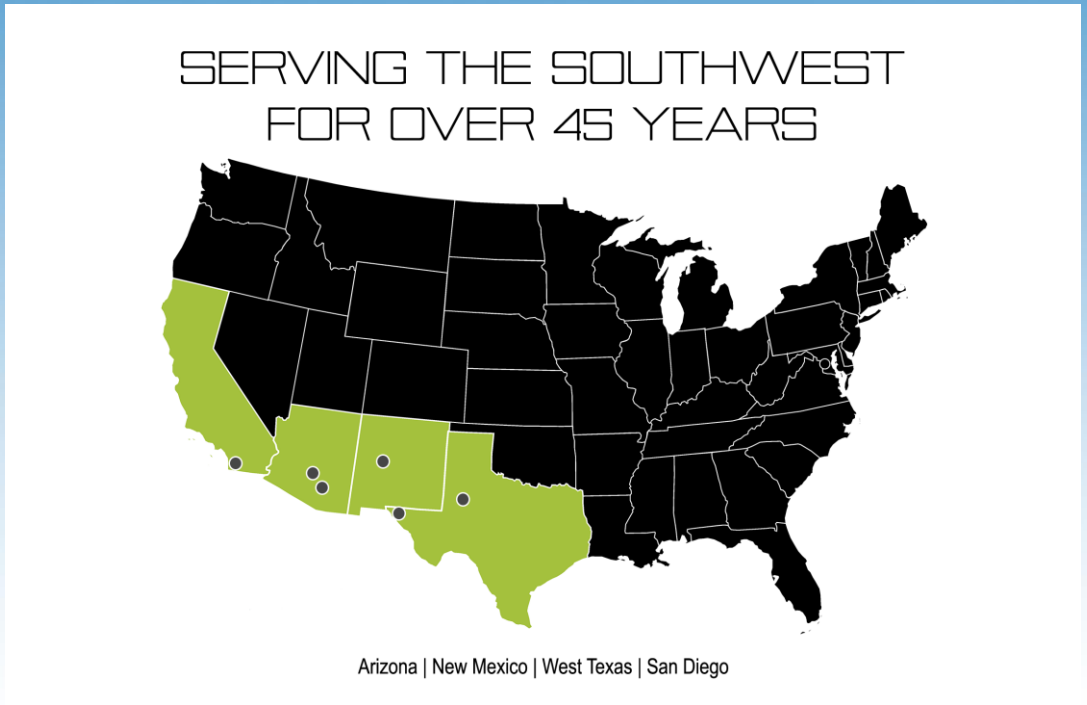
Varitec: The HVAC System Solution



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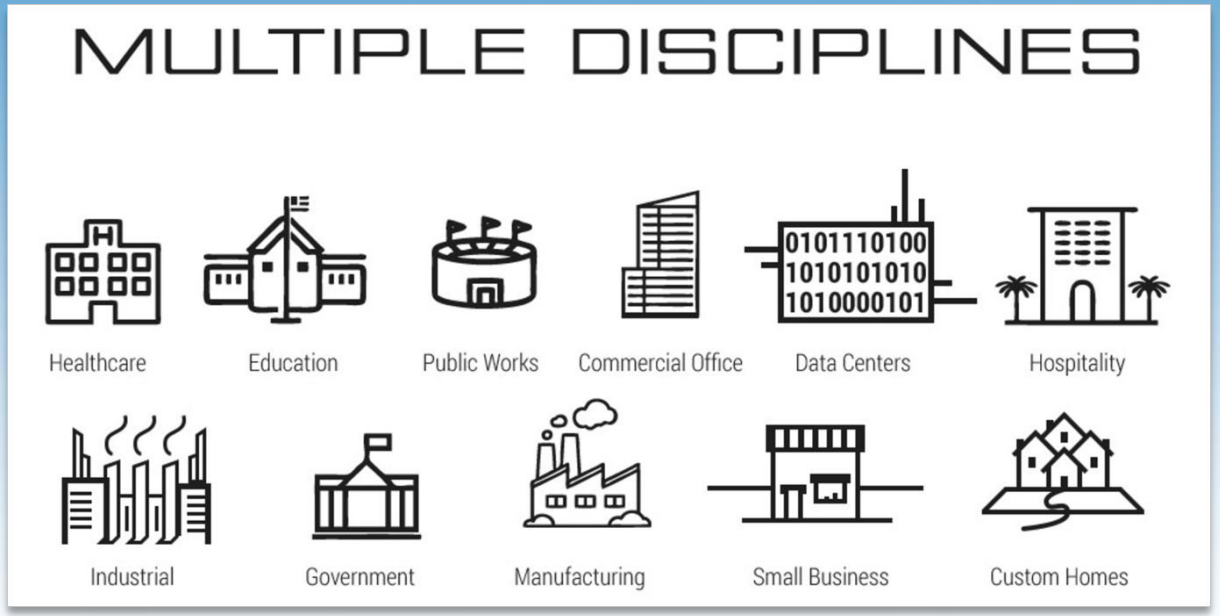
Varitec: The HVAC System Solution



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Varitec: The HVAC System Solution

System Solutions:

- Mixed Air VAV Systems
- Variable Refrigerant Systems
- Package Central Plants for Air & Water Cooled Designs
- Underfloor Air Systems
- 100% OSA Systems
  - DOAS Technology
  - Active Chilled Beams
  - Passive Hydronic Cooling & Heating Systems
- Cloud Based Controls
- Humidity Control

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HVAC Fundamentals

Agenda:

- HVAC: Purpose and Objectives
  - Comfortable & Healthy Environments
- Thermal Comfort
  - Principles of Thermal Comfort
  - Criteria for Thermal Comfort
  - Modes of Heat Transfer
  - Heat Transfer Mediums
- ASHRAE Standards
  - Introduction to Standard 52.2 (Filtration)
  - Introduction to Standard 55 (Thermal Comfort)
  - Introduction to Standard 62.1 (Ventilation)
  - Introduction to Standard 170 (Health Care)

HVAC: Purpose & Objectives

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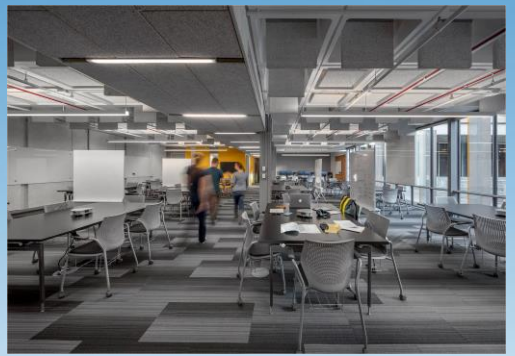
HVAC: Purpose & Objectives

- **HVAC Purpose: The Built Environment**
  - Provide environments conducive to well being by maintaining thermal comfort and good IAQ while reducing the risk of germicidal infection for occupants.



- **Thermal Comfort:**
  - Maintain building occupant personal comfort
- **Indoor Air Quality (IAQ):**
  - To maintain occupant health, reduce the risk of infection, and to promote personal well being

Who defines the criteria for thermal comfort?

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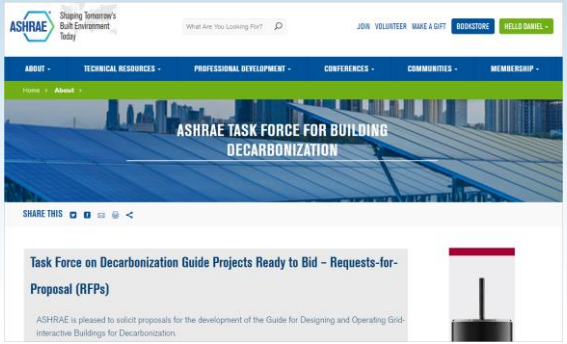
HVAC: Purpose & Objectives

ASHRAE: American Society of Heating Refrigeration & Air Conditioning Engineers

- An American professional association seeking to advance heating, ventilation, air conditioning and refrigeration systems design and construction

ASHRAE: Mission Statement

- To serve humanity by advancing the arts and sciences of heating, ventilation, air conditioning refrigeration and their allied fields.



www.ashrae.org

- **ASHRAE** writes the **HVAC standards** adopted by many state and municipal authorities for HVAC minimum requirements, recommendations and research information
- **ASHRAE: Task Force for Decarbonization**

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Thermal Comfort

Thermal Comfort

Thermal Comfort: Definitions

- **Green Educational Foundation:**
  - **"Thermal comfort means that a person feels neither too cold nor too warm."**
  - "Thermal comfort is important for health and well-being as well as productivity."
- **ASHRAE: Standard 55-2010: Thermal Occupant Conditions for Human Occupancy**
  - "…the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation."

ASHRAE Standard 55:

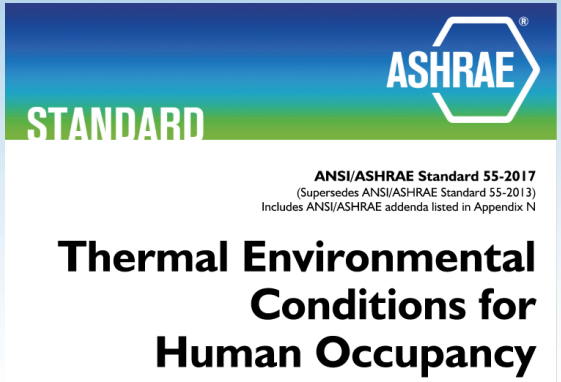
- **Building set point criteria** is based on a number of different **factors**

It's not just room temperature

Thermal Comfort

Thermal Comfort: Subjective

- **Occupant Comfort:**
  - No one room temperature set point will satisfy human comfort for all occupants



- **Occupant comfort** is affected by gender, age, size and weight, activity…etc.
- **ASHRAE Standard 55 (Thermal Environmental Conditions for Human Occupancy): Design to 80% occupant satisfaction**

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Principles of Thermal Comfort

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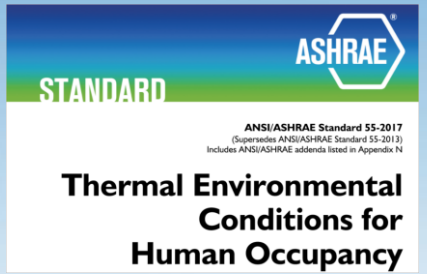
Principles of Thermal Comfort

Thermal Comfort: ASHRAE Standard 55

- **1.0 Purpose:** "…to specify the combinations of indoor thermal environmental factors and personal factors that will produce thermal environmental conditions acceptable to a majority of occupants within a space."
- **Standard 55 Assigns Space Set Point Conditions**



Comfort Zone Design Range

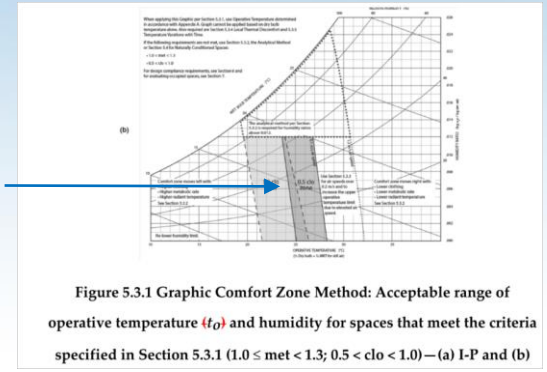


Figure 5.3.1 Graphic Comfort Zone Method: Acceptable range of operative temperature (t_o) and humidity for spaces that meet the criteria specified in Section 5.3.1 (1.0 ≤ met < 1.3; 0.5 < clo < 1.0)—(a) I-P and (b)

- **2.0 Scope:** "It is intended that all of the criteria in this standard be applied together as **comfort in the indoor environment is complex and responds to the interaction of all of the factors...**"

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Principles of Thermal Comfort

“Factors” for Thermal Comfort:

- Temperature
- Humidity
- Radiant Heat
- Air Speed
- Occupant Metabolic Rate
- Clothing Insulation

- All **factors** should to be assessed to calculate HVAC design requirements

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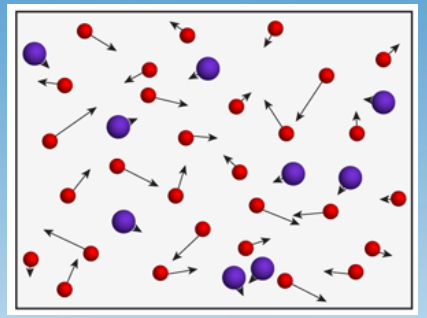
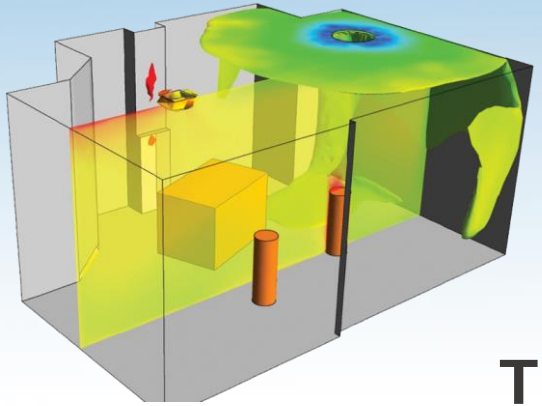
Principles of Thermal Comfort

Factor #1: Temperature

- **Definition:** "The degree of **intensity of heat** present in a substance or object…" (Oxford Dictionary)
- "The **air temperature** is the measure of the rate of molecular movement." (American Geosciences Institute)





- "The higher the **molecular energy (Kinetic Energy)** the higher the temperature you feel in the air."

  (American Geosciences Institute)

Thermal Energy is Sensible Heat Energy

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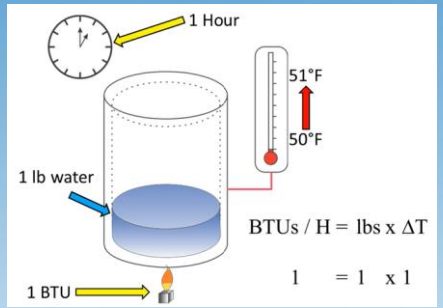
Principles of Thermal Comfort

Factor #1: Temperature

- **Temperature is** a measure of the amount of **thermal energy in the air**



Thermal Energy: Units of Measurement: British Thermal Units (BTU)

- **(1) BTU =** The amount of energy to raise (1) pound of water (1) degree Fahrenheit (F)

- **(1) ton of energy (load) = 12,000 BTUs of energy**
- **The average adult male produces ~400-BTUs of sensible energy/hour (~75 watts)**

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Principles of Thermal Comfort

Factor #2: Humidity

- **ASHRAE: Standard 55: Definition**
  - "…the moisture content of the air…"
  - Common measure of humidity is **Relative Humidity**
  - Absolute measure of moisture content is **Dew Point (F)** or **Specific Humidity (grains/lb air)**

Properly humidified environments: Why?

- Improved thermal comfort
- Prevents water vapor from condensing in a building
- Prevents building mold, fungus and bio-growth
- Reduces the risk of spreading infectious germicides
- Optimizes an occupants immune system

Principles of Thermal Comfort

Factor #2: Humidity

States of Water:

- Solid (ice)
- Fluid (water)
- Gas (vapor)

Phase Change: Change of State

- Melting: Solid becomes a liquid (Below 32F degrees)
- Freezing: Liquid becomes a solid (Above 32F degrees)
- Evaporation: Liquid becomes a gas, “vaporization”
- Condensation: Gas becomes a liquid (Dew point)

Water vapor REQUIRES THERMAL (LATENT) ENERGY present to a volume of air

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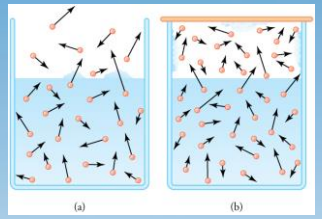
Principles of Thermal Comfort

Factor #2: Humidity



Thermal Energy & Water Relationship:

- The state of water is determined by **the amount of thermal energy** present in a given sample of water

Evaporation: Water Vapor

- Higher fluid temperature = Greater molecular activity
- Greater molecular activity = greater evaporation rate. (Water molecules break free from a fluid state)

- **Energy needed to sustain water in a vapor state is LATENT ENERGY!!!**

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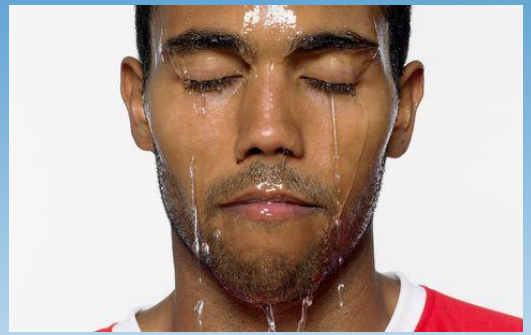
Principles of Thermal Comfort

Factor #2: Humidity

- **Water Vapor, the Occupant and Thermal Comfort**



- **High humidity** reduces the evaporation rate of skin moisture (e.g. perspiration) and its cooling effect.
- Thermal comfort affected, occupants feel warmer

- **The average adult male occupant produces 200 BTUs of latent energy/hour or water vapor**

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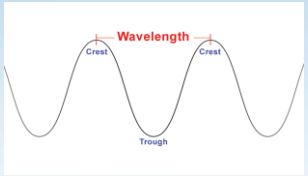
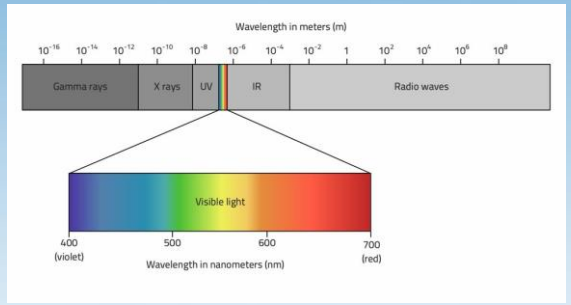
Principles of Thermal Comfort

Factor #3: Radiant Heat

- **Definition**"…the emission or **transmission of energy in the form of waves or particles** through space or through a material medium…" **(Wikipedia)**

The **sun is a radiant heat source** for earth transferring energy through electromagnetic waves





Electromagnetic Spectrum

Electromagnetic wavelength range: 10^{-18} **meters to 100 km (~62 miles)**

Radiant heat is a common cause for thermal comfort complaints!

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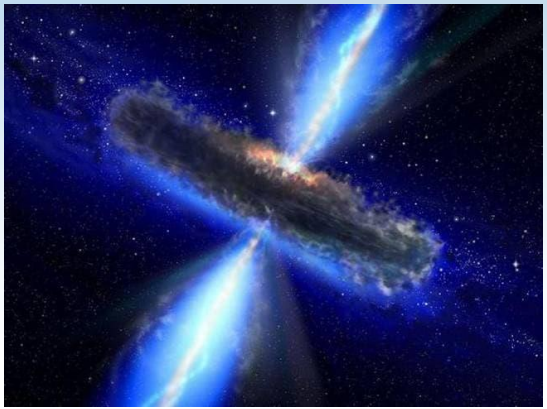
Principles of Thermal Comfort

Factor #3: Radiant Heat:

- **Radiant energy moves from high energy states to lower energy states**
- **Heat energy moves from warm surfaces moves to cooler surfaces**
- **Travels at the speed of light; 186,000 miles/sec**
    - Radiant energy **DOES NOT** warm the air



“Radiant” Cooling: Sensible heat from space moves to chilled panels or sails

Radiant Heating: Warm surfaces (panels or sails) add sensible heat energy to surfaces in space

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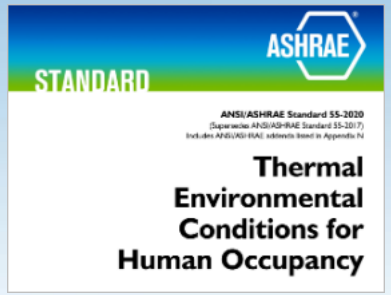
Principles of Thermal Comfort

Factor #4: Air Movement

- **Temperature and/or pressure differentials = Air Movement ("Nothing sucks, everything blows")** (Dan Int-Hout)
- Air movement improves thermal comfort.
  - Impacts thermal sensation and occupant comfort.



- A cooling sensation occurs when air moves across the skin by increasing the evaporation rate of moisture (perspiration) at the skin.

Design air movement to 50 fpm in occupant zone (5 feet above the floor and 1 foot in from walls)

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Principles of Thermal Comfort

Factor #5: Metabolic Rate

- **Definition:** “The rate of transformation of chemical energy into heat and mechanical work by metabolic activities of an individual per unit of skin surface area…”
- What is the occupant activity level in a room expressed in units of ***met***

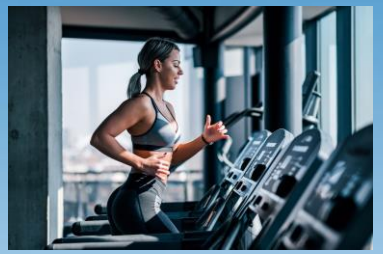
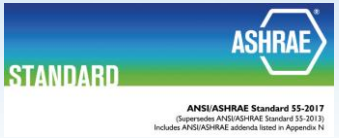


Table 5.2.1.2 Metabolic Rates for Typical Tasks

Activity	Metabolic Rate		
	Met Units	W/m²	Btu/h·ft²
Resting			
Sleeping	0.7	40	13
Reclining	0.8	45	15
Seated, quiet	1.0	60	18
Standing, relaxed	1.2	70	22
Walking (on level surface)			
0.9 m/s, 3.2 km/h, 2.0 mph	2.0	115	37
1.2 m/s, 4.3 km/h, 2.7 mph	2.6	150	48
1.8 m/s, 6.8 km/h, 4.2 mph	3.8	220	70
Office Activities			
Reading, seated	1.0	55	18
Writing	1.0	60	18
Typing	1.1	65	20
Filing, seated	1.2	70	22
Filing, standing	1.4	80	26
Walking about	1.7	100	31
Lifting/packing	2.1	120	39

ASHRAE Table 5.2.1.2



5.2.1.2: Rate of Determination:

- Metabolic rates for typical occupant activity types given in **Table 5.2.1.2**
- Interpolate or extrapolate from the values given in Table 5.2.1.2
- Use estimation methods described in **2009 *ASHRAE Handbook - Fundamentals***

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Principles of Thermal Comfort

Factor #6: Clothing Insulation

- **Definition:** "The resistance to sensible heat transfer provided by a clothing ensemble, expressed in units of *clo.*"
- "The definition of clothing insulation relates to heat transfer from the whole body and, thus, also includes the uncovered parts of the body such as head and hands."

Table 5.2.2.2A Clothing Insulation I_{cl} Values for Typical Ensembles

Clothing Description	Garments Included [a]	I_{cl}, clo
Trousers	(1) Trousers, short-sleeve shirt	0.57
	(2) Trousers, long-sleeve shirt	0.61
	(3) #2 plus suit jacket	0.96
	(4) #2 plus suit jacket, vest, t-shirt	1.14
	(5) #2 plus long-sleeve sweater, t-shirt	1.01
	(6) #5 plus suit jacket, long underwear bottoms	1.30
Skirts/dresses	(7) Knee-length skirt, short-sleeve shirt (sandals)	0.54
	(8) Knee-length skirt, long-sleeve shirt, full slip	0.67
	(9) Knee-length skirt, long-sleeve shirt, half slip, long-sleeve sweater	1.10
	(10) Knee-length skirt, long-sleeve shirt, half slip, suit jacket	1.04
	(11) Ankle-length skirt, long-sleeve shirt, suit jacket	1.10
Shorts	(12) Walking shorts, short-sleeve shirt	0.36

ASHRAE Table 5.2.2.2A

- Use date presented in **Table 5.2.2.2A** for the expected ensemble of each representative occupant

Modes of Heat Transfer

Modes of Heat Transfer

Energy: Physics of Equilibrium

- Physical states and/or objects seek to be at rest; i.e. **Equilibrium**
- **Heat transfer through natural properties** as the universe tends to a state of entropy; i.e. complete uniformity

Definition of cold: "The Absence of Heat"

Thermal "sensible" energy is the measured value at a **room thermostat (Dry Bulb (DB) temperature)**

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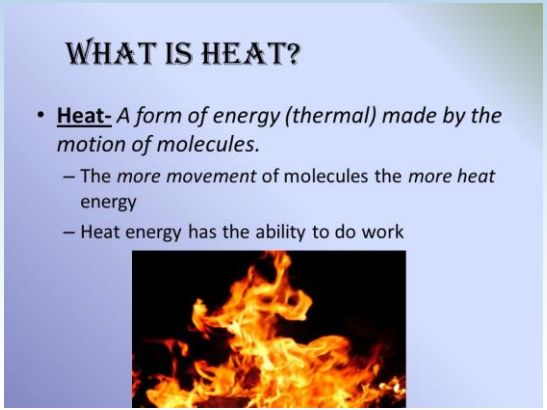
Modes of Heat Transfer

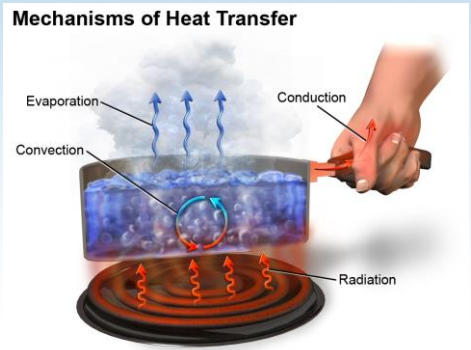
Thermal Energy & Equilibrium: Review

- **Thermal (Sensible Heat) Energy:** The measured value at a room thermostat **(Dry Bulb (DB) temperature)**
- **Latent Energy:** Energy to sustain water in a vapor phase
- **Energy naturally moves from high energy states to lower energy states (Heat Transfer):**



Modes of Heat Transfer

- **Conduction**
- **Convection**
- **Radiation**
- **Evaporation**



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Modes of Heat Transfer

Heat Energy Building Sources:

- **Sensible Heat Energy Sources:**
  - Occupants
  - Lighting
  - Computers and other electronic equipment
  - Radiated heat from a perimeter wall

- **Water Vapor: "Latent" Heat**
  - Occupants (200 BTU/Person)
    - Perspiration
    - Breathing
  - Sinks
  - Toilets
  - Coffee pots
  - Moisture penetrating perimeter walls

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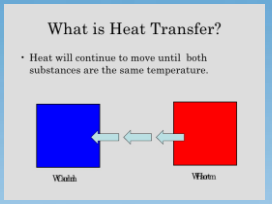
Modes of Heat Transfer

Heat Transfer: Definition

- "…any or all of several types of phenomena … that convey energy and entropy from one location to another" (Britannica)



Mechanical Heat Transfer: Applications

Cooling: Transfer heat energy from a building and deposit it outdoors

- Sensible Cooling: Reduce thermal energy in a building
- Latent Cooling: Reduce the amount of water vapor (moisture)

Heating: Add heat energy to a building

- Sensible Heating: Add thermal energy
- Latent "Heating": Adding moisture to a building (Humidification)

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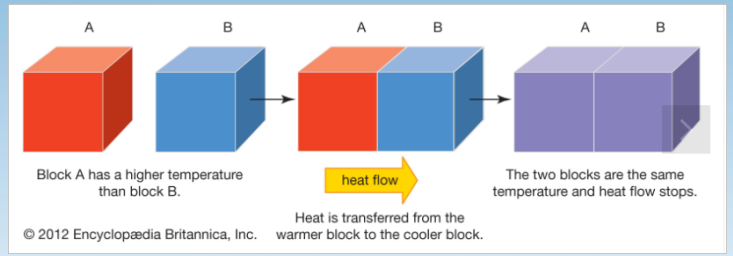
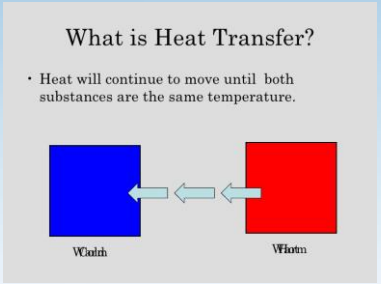
Modes of Heat Transfer

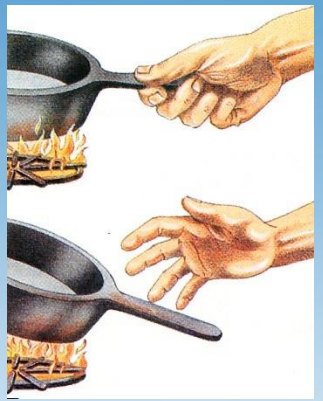
Modes of Heat Transfer: Review

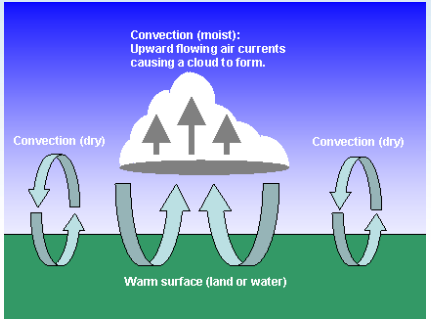
Conduction:

- Thermal imbalance within a continuous body
- Hot (Thermal Energy) move to Cold (Absence of Energy)



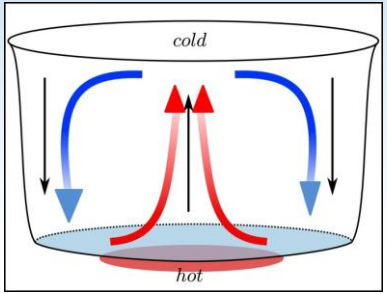






Convection:

- Fluid motion caused by less dense hot material to rise & colder more dense material to fall



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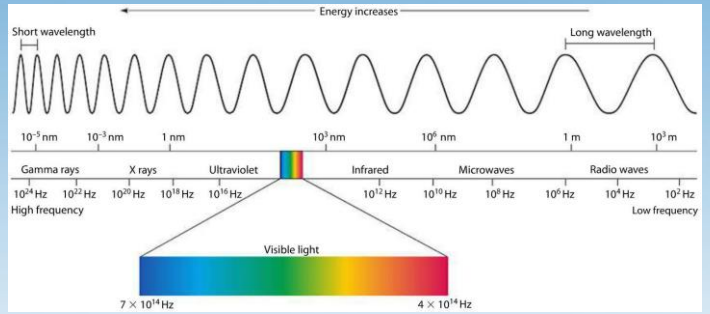
Modes of Heat Transfer

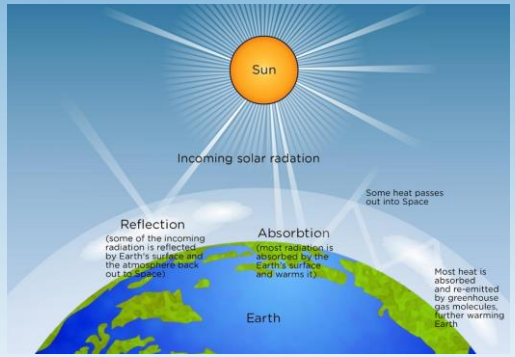
Types of Heat Transfer: Radiant Energy

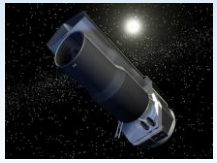
- **Radiation**



Radiant Energy Sources

The Sun:





(Spitzer Telescope Infrared Telescope)

The Sun: Earth's everyday source of radiation during daylight hours

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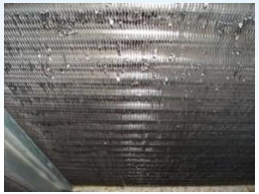
Modes of Heat Transfer

Types of Heat Transfer: Evaporation

- **Evaporation**
  - "The process by which an element or compound transitions from its liquid state to its gaseous state below the temperature at which it boils;
  - …the process by which liquid water enters the atmosphere as water vapor." (Britanica)



- Water needs energy **(Latent Energy)** to remain in a vapor state
- Decrease **latent energy** water vapor condenses at the dew point: **Rain**

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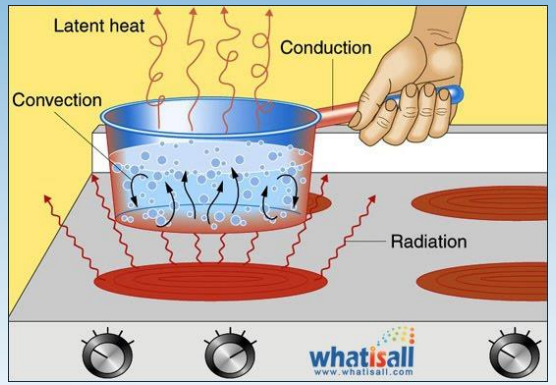
Modes of Heat Transfer

Types of Heat Transfer: Evaporation

What Force Moves Moisture?: Wet Moves to Dry



Vapor Pressure – the force that drives moisture from wet areas to drier areas

Important: Water vapor requires heat energy (measured as temperature) to remain in a vapor state

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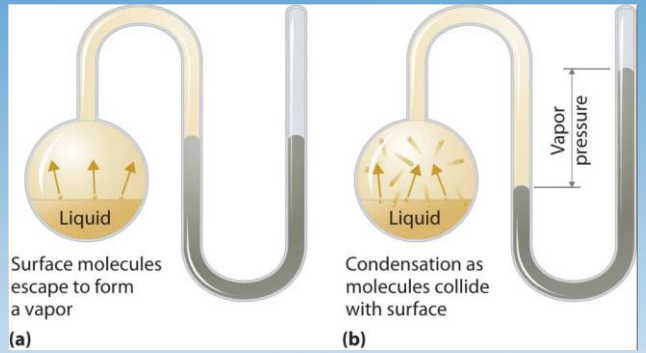
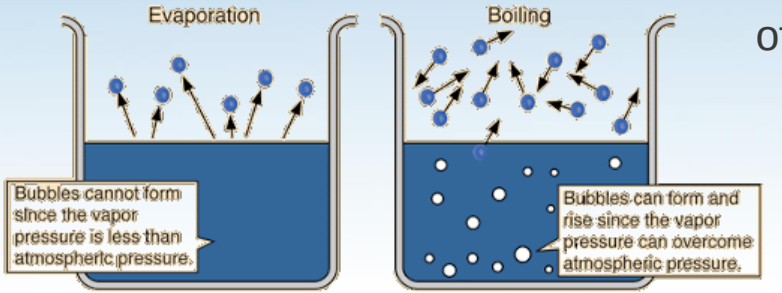
Modes of Heat Transfer

Types of Heat Transfer: Evaporation

Vapor Pressure: Definition

- "…the pressure of the vapor (measured in inches of mercury) resulting from evaporation of a liquid (or solid; off-gassing) above a sample of the liquid or solid…"
- The vapor pressure of a liquid varies with its temperature,





Phase Change: The change of water between any of its three states.

- Adding thermal energy to a fluid increases the phase change rate.
- Increasing amount of water vapor in a room increases the rooms **vapor pressure**

Heat Transfer Mediums

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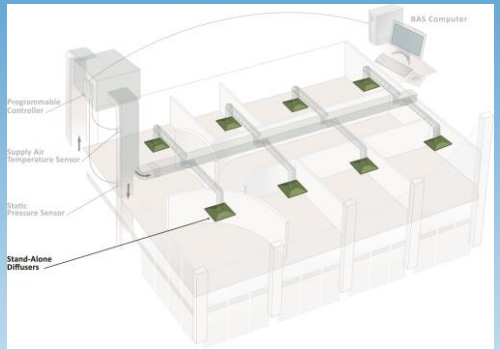
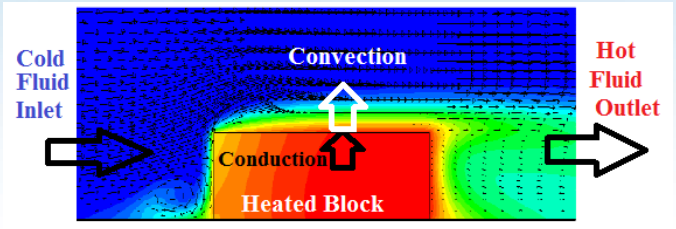
Heat Transfer Mediums

What is a Heat Transfer Medium:

Heat Transfer Fluid: Definition

- "**..heat transfer fluid is a gas or liquid** that takes part in heat transfer by serving as an intermediary in cooling on one side of a process (i.e. a building), transporting and storing thermal energy and heating on another side of a process". (i.e. outdoors) (Wikipedia)





HVAC Heat Transfer: Review

- **Cooling:** To move thermal energy from inside of building to outside
- **Heating:** To add thermal energy to a building
- **Dehumidification:** To remove latent energy (water vapor) from a building

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Heat Transfer Mediums

Heat Transfer Fluid:

Gas: Definition

- **A substance (as oxygen or hydrogen) having no fixed shape and tending to expand without limit** (Merriam-Webster)
- A gas fills its container, taking both the shape and the volume of the container

Gas is a Fluid:

- **Fluid:** "…**having particles that easily move** and change their relative position without a separation of the mass and that easily yield to pressure: **capable of flowing**." (Merriam-Webster)

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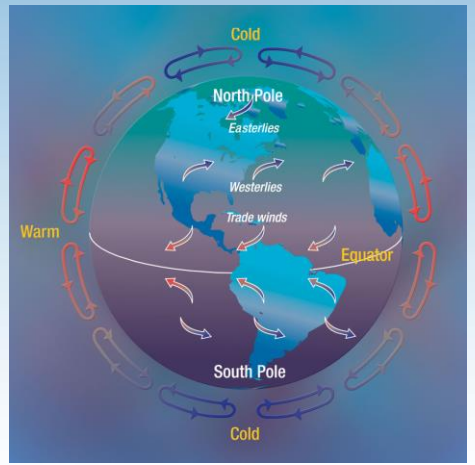
Heat Transfer Mediums

Heat Transfer Fluid:
Air: Definition

- A mixture of **invisible odorless tasteless gases** (such as nitrogen and oxygen) that surrounds the earth



Air: Heat Transfer Medium

- Air has mass and flows as a fluid.
- Air can absorb and distribute heat energy
- Air is a heat transfer medium that can move heat from one location to another

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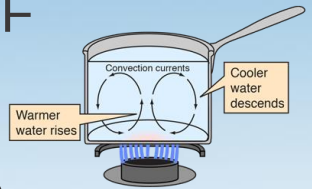
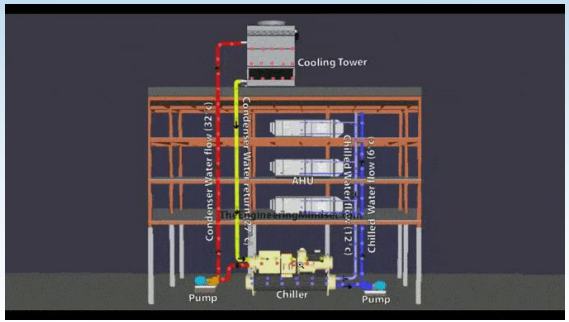
Heat Transfer Mediums

Heat Transfer Fluid:
Water: Definition

- "…a substance composed of the chemical elements hydrogen and oxygen and existing in gaseous, liquid, and solid states." (Britanica)
- Water is a fluid between a temperature range of 32F and 212F Fahrenheit at sea level.





Water: Heat Transfer Medium

- Water has mass and flows.
- Water can absorb and distribute heat energy
- Water is a heat transfer medium that can move heat from one location to another

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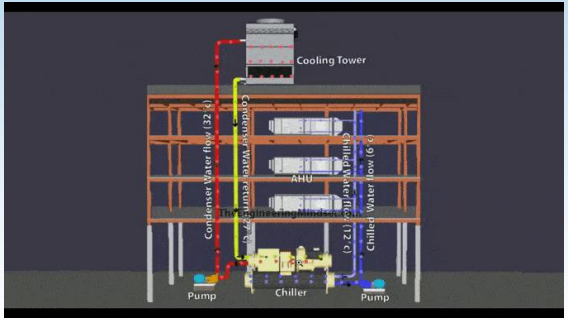
Heat Transfer Mediums

Heat Transfer Fluid:
Refrigerant: Definition

- "…a **working fluid** used in the refrigeration cycle of air conditioning systems…where…they undergo a repeated phase transition from liquid to gas…" (Wikipedia)



Water: Heat Transfer Medium

- Water has mass and flows.
- Water can absorb and distribute heat energy
- Water is a heat transfer medium that can move heat from one location to another

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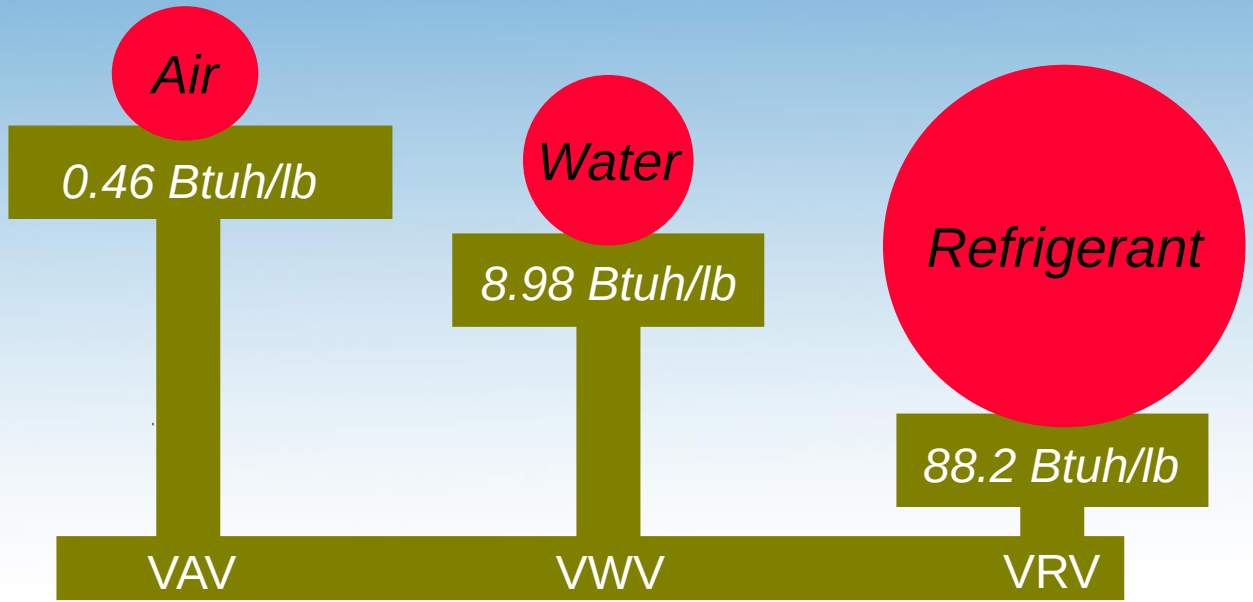
Heat Transfer Mediums

Heat Transfer Medium: Types & Capacity

Heat Transfer Medium: Principle:

- **Less dense fluids (Air) move less energy than more dense fluids (water & refrigerant).**



Medium Density & Heat Transfer

More air is required to move the same amount of thermal or latent energy than **water or refrigerant**

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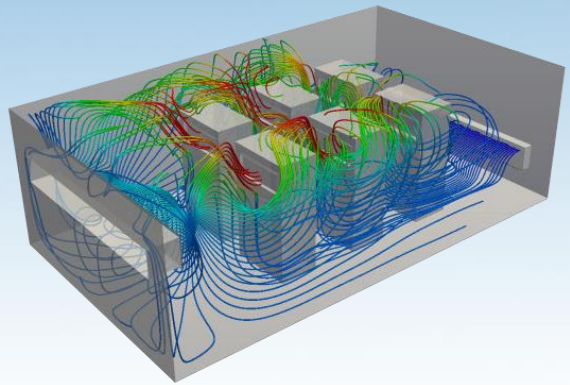
Heat Transfer Mediums

Heat Transfer Medium: Fluid Types

Air as a Heat Transfer Medium:

- Air is a building heat transfer medium supplied via metal ducts to remove or add thermal energy to or from a building



Cooling Mode:

- **Supply:**
  - 55F degree air is injected into a space at high velocity to create a mixed air condition and uniform temperature throughout the cubic volume of space
- **Return/Exhaust:**
  - Warm 75-80F degree air is removed at the return or exhaust grille in the space

Total Energy Load (Sensible Heat + Latent Heat) present to an AHU cooling coil

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Heat Transfer Mediums

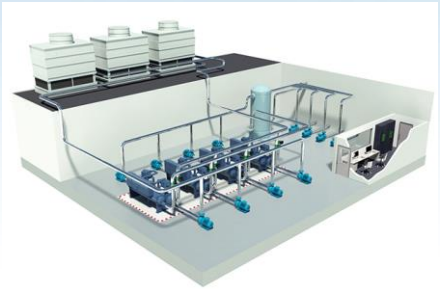
Heat Transfer Medium: Fluid Types

Water:

- Water is a heat transfer medium supplying either chilled water (chillers) for cooling or hot water (boilers) for heating

(Air Cooled Chillers)

- **Water is more dense than air and retains more energy**
- **More efficient than all air systems**



(Water Cooled Chillers)

Chiller Central Plants

- Air Cooled Chillers:
- Water Cooled Chillers

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Heat Transfer Mediums

Heat Transfer Medium: Fluid Types

Refrigerant:

- Refrigerant is a heat transfer medium supplying
  - Cooling only units
  - Heating and cooling units (Heat Pumps)

(Variable Refrigerant Systems)

(Rooftop Package DX)

- Refrigerant is a very dense heat transfer medium.
- Transfers a lot of energy with a low volume of refrigerant

ASHRAE Standards

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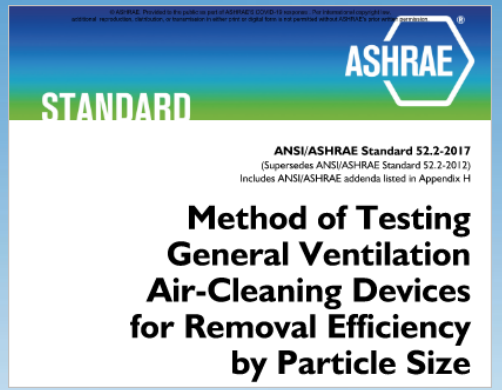
ASHRAE Standards

ASHRAE Standard 52.2

1.0: Purpose:

- This standard establishes a test procedure for evaluating the performance of air-cleaning devices as a function of particle size.



Foreward: Version 2017

- *"The committee's intentions were to provide the best possible information for the end user to select the best aircleaning devices to protect people and equipment."*
- *Originally the standard was written to protect machinery and coils first, then reduction of soiling. "…Now the concerns about indoor air quality and respirable particles, protection of products during manufacturing, and protection of HVAC equipment have prompted development of this test standard based on particle size."*

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ASHRAE Standards

ASHRAE Standard 55

1.0: Purpose:

- The purpose of this standard is to specify minimum ventilation rates and other measures intended to provide indoor air quality (IAQ) that is acceptable to human occupants and that minimizes adverse health effects.

Foreward: Version 2019

- "While the purpose of the standard remains unchanged – to specify minimum ventilation by rates and other measures intended to provide indoor air quality (IAQ) that is acceptable to human occupants and that minimizes adverse health effects…"

Note:

- **ASHRAE Standard 170** minimum ventilation rates take precedence over Standard 62.1 for hospitals, outpatient clinics and nursing homes

ASHRAE Standards

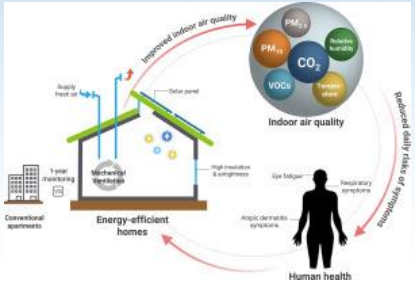
ASHRAE Standard 62.1

1.0: Purpose:

- **1.1** The purpose of this standard is to specify minimum ventilation rates and other measures intended to provide indoor air quality (IAQ) that is acceptable to human occupants and that minimizes adverse health effects.
- **Applications:** New, additions to existing, existing buildings

2.0: Scope:

- **2.1** …applies to spaces intended for human occupancy within buildings except those within dwelling units in residential occupancies…
- 2.3 …this standard contains requirements related to certain contaminants and contaminant sources, including outdoor air, construction processes, moisture, and biological growth



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ASHRAE Standards

ASHRAE Standard 170

1.0: Purpose:

- The purpose of this standard is to define ventilation system design requirements that provide environmental control for comfort, asepsis, and odor in health care facilities.

Foreward:

- "…*This standard does not constitute a design guide. Rather it comprises a set of minimum requirements intended for adoption by cod-enforcing agencies.*
- *Best practices are provided by other ASHRAE publications such as the* ASHRAE Handbook – HVAC Applications *and* HVAC Design Manual for Hospitals and Clinics."

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Questions?

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Thank you.

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