COMFORT AIR CONDITIONING BASICS

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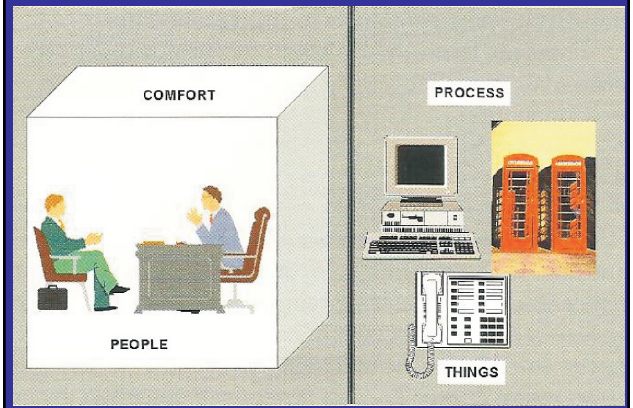
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AIR CONDITIONING

"The Process of Treating Air so as to Control Simultaneously its Temperature, Humidity, Cleanliness and Distribution to Meet the Requirements of the Conditioned Space."

– ASHRAE

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PROCESS AIR CONDITIONING APPLICATIONS

Some of the major process air conditioning applications are:

1. Textile air-conditioning: Here the humidity to be maintained is the primary concern.
2. Printing and paper manufacturing - requires close temperature and humidity control.
3. Electronics/ computer rooms - air cleanliness, lower temperatures, and close humidity control
4. Pharmaceuticals: Indoor Air Quality, Positive static pressure in the space, clean rooms
5. Hospitals/operation theatres: Indoor Air quality / contamination control
6. Music and sound recording rooms: acoustics.
7. CNC machine control panels/air conditioners for control rooms and switch rooms-High Sensible loads

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Comfort Air Conditioning

- Heat
- Cool
- Humidify
- Ventilate
- Filter
- Circulate
- Dehumidify

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PURPOSE OF AIR CONDITIONING

- TO PROVIDE THERMAL COMFORT TO OCCUPANTS OF AIR- CONDITIONED SPACE

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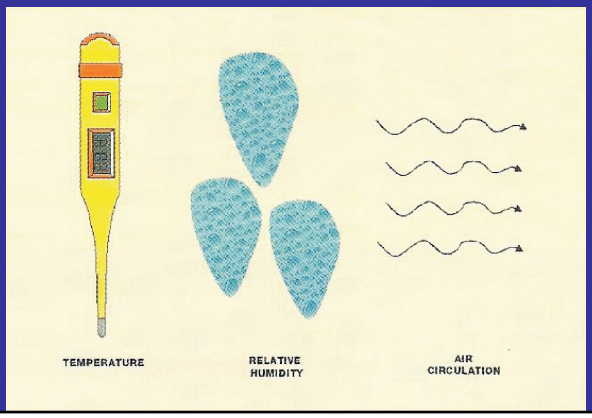
WHAT IS COMFORT

IT IS THE CONDITION OF MIND THAT EXPRESSES THERMAL ENVIRONMENTAL SATISFACTION & IS ASSESSED BY SUBJECTIVE EVALUATION –

Ref:(ASHRAE FUNDAMENTALS (2025)-ASHRAE/ANSI STANDARD 55-2004/ISO7730)

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FACTORS AFFECTING HUMAN COMFORT



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WHAT INFLUENCES THERMAL COMFORT-?

1.PHYSICAL CONDITION

2 PSYCHOLOGICAL CONDITIONS

3. FROM DIRECT TEMPERATURE

4. AIR MOTION

5. MOISTURE SENSATIONS SENSED BY SKIN

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NORMAL BODY CONDITIONS

1. NORMAL TEMPERATURE-36.8^{0}C to 37.4^{0}C- (98.24^{0}F - 99.32^{0}F)

2. SKIN TEMPERATURE 33/34^{0}C-(91.40F-93.2^{0}F)

3.Resting adult produces 100W of heat while resting

4.Heat produced per unit area of skin-58W/m2

5. 1 met=58W/m2

6. Average skin area-1.6 to 1.8m2

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METABOLIC RATE

- The metabolic rate **M** is the rate of energy release per unit area of skin surface as a result of the oxidative processes in the living cells. Metabolic rate depends mainly on the intensity of the physical activities performed by the human body. The unit of metabolic rate is called the met. One met is defined as 18.46 Btu/h ft2 (58.24 W/m2) of metabolic heat produced in the body core. In Table 4.1 are listed the metabolic rates of various activities

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TABLE4.1 ASHRAE Handbook Fundamentals-2025
Typical Metabolic heat generation

	W/m2	met
Resting	40	0.7
Standing	70	1.2
Walking-medium speed	150	2.6
Driving car	60-115	1.0 to 2.0
House Cleaning	115 to 200	2.0 to 3.4
Exercise/Dansing	175-255	3.0 to 4.4
Games-Tennis	210-270	3.6 to 4.0

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CLOTHING

- Clothing insulation value may be expressed in **clo** units.
- To avoid confusion, the symbol 1 is used with the clo unit instead of the symbol R.
- 1.0 clo is equivalent to 0.155 (m2·K)/W.
- For persons wearing cloths it varies between 1.02 t0 1.94 depending on normal to heavy thermal protection dress

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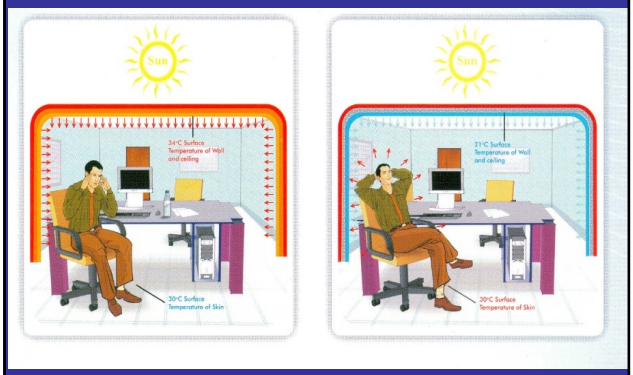
HUMAN RESPONSE TO COMFORT

- A survey is used to measure the sensation of occupants towards thermal environment comfort based on the seven-point scale [1],
- where +3 = hot,
- +2 = warm,
- +1 = slightly warm,
- 0 = neutral,
- -1 = slightly cool,
- -2 = cool,
- -3 = cold.

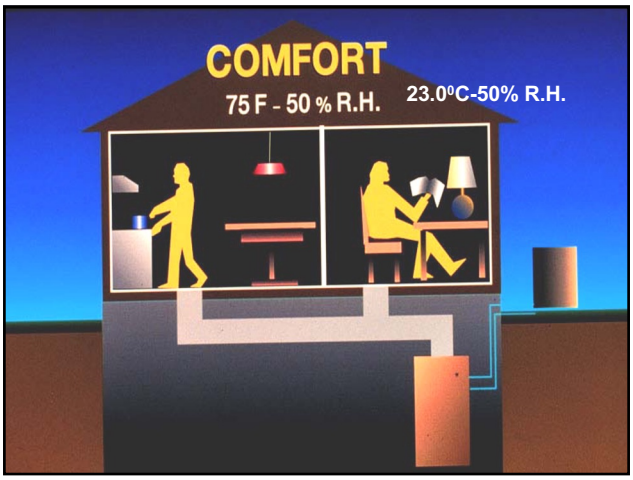
- Ref. [1]-Thermal Environmental Conditions for Human Occupancy, ASHRAE Standard 55, 2010.

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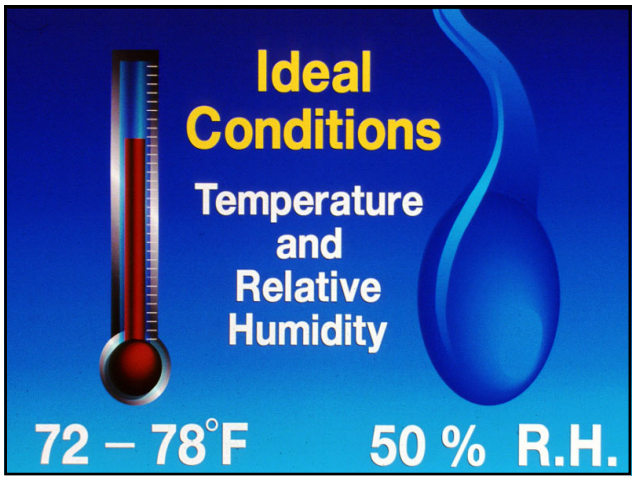
HUMAN COMFORT



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INSIDE DESIGN CONDITIONS

1. ASHRAE comfort chart:
   68-78 ^{0}F DBT [20 ^{0}C to 25.5 ^{0}C], 20-60% RH
2. Carrier bench mark conditions:
   75 ^{0}F or 23.9 ^{0}C DBT; 50% RH
3. ASHRAE:
   78 ^{0}F or 25.6 ^{0}C; 50% RH
4. NBC code:
   23-26 ^{0}C; 50-60% RH

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DIFFERENCE BETWEEN MALE & FEMALE COMFORT REQUIREMENTS

Females have 0.54Clo rating
Males have 0.49 Clo rating

Men generally have higher metabolic rates of 1.0, generating more heat, while women have lower metabolic rate as 0.9.

Female often have lower skin temperatures and different heat loss mechanisms, influencing their perception of warmth.

Males prefer comfort temperature as 24.5^{0}C to 27.1^{0}C
Females prefer comfort temperature as 25.4^{0}C to 27.5^{0}C

Males have generally higher PMV ratings than Female, because Male has warmer thermal sensation than Female.

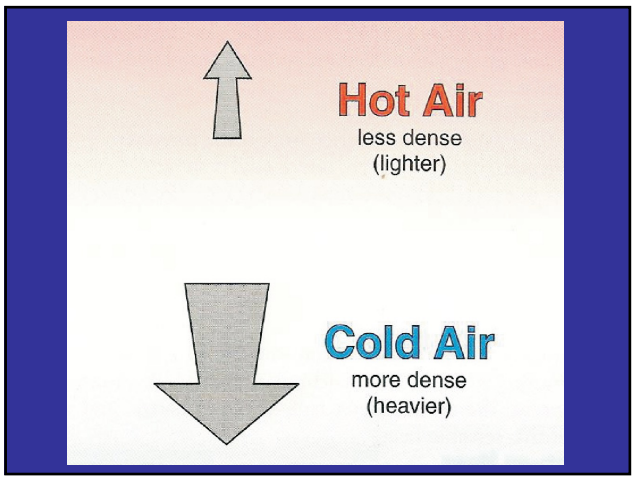
Therefore, female will feel cold more easily & prefers higher room temperatures.

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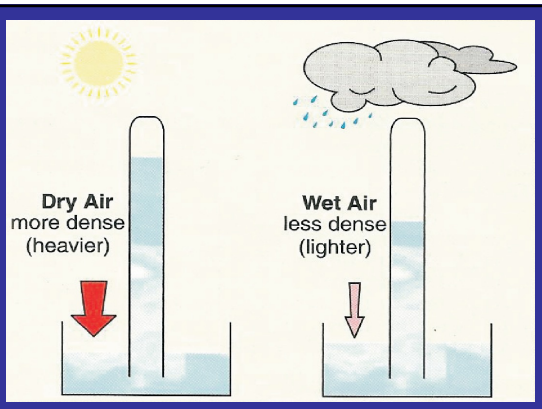
UNDERSTADING SOME BASIC AIR PROPERTIES

(More details in the Psychrometrics module)

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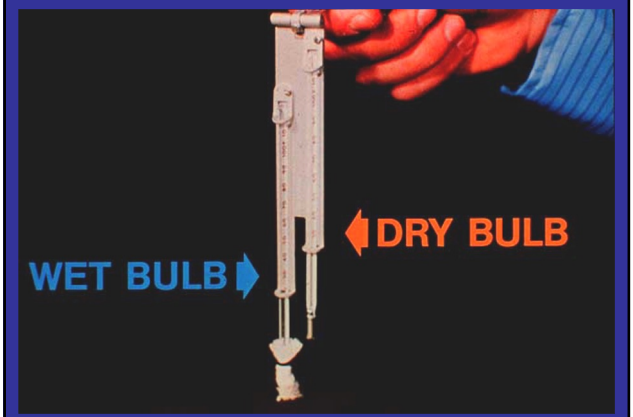


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DRY AIR IS HEAVIER THAN MOIST AIR

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DRY BULB TEMPERATURE (DBT)

It is the temperature recorded by a thermometer of moist air whose bulb is perfectly dry and is not affected by any moisture present in atmosphere and also is not affected by any radiations from the surrounding.
Thus, the bulb surface must be completely dry.

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• WET BULB TEMPERATURE (WBT):

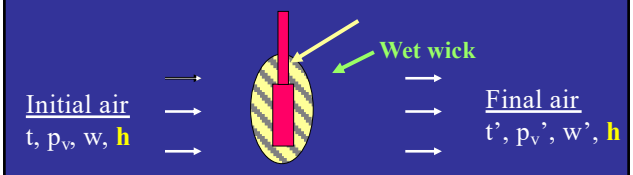
The temperature of air recorded by a thermometer, when its bulb is surrounded by a wet cloth and is exposed to moving air at a velocity of 2.5 – 5 m/s.

Wet bulb depression: Difference between DBT and WBT

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WET BULB TEMPERATURE

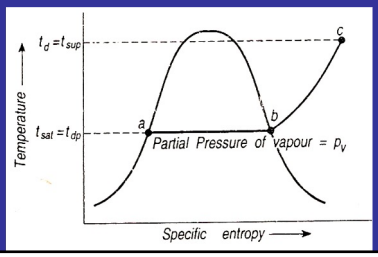
The temperature measured by thermometer that has a bulb covered with moistened wick with air flowing over it.



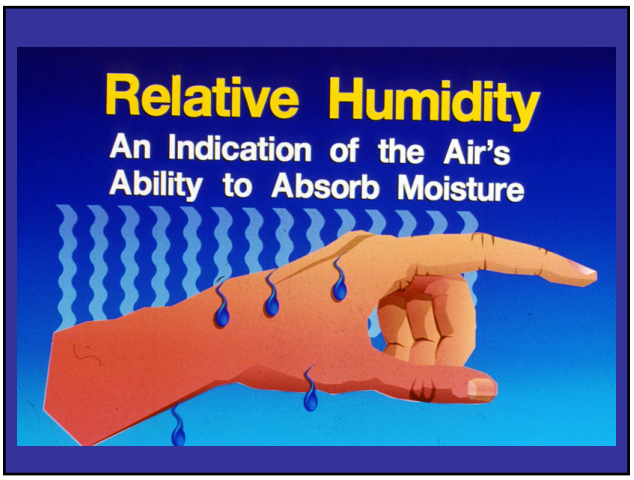
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DEW POINT TEMPERATURE (DPT)

It is the temperature of air at which the first particle of water vapour in air starts condensing and a dew is formed and becomes visible. Thus, this temperature will correspond to the saturation temperature of vapour at its partial pressure.



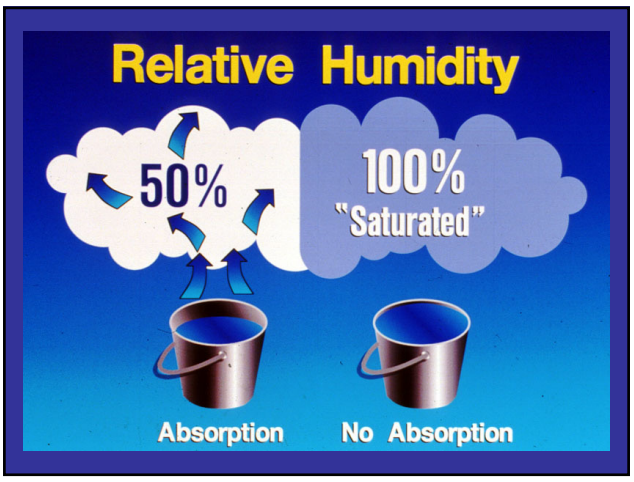
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Relative Humidity
An Indication of the Air's Ability to Absorb Moisture

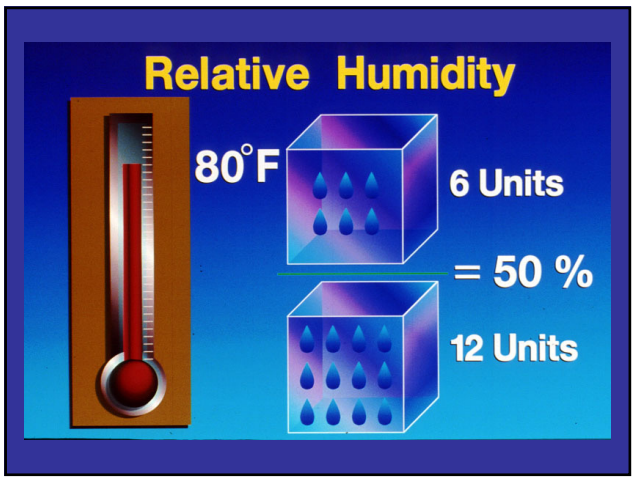
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RELATIVE HUMIDITY
EQUALS
MOISTURE PRESENT
MOISTURE AIR CAN HOLD

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Relative Humidity
50%
100%
"Saturated"
Absorption
No Absorption

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Relative Humidity
80°F
6 Units
= 50 %
12 Units

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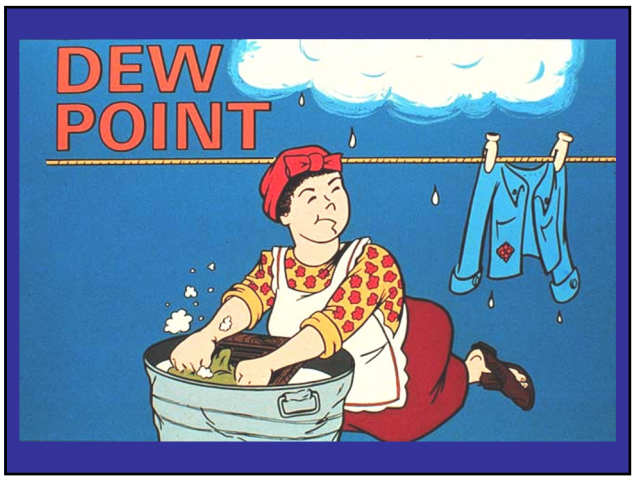
RELATIVE HUMIDITY

COMFORT RELATIVE HUMIDITY

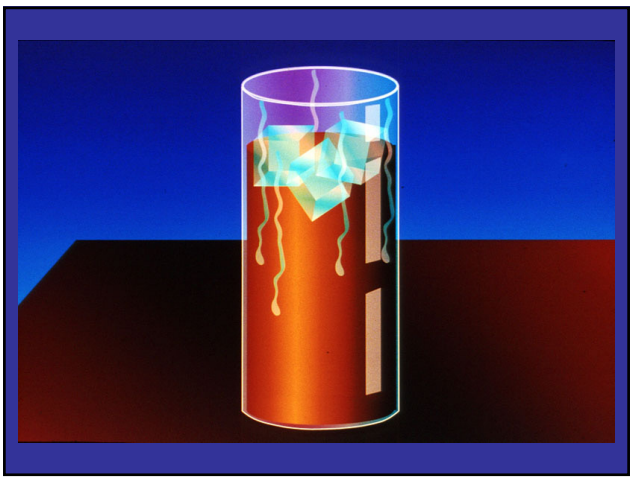
RANGE 30%-60%

WITH 50% AS BENCH MARK VALUE

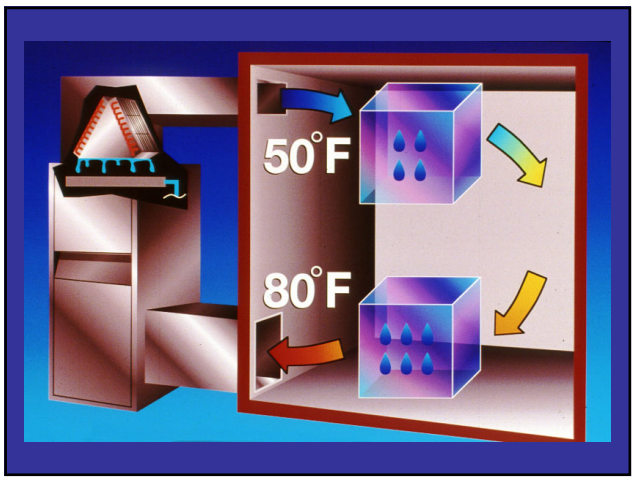
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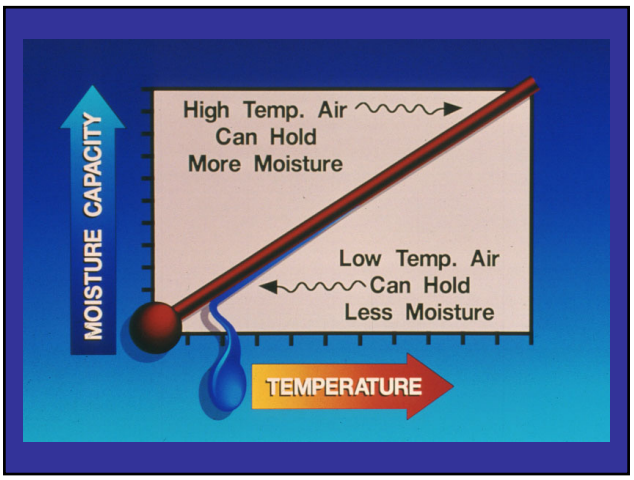
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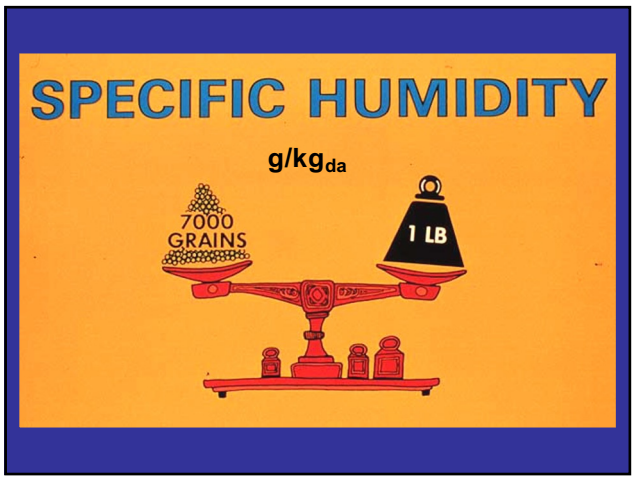
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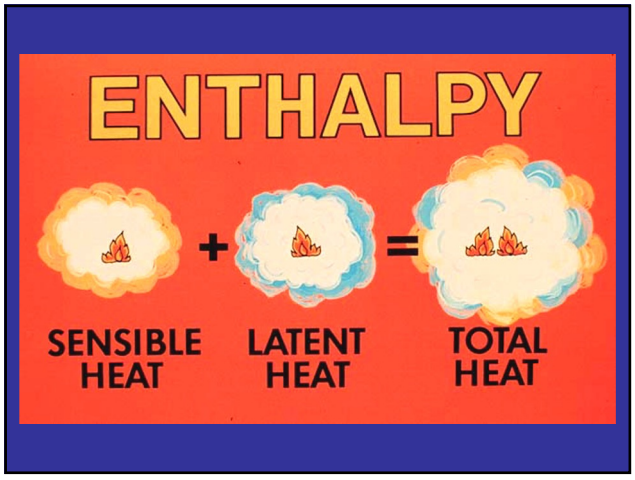
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SPECIFIC HEAT/SPECIFIC DENSITY

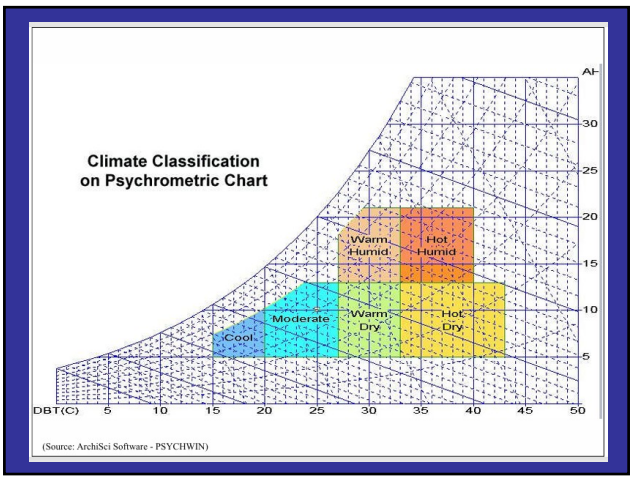
The specific heat capacity of dry air at constant pressure 1.005kJ/kg.K

Specific Density=1.204 kg/m³ at typical room temperature (20 °C / 68 °F) and standard atmospheric pressure.

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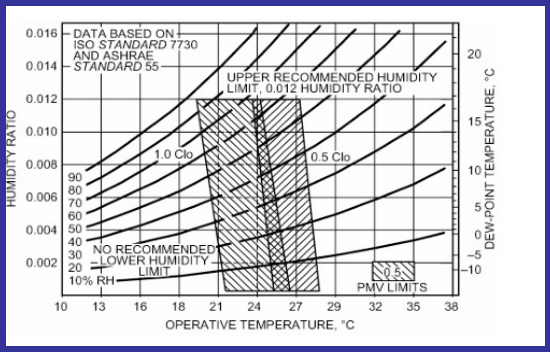


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ASHRAE COMFORT ZONE ON PSYCHROMETRIC CHART



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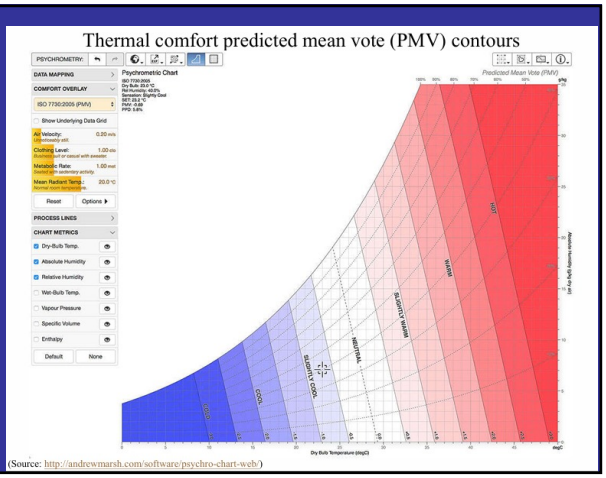
UNDERSTANDING PMV(PREDICTED MEAN VOTE)

For optimal thermal comfort, the widely accepted PMV (Predicted Mean Vote) limit is between **-0.5 and +0.5**, as defined by standards like ASHRAE 55 and ISO 7730, indicating a neutral to slightly warm/cool sensation where over 90% of people feel comfortable, corresponding to a PPD (Predicted Percentage Dissatisfied) of less than 10%

- **PMV Scale**: PMV uses a 7-point scale from -3 (cold) to +3 (hot), with 0 representing neutral thermal sensation.
- **Comfort Zone**: A range of -0.5 to +0.5 signifies a highly comfortable environment, with minimal dissatisfaction.
- **PPD Connection**: This PMV range ensures that the percentage of people who are dissatisfied (PPD) is kept below 10%.
- **Practical Application**: HVAC designers use these limits to create comfortable spaces,
- aim for a PMV reading near zero, but within the -0.5 to +0.5 range for broad acceptance.

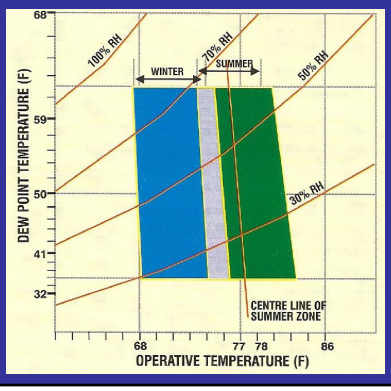
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Thermal comfort predicted mean vote (PMV) contours



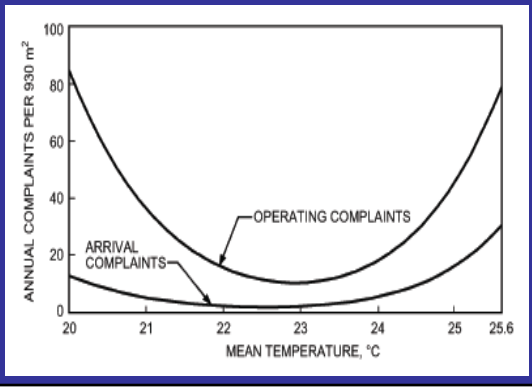
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COMFORT ZONE-SUMMER/WINTER



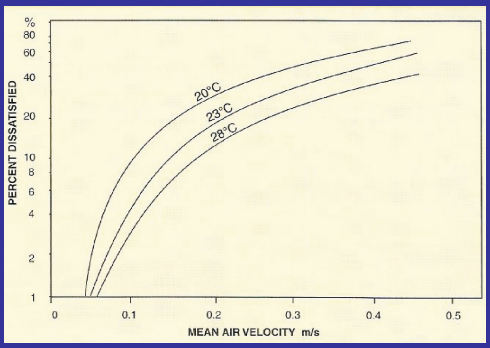
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MAXIMUM SATISFACTION RANGE:-22^{0}C-24^{0}C



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PERCENTAGE DISSATISFACTION V/S MEAN AIR VELOCITY



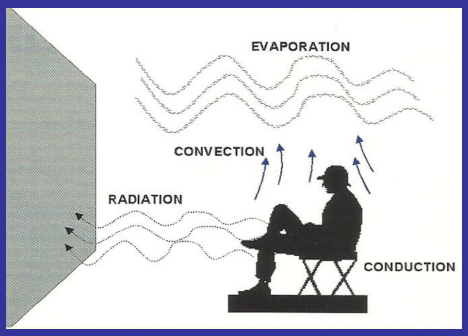
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SET DEFAULT AC TEMPERATURE AT 24°C, SAYS GOVERNMENT

- The ministry has launched an awareness campaign around air conditioning to target substantial energy savings and reduce greenhouse gas emissions.
- Power Ministry to indicate the optimum temperature settings as 24°C to 26°C. & mandatory labels on ACs for this range.
- "**Every one degree increase in the air conditioner temperature setting results in a power saving of 6%,**" making the optimum temperature levels mandatory.
- Some countries like Japan have enacted regulation to keep the default AC temperature at 28°C.
- If all the consumers comply, this will result in savings of 20 billion units of electricity per year," (BEE) estimates that the total connected load in India due to air conditioning will be 200 GW by 2030.
- Source: https://ishrae.in/

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HEAT REJECTION BY PERSON –NORMALLY SEATED



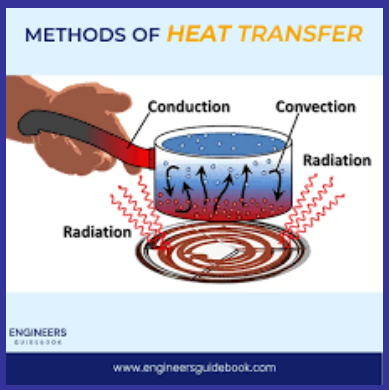
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Heat Flows 3 Ways:

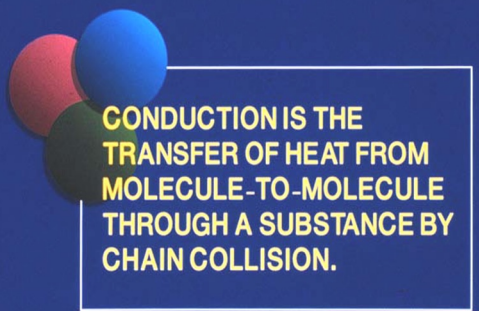
1. Conduction
2. Convection
3. Radiation

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HEAT TRANSFER METHODS



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CONDUCTION

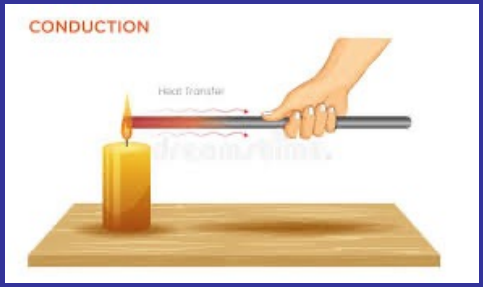
Conduction refers to the transfer of energy through the movement of particles that are in contact with each other.

Whenever our body parts come in contact with any object or air which is at a lower temperature than the body temperature, the heat will be transferred by conduction.

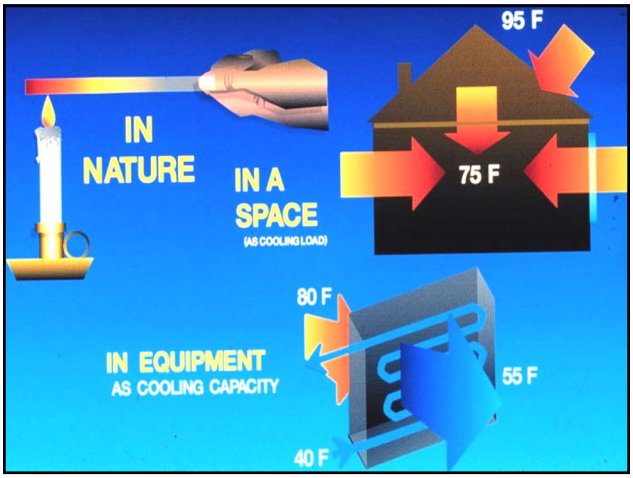
Cooler the surrounding air, faster will be the heat leaving the body. When the temperature is very low, occupants will complain about feeling too cold and when the temperature is very high, they will complain about feeling too hot.

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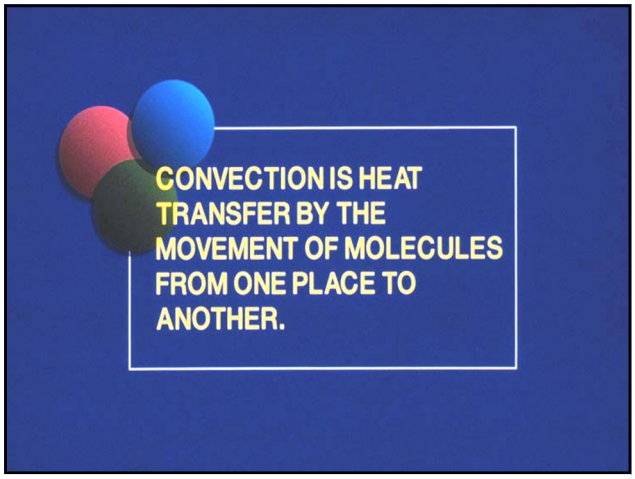
CONDUCTION



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CONVECTION

Convection (or convective heat transfer) is the transfer of heat from one place to another due to the movement of fluid.

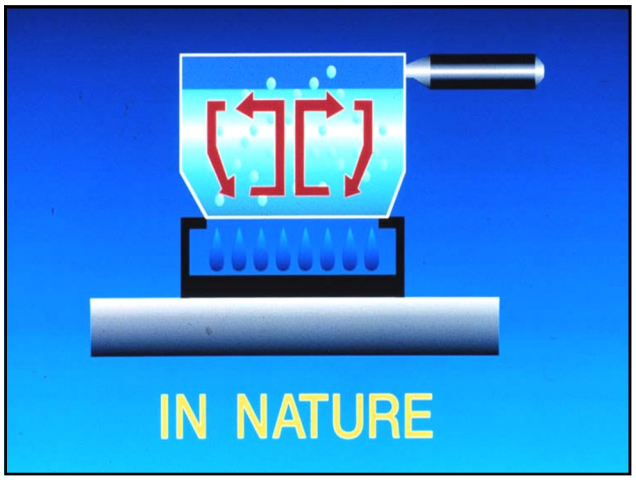
When the body is rejecting heat, the air closer to the body becomes warmer than the air which is away from the body.

As warm air is lighter than cold air, it rises upward and is being replaced by the cold air.

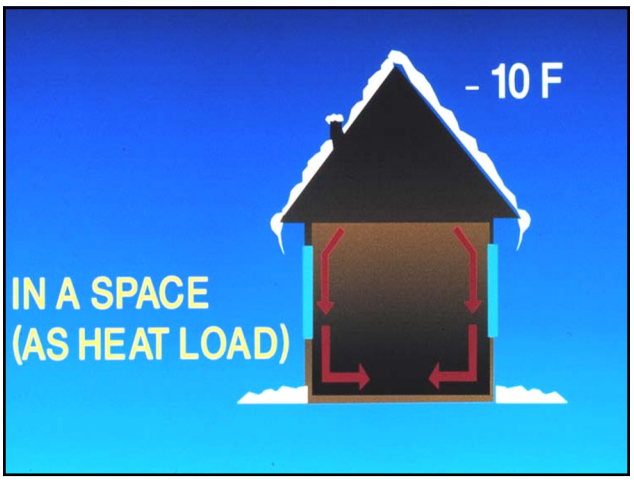
Convection currents are therefore set-in motion and heat is thus rejected to the surrounding air.

If the fans are circulating air, then the heat transfer is faster as it would amount to forced convection which is faster than natural convection heat transfer.

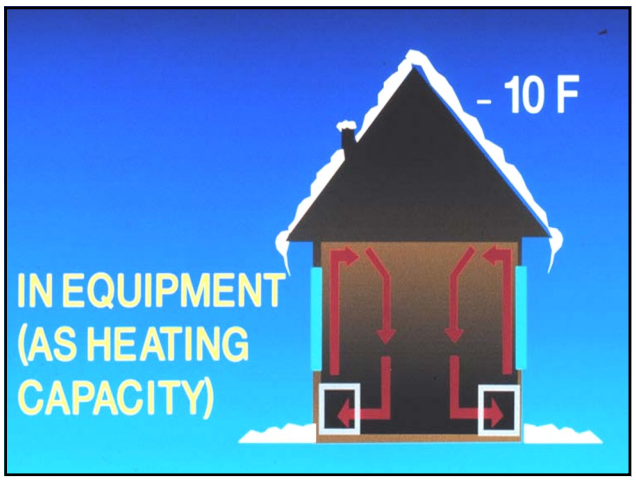
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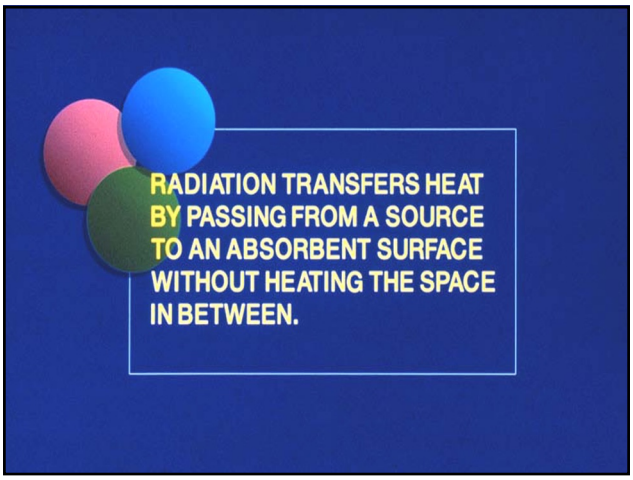
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RADIATION

Radiation can be defined as the transmission of energy from a body in the form of waves or particles.

This heat transfer takes place due to temperature difference between the body and the objects in the premises which are at a lower temperature than the body.

Radiant heat travels from a warmer body to colder objects or surfaces like walls, furniture etc. without heating the medium between the two.

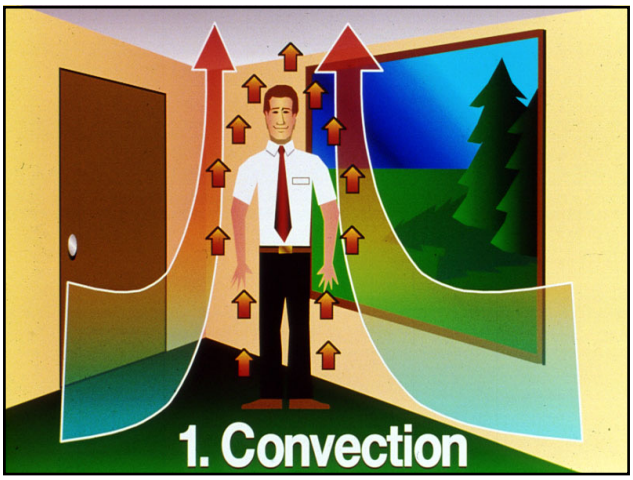
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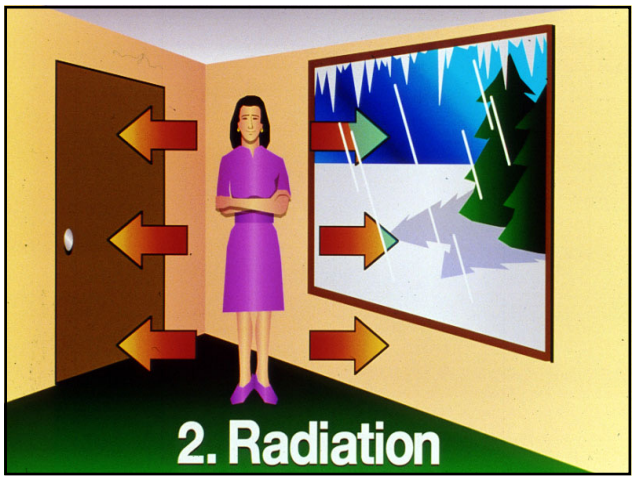
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EVAPORATION

It is the fourth way in which heat is transferred from our body to the space surrounding it.

Evaporation is a type of vaporization that occurs on the surface of a liquid as it changes into the gas phase.

Moisture, what we call perspiration is released from the pores of our skin.

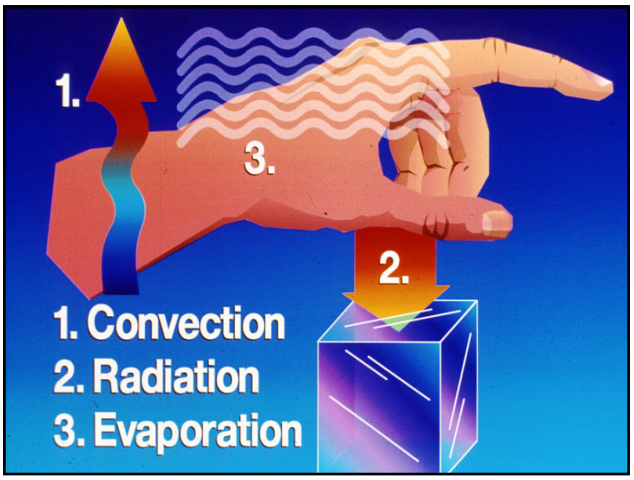
As the moisture evaporates, the heat needed for such evaporation is provided by our body and in turn the body cools.

This evaporation process is going on constantly whether we notice it or not.

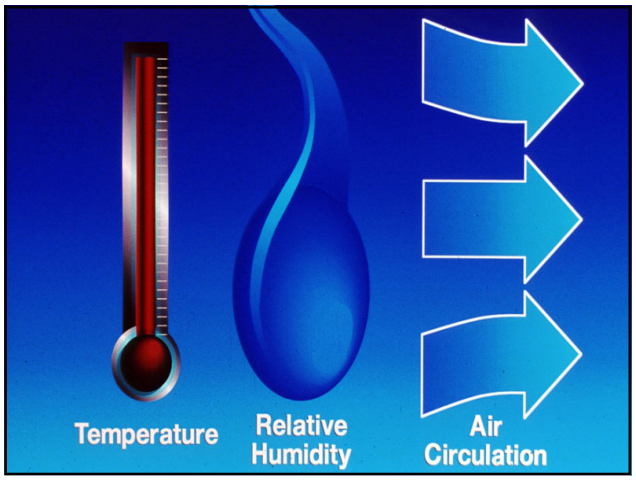
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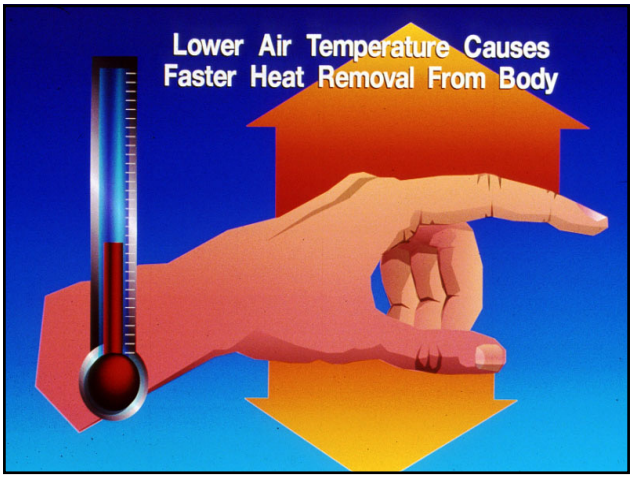
68


1.
3.
2.
1. Convection
2. Radiation
3. Evaporation

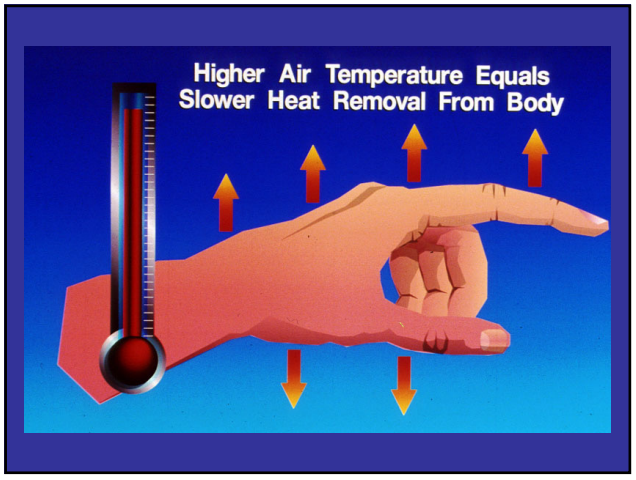
69


Temperature
Relative Humidity
Air Circulation

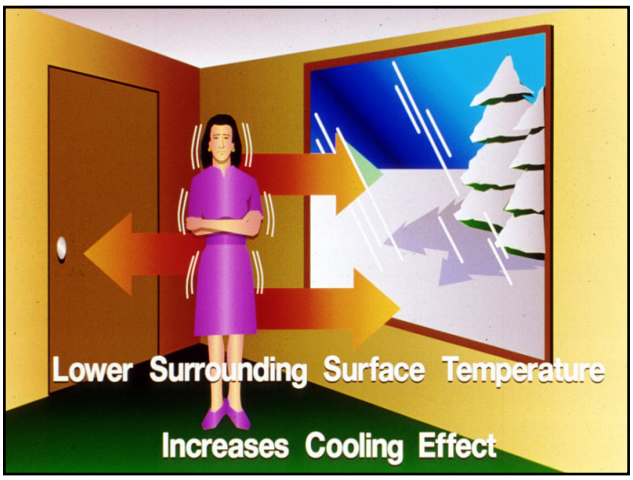
70


Lower Air Temperature Causes
Faster Heat Removal From Body

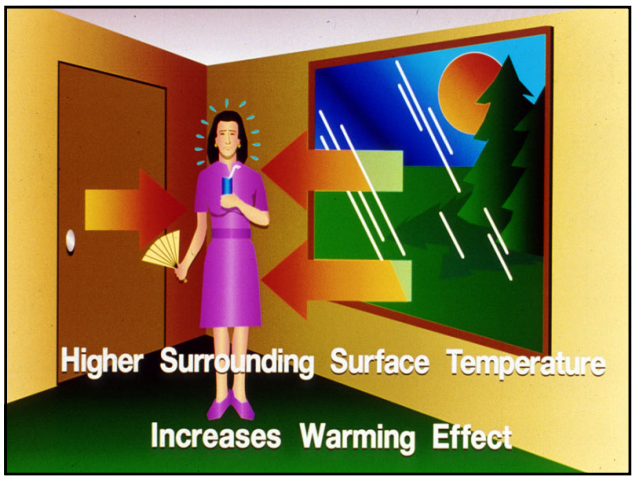
71


Higher Air Temperature Equals
Slower Heat Removal From Body

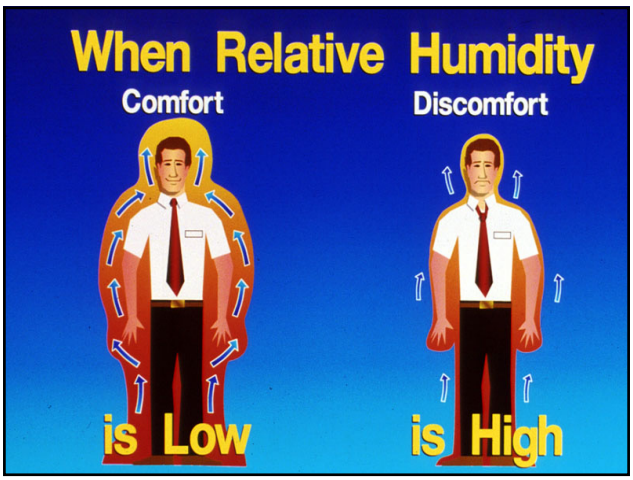
72



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75

SWEATING

When we start sweating and the drops of perspiration appear on the skin, it means the rate at which the body is rejecting heat is faster than the rate at which the surrounding air can absorb it.

This could be either due to excess moisture (or a higher relative humidity) already present in the air or due to a higher activity level, when the body is generating more heat than it can reject at a normal rate.

Since most of the heat is rejected to the environment through the skin, the moisture appears as sweating

76



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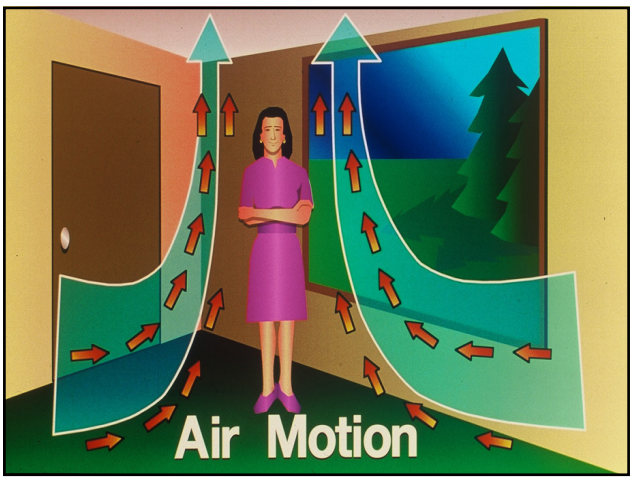
RESPIRATION

During respiration, the body loses both sensible and latent heat by convection and evaporation, since air inhaled is at the surrounding temperature, whereas exhaled air is warmer and nearly saturated.

All these processes of heat rejection from the body to surroundings are taking place simultaneously.

However, depending on the individual conditions, one form of heat transfer is more active compared to the other three.

78

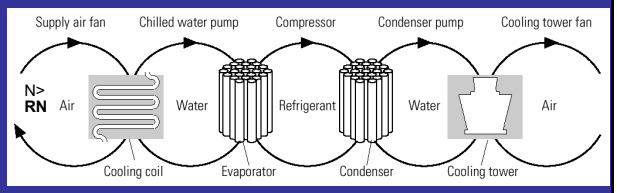


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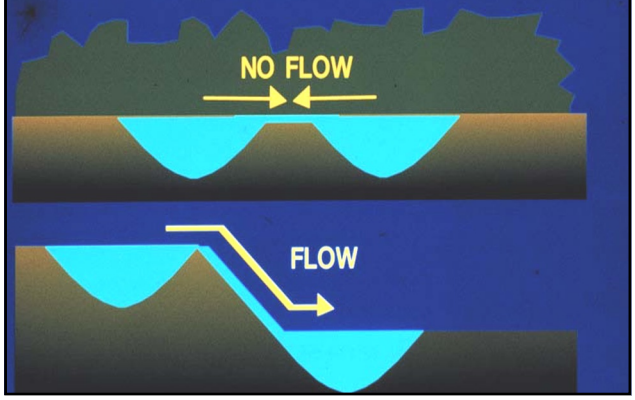
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Heat transfer loops in Air Conditioning & Refrigeration systems

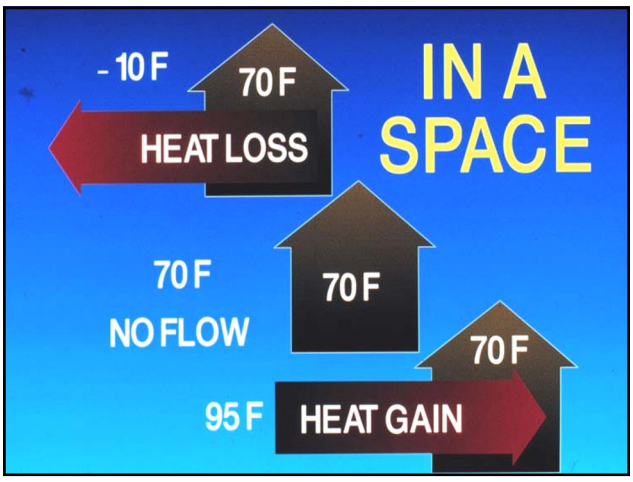


81

ENERGY FLOWS "DOWNHILL"



82



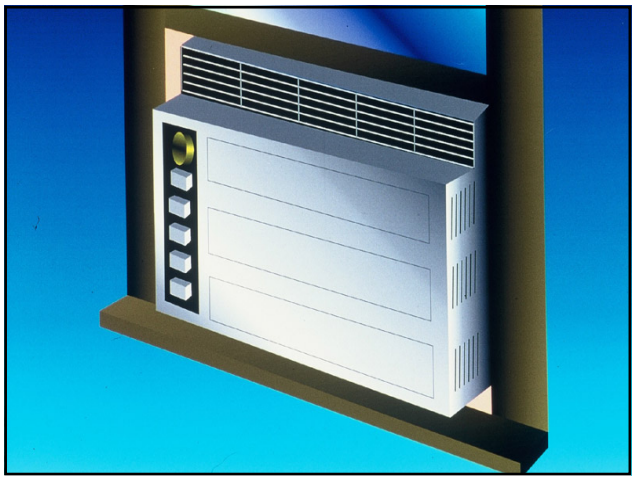
83

AIR CONDITIONING IS EITHER DOMASTIC OR FOR LARGE PREMISES CENTRAL PLANT

84

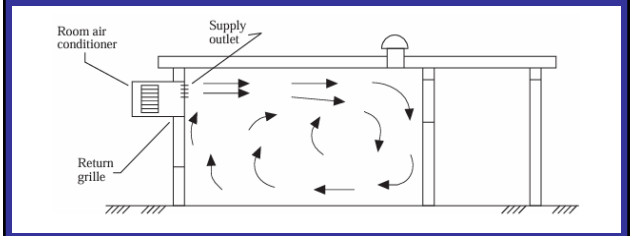
DOMASTIC AIR CONDITIONERS

85



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INDIVIDUAL ROOM AIR CONDITIONER



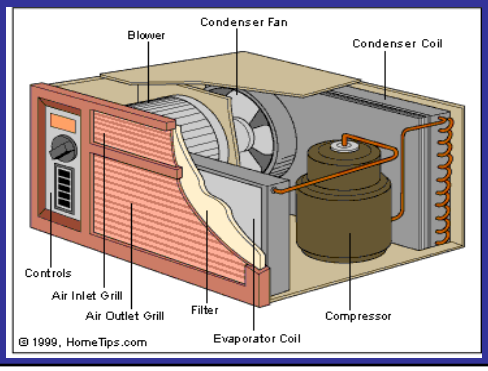
87

WINDOW AIR CONDITIONER-OUTSIDE VIEW



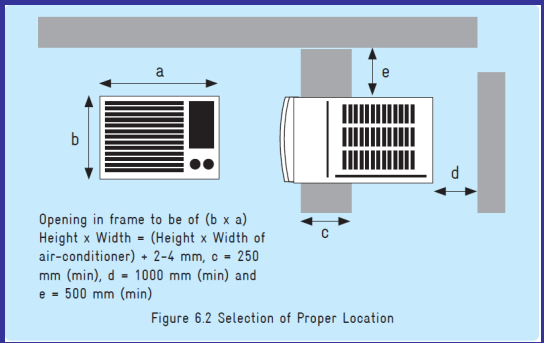
88

INTERNALS OF AIR CONDITIONER



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INSTALLATION GUIDE LINES-WINDOW A/C



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ROOM SIZE AND CAPACITIES

BTU Calculator for Window Air Conditioners

Room Size in Feet	Area Sq. Ft.	Recommended BTU's	Full Sun	Kitchen
39 x 40	1,560	24,500	26,950	28,500
25 x 40	1,000	18,000	19,800	22,000
25 x 32	800	15,000	16,500	19,000
22 x 25	550	12,000	13,200	16,000
18 x 25	450	10,000	11,000	14,000
17 x 20	340	8,000	8,800	12,000
14 x 20	280	7,000	7,700	11,000
13 x 20	260	6,000	6,600	10,000
10 x 15	150	5,000	5,500	9,000

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DIRECT EXPANSION OR DX SYSTEMS

1. Unitary Air-Conditioners: BIS 1391 Part 1 – 1992 Amendment No 2 Dec. 2006
   Power requirements under test conditions

Rated Cooling (kcal / hr)	Capacity kW	Maximum Power Consumption (kW)	COP
1500	1.7	1.1	1.545
2250	2.6	1.4	1.857
3000	3.5	1.6	2.180
3750	4.4	2.0	2.20
4500	5.2	2.4	2.16
7500	8.7	4.25	2.04
9000	10.5	5.2	2.01

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BEE NORMS- 1.5 TR A/C

Rating	COP
1 STAR	2.3
2 STAR	2.5
3 STAR	2.7
4 STAR	2.9
5 STAR	3.10

For Further details, visit www.bee-india.nic.in

www.energymanagerstraining.com

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ENERGY LABELS

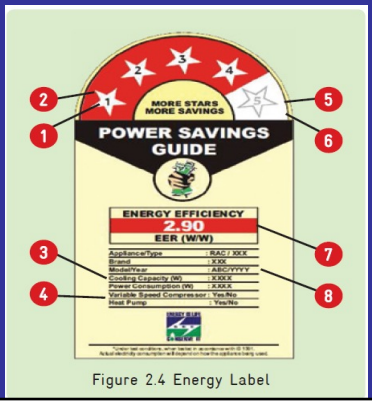


Figure 2.4 Energy Label

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AIR CONDITIONERS MOUNTED IN BUILDING



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SPLIT AIR CONDITIONER



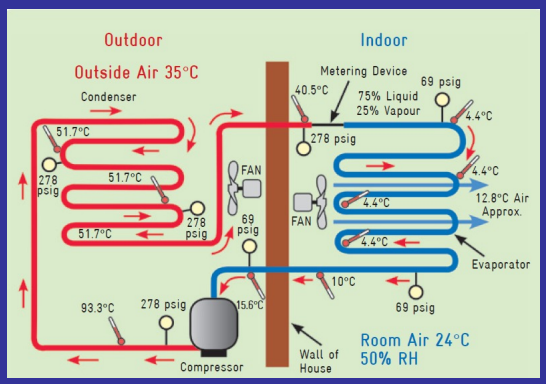
97

SPLIT AIR CONDITIONER



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WORKING OF SPLIT AIR CONDITIONER



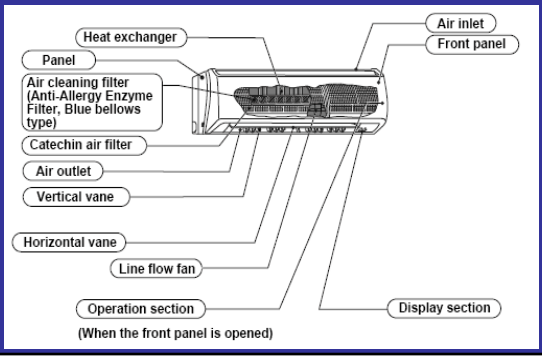
99

SPLIT AIR CONDITIONER INDOOR UNIT



100

INDOOR UNIT PARTS FOR SPLIT AIR CONDITIONER



101

SPLIT SYSTEM OUT DOOR UNIT



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INSTALLATION OF INDOOR UNIT

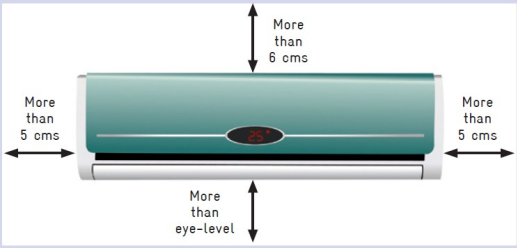


Figure 6.4 Proper Location for Indoor Unit (IDU)

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INSTALLATION OF OUTDOOR UNIT



Figure 6.5 Proper Location for Outdoor Unit (ODU)

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DIRECT EXPANSION OR DX SYSTEMS

Split Air Conditioners: IS 1391 Part 2 – 1992 Amendment No 2 Dec. 2006

Rated Cooling (kcal / hr)	Capacity kW	Maximum Power Consumption (kW)	COP
3000	3.5	1.7	2.05
4500	5.2	2.6	2.0
6000	7.0	3.4	2.05
7500	8.7	4.5	1.933
9000	10.5	5.4	1.944

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AIR CONDITIONING LOAD CALCULATIONS

(since this a vast subject there would be sperate module for load calculations, we shall only cover factors that need to be considered for the load calculations)

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STEPS FOR COOLING LOAD CALCULATION

1. Prepare assumption sheet and get it approved by customer. (details enclosed)
2. Zone the areas
3. Calculate cooling load for each zone
4. Calculate cooling load for building envelope as one zone
5. Check ratio of 3 and 4 which should be between 75% to 85%
6. Check Ton/sq.ft obtained and cfm/sq.ft and verify against thumb rules
7. Prepare Pie chart for load distribution to attack area contributing larger load if necessary.
8. Prepare summary cooling load sheet based on each floor/zone
9. Prepare AHU data sheet indicating outside air cfm, return air cfm, and tonnage. Match these figures with sr.no.3

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STEPS FOR COOLING LOAD CALCULATION

10. Prepare chilled water piping data sheet having pipe size, length (approx.), pressure drop/100 ft of equivalent length and actual pressure drop for each segment. Balance these values wherever required .
11. Include in above calculations valves , fittings pressure drops
12. Select primary pump after including machine pressure drop and secondary pumps based on actual pressure drop.
13. Select cooling tower on the basis of 0.4% wet bulb temperature, water in /out temperature. i.e on the basis of approach and range. Prepare ducting layout on the basis of equal friction method with main supply air duct velocity as 1500 fpm and grills /diffusers 500/600 fpm.

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STEPS FOR COOLING LOAD CALCULATION

14. Prepare ducting layout on the basis of equal friction method with main supply air duct velocity as 1500 fpm and grills /diffusers 500/600 fpm.
15. Find actual pressure drop in the longest route and verify whether available fan static is adequate. Re balance duct sizes if needed.
16. Provide return air ducts if required with air velocity 1000-1200 fpm (80 of supply air velocity)
17. Provide exhaust fans equal to out side air . Air quantity balancing essential.
18. Prepare BOQ and indicate budgetary prices.
19. Attach specification sheets for chiller package/cooling tower/pumps/AHU/valves/filters
20. Include list of approved vendors with 3 makes of each type
21. Attach/mention relevant applicable BIS/ ASHRAE /ARI standards.

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ASSUMPTION SHEET

Factors to be considered:

- Location of project-City
- Building orientation-North/South/East/West
- Application-
- Plant operating hours

(12hrs, 16 hrs and 24 hrs)

- Zones
- Inside and Outside Conditions
- Occurrence
- Occupancy, Equipment and Lighting load
- Material of Construction: Glass, Walls & Partition-Glass/Wall area

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LOAD ESTIMATION

Space Characteristics and Heat Load Sources

1. <u>Orientation of building:</u> Location of the space to be air conditioned with respect to

a. Compass points – Sun and wind effects

b. Nearby permanent structures – shading effects

c. Reflective surfaces – water, sand, parking lots, etc.

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2. APPLICATION:

Office, hospital, department store, specialty shop, machine shop, factory, assembly plant, etc.

3. Physical dimensions of space

4. Ceiling height

5. Columns and beams

6. Construction materials

7. Surrounding conditions

8. Windows

9. Doors

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10. Stairways, elevators and escalators

11. People

12. Lighting

13. Motors

14. Appliances, business machines, electronic equipment

15. Ventilation

16. Thermal Storage

17. Continuous or intermittent operation

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LOAD COMPONENTS

- SENSIBLE HEAT LOAD – Always Associated with change in temperature
- LATENT HEAT LOAD- Associated with change in moisture content

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SENSIBLE HEAT LOAD

- The heat flowing into the building by conduction through exterior walls, floors, ceilings, doors and windows due to temperature difference.
- The heat received from solar radiation.
  - i. The heat transmitted directly through glass of windows, ventilators or doors
  - ii. The heat absorbed by walls and roofs exposed to solar radiation and later on transferred to the room by conduction.
- The heat given off by lights, motors, machinery, etc.
- The heat liberated by occupants
- The heat carried by outside air through infiltration/Ventilation.

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LATENT HEAT LOAD

- **Heat gain due to moisture in the outside air through infiltration/ventilation.**
- **Heat gain due to occupants.**
- **Heat gain due to of moisture from any process such as cooking foods/bathroom showers.**
- **Fruits/Vegetables**
- **Heat gain due to moisture passing directly into conditioned space from outside air or adjoining regions where the water vapour pressure is higher.**

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LOAD COMPONENTS

1. **External Loads -Walls, roofs, windows, partitions, ceiling ,floors, infiltration, ventilation**
2. **Internal Loads-** Lights, people, appliances, and equipment
3. **Other loads:**

   duct leakage, reheat, fan & pump energy

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HEAT LOAD –PEOPLE

(75 deg F table-48 Page 100)

	Sensible – Btuh	Latent- Btuh	Total
Theatre	195	155	350
Office	200	250	450
Factiory	245	505	750

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VENTILATION REQUIREMENTS

(ASHRAE/ANSI 62.1-20070

Office Building	5 Cfm/Person+0.06Cfm/Sq.ft.
Mall/COMMON AREAS SUPER MARKET	10Cfm/Person+0.12Cfm/Sq.ft
Class Room /Colleges	10Cfm/person+0.12cfm/Sq.ft.
Theaters	10Cfm/Person+0.06cfm/sq.ft.
Restaurants	7.5 Cfm/Person+0.18cfm/sq.ft.
Health Clubs/Aerobics	20cfm/person+ 0.06cfm/sq.ft.

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THUMB RULES

1.	10 kW	3 Tons
2.	100 People	3 Tons
3.	1000 cfm	3 Tons

120

POPULAR SOFTWARE

- Carrier E-20 -Hourly Analysis Program (HAP) E20-II
- BLAST- Building load Analysis and System Thermodynamics-University of Illinois
- DOE 2.1E -Dept. of Energy
- TRACE 600 -Trane company
- HLCP- ISHRAE Mumbai
- EXCEL-SPREAD SHEET

121

COMFORT AIR CONDITIONING APPLICATIONS

Key Applications of Comfort AC:

1. Residential: Homes and apartments for pleasant living conditions.

2. Commercial Buildings: Offices, shopping malls, restaurants, and hotels to improve customer experience and worker efficiency.

3. Healthcare: Hospitals and clinics to maintain hygienic and comfortable environments, especially in operating theaters.

4. Education: Schools, colleges, and libraries

5. Entertainment: Cinemas, theaters, and auditoriums

6. Transportation: Cars, buses, trains, planes, ships

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THE TASK OF AIR CONDITIONING

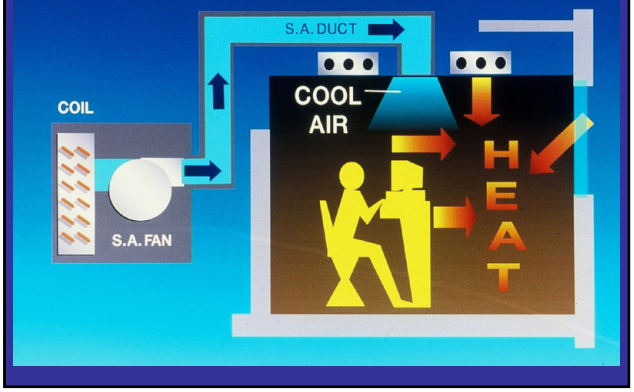
HOW TO REMOVE THIS HEAT

FOUR BASIC SYSTEMS

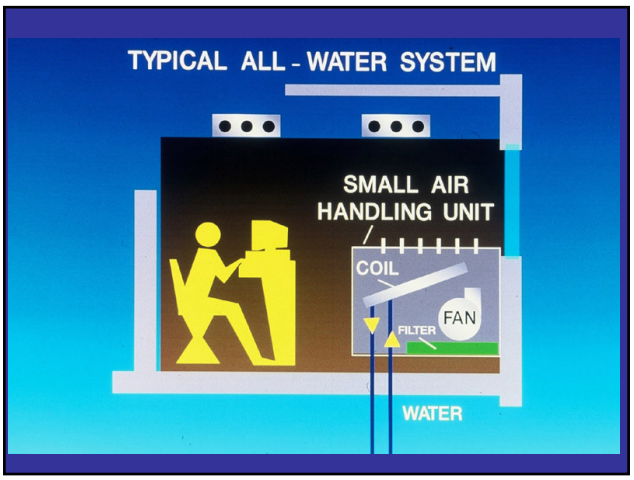
1. ALL AIR
2. ALL WATER
3. AIR \ WATER
4. DIRECT REFRIGERANT

123

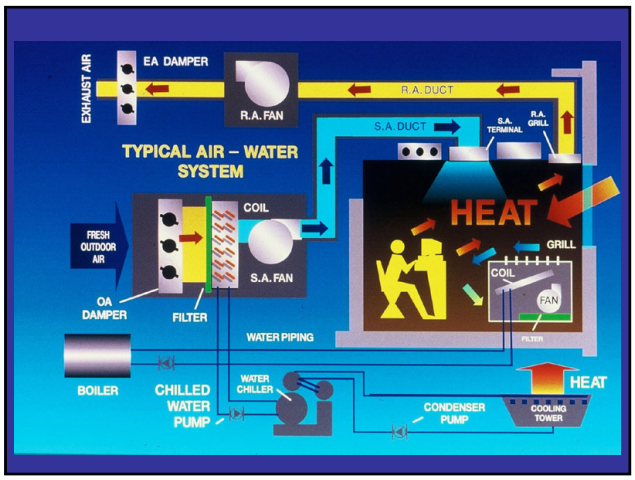
TYPICAL ALL – AIR SYSTEM



124



125

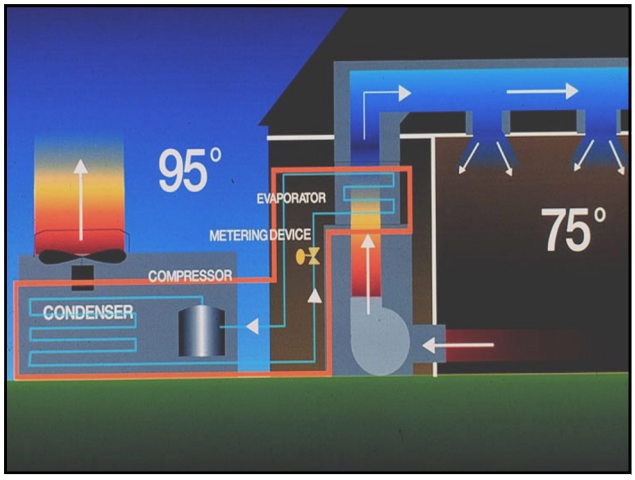


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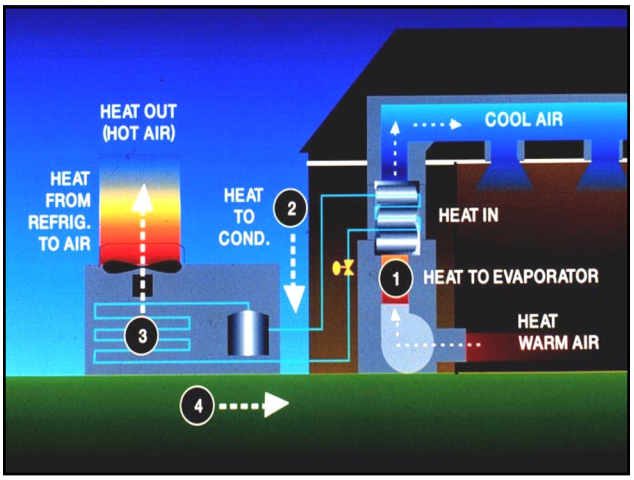
The air conditioning systems are generally divided into two categories

1. **A direct expansion system**
2. **Central chilled water recirculation system**
3. **Any system can have common air handling unit with cold air distributed through ducts or individual fan coil units for the specific areas**

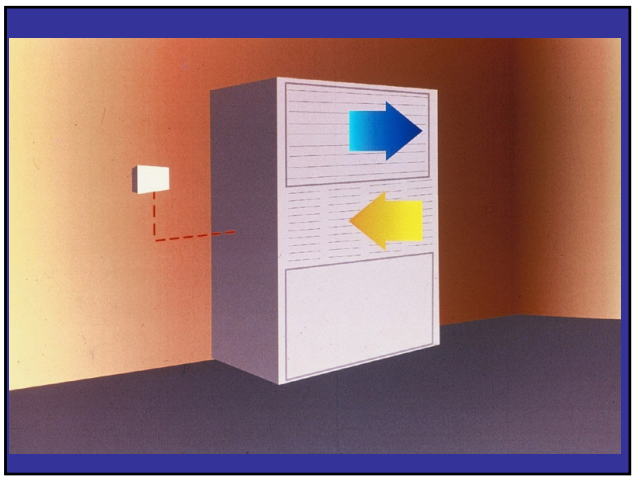
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Direct Expansion or DX systems

3. Packaged Air Conditioners: IS 8148 - 2003

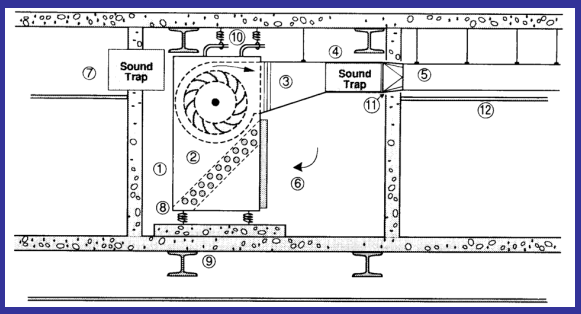
Rated Cooling (kcal / hr)	Capacity	Water Cooled		Air Cooled	
		kW	COP	kW	COP
10000	3 TR (10.551 kW)	3.7	2.85	4.75	2.22
17500	5 TR (17.585 kW)	6.0	2.93	7.00	2.5
26500	7.5 TR (26.377 kW)	9.0	2.93	10.00	2.637
35000	10 TR (35.17 kW)	11.5	3.05	13.5	2.60
52000	15 TR (52.755 kW)	17.0	3.10	20.0	2.63

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AIR DISTRBUTION WITH COMMON AIR HANDLING UNIT

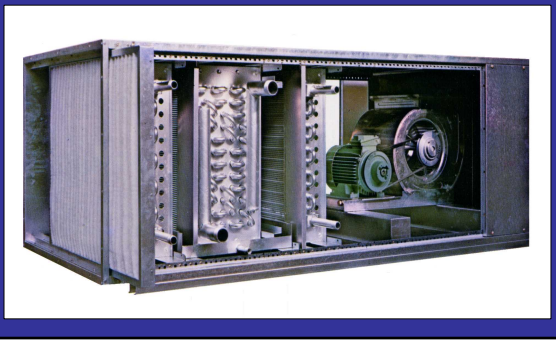
132

Figure 10-2. AHU Room with Optimal Acoustical Features



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AIR HADLING UNIT



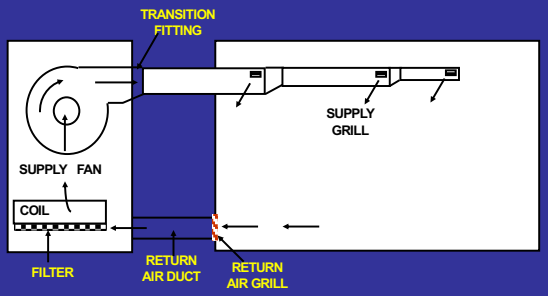
134

INDUSTRIAL AIR HANDLING UNIT

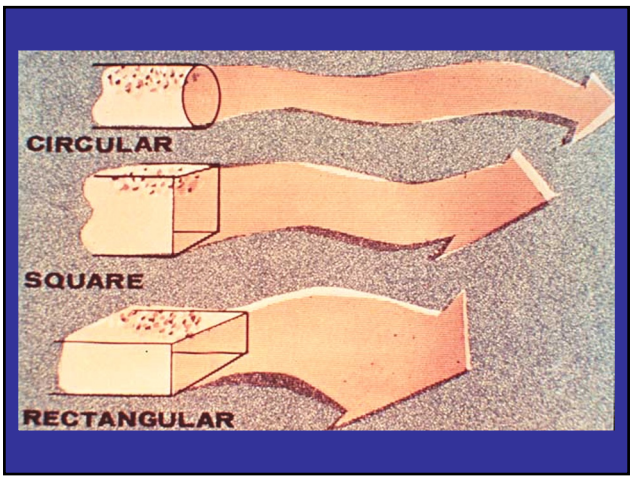


135

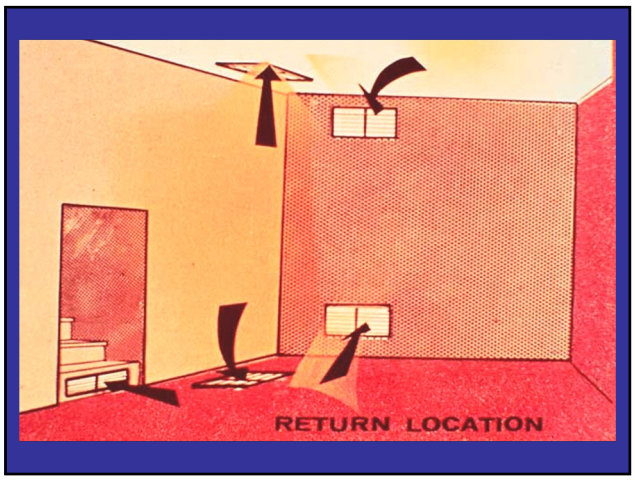
AIR DISTRIBUTION SYSTEM COMPONENTS



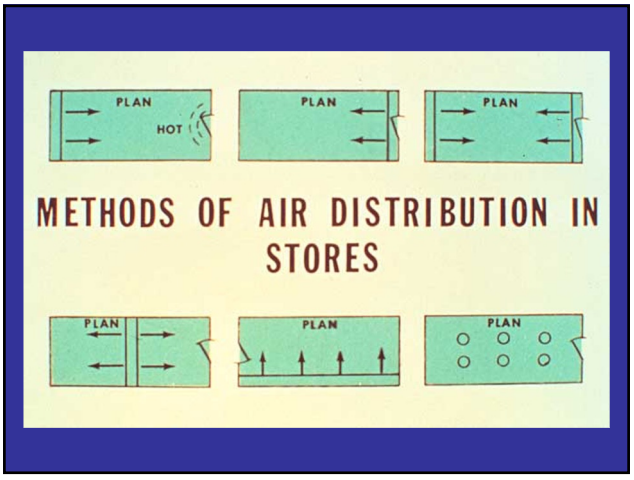
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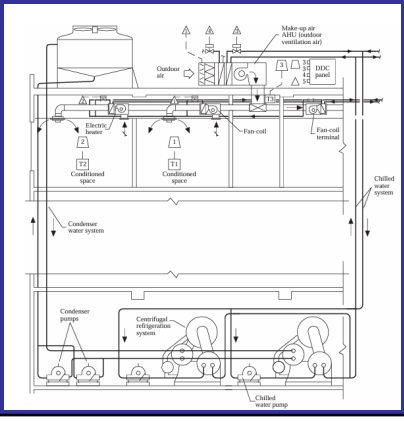


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CHILLED WATER SYSTEMS NORMALLY USE INDEPENDENT AIR COOLING UNITS FOR THE INDIVIDUAL ROOMS,DEDICATED AREAS

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COMMERCIAL SPACE AIR CONDITIONING



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JHONSON CONTROLS USES AMMNIA SYSTEM TO AIR CONDITION 5000 SQ.M OF OF OFFICE AREA USING FOUR AMMONIA WATER CHILLING UNITS EACH OF 2MW CAPACITY



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EQUIPMENT EFFICIENCY

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MINIMUM EQUIPMENT EFFICIENCIES

Equipment Class	Minimum COP	Minimum IPLV	Test Standard
Air Cooled Chiller <530 kW (<150 tons)	2.90	3.16	ARI 550/590-1998
Air Cooled Chiller >=530 kW (>=150 tons)	3.05	3.32	ARI 550/590-1998
Centrifugal Water Cooled Chiller < 530 kW (<150 tons)	5.80	6.09	ARI 550/590-1998
Centrifugal Water Cooled Chiller >=530 and <1050 kW (>=150 and <300 tons)	5.80	6.17	ARI 550/590-1998
Centrifugal Water Cooled Chiller >= 1050 kW (>= 300 tons)	6.30	6.61	ARI 550/590-1998
Reciprocating Compressor, Water Cooled Chiller all sizes	4.20	5.05	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water Cooled Chiller <530 kW (<150 tons)	4.70	5.49	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water Cooled Chiller >=530 and <1050 kW (>=150 and <300 tons)	5.40	6.17	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water Cooled Chiller >= 1050 kW (>= 300 tons)	5.75	6.43	ARI 550/590-1998

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SELECTION NORMS

Centrifugal chillers	> 400 Tons
Water & air-cooled Screw chillers	100-750 TR
Air cooled & Water-cooled reciprocating chillers	30-200TR
Packaged air conditioners	Up to 30 TR
Split Air conditioners/Ductable splits	20 TR
Room Air conditioner	3 TR

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REQUIREMENT OF AIR CONDITIONING

City	No. of hours Dry bulb exceeds 26 ^{0} C-Hrs	% in 8760 hrs
Bengaluru	2266	26 (74)
Pune	2972	34 (66)
New Delhi	4443	51 (49)
Hyderabad	4613	53 (47)
Kolkatta	5285	60 (40)
Ahmedabad	5677	65 (35)
Mumbai	5911	67 (33)
Chennai	6164	70 (30)

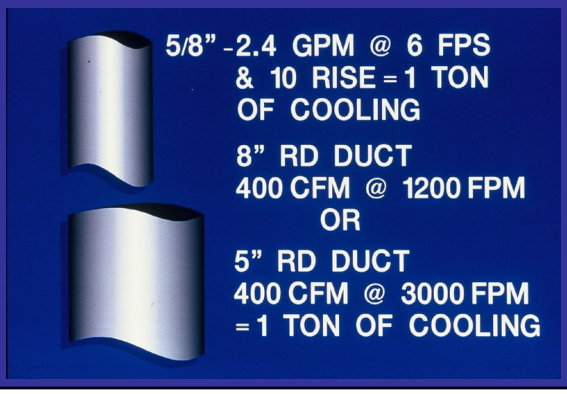
Ref: eere.energy.gov.com

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DUCTED or CHILLED WATER SYSTEM ?

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DUCT V/S PIPE COMPARISON



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HEAT TRANSFER BY 1 M3 OF AIR AND 1 M^3 OF WATER FOR TEMP RISE OF 1^0 C

For Air:

Q_{air} = m x Cp x ΔT = ρ x volume x Cp x ΔT

1.005 is specific heat of moist air and 1.20 is density of air in kg/ m^3

For water:

Q_{water} = m x Cp x ΔT = ρ x volume x Cp x ΔT

4.187 is specific heat of water and 1000 is density of water in kg/ m^3

For same ΔT say = 1^0C

Q_{water} / Q_{air} = 1000 x 4.187 / 1.20 x 1.005

= 3471(in FPS,1x62.4/0.24x.075=3466)

In other words, Water system is approximately 3471 times more efficient than air systems for same volume.

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LOAD CALCULATIONS- formulae

- **Sensible heat**- W=J/s = m x c_p x ΔT
- W= 1.204 kg/m^3x l/s x 1.0216 kJ/kg.k x ΔT-k
- **W= 1.23 xl/s x ΔT**
- (Air density =1.204Kg/m^3)
- (Specific heat =1.0216 KJ/kg.K)

- **Latent heat**
-
- **W=J/s= 1.204 kg/m^3xL/s x 2500 kJ/kg x ΔW g/kg_{da}**
- **=**3.010 x L/s x ΔW or **3 x L/s x ΔWg/kg_{da}**

- **Total Heat=W =**J/s=1.204 kg/m^3xL/s x ΔH kJ/kg or **1.2xL/s x ΔH**
- (Air density =1.204Kg/m3)
- ΔH= kJ/kg
- Or kW=m3/secx1.204kg/m3xΔH kJ/kg

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Thank you

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