Heating Ventilation and Air Conditioning Efficiency

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Functions of HVAC Systems

- The purpose of a Heating, Ventilation and Air Conditioning (HVAC) system is to provide and maintain a comfortable environment within a building for the occupants or for the process being conducted
- Many HVAC systems were not designed with energy efficiency as one of the design factors

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Air

Air is the major conductor of heat.

OR

Lack of heat = air conditioning

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Basics of Air Conditioning

Btu – Amount of heat required to raise one pound of water 1°F = 0.252 KgCal

1 Pound of Water =

About 1 Pint of Water
~ 1 Large Glass

1 Kitchen Match =

1 Btu

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12,000 Btu/hour =

1 ton of air conditioning

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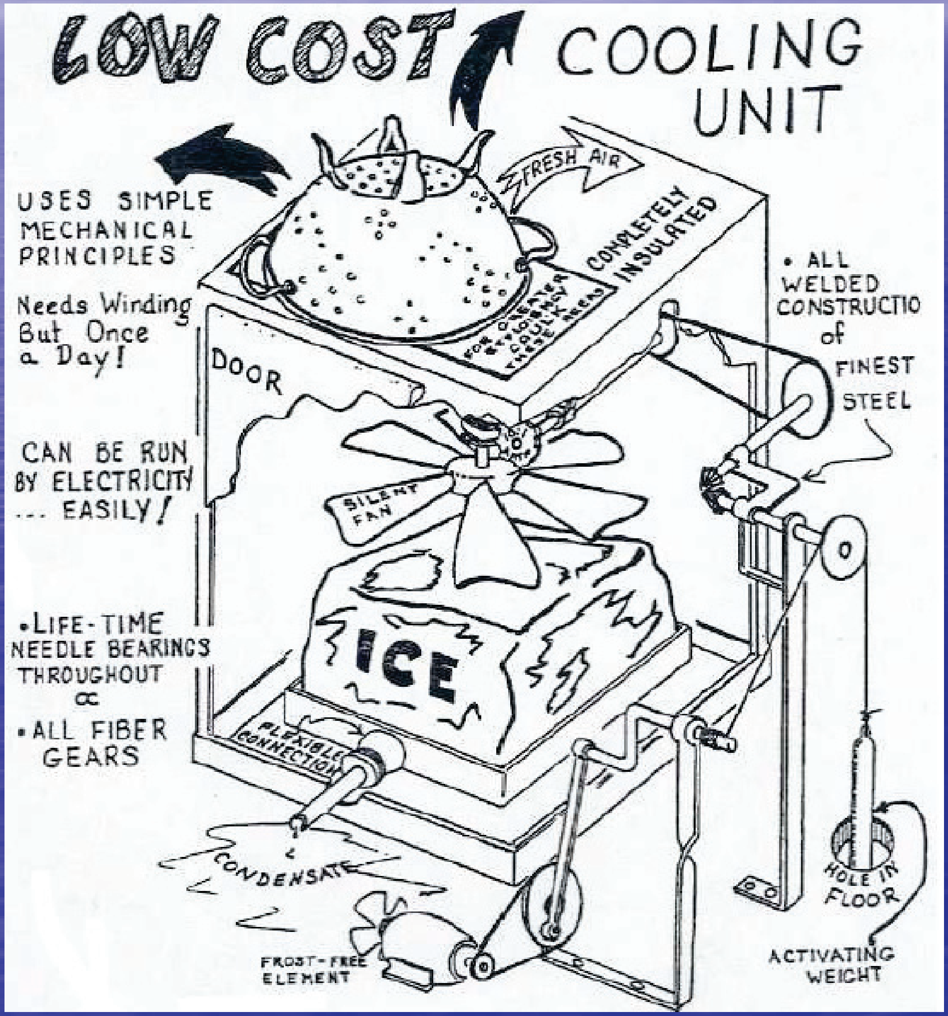
Low Cost Cooling Unit



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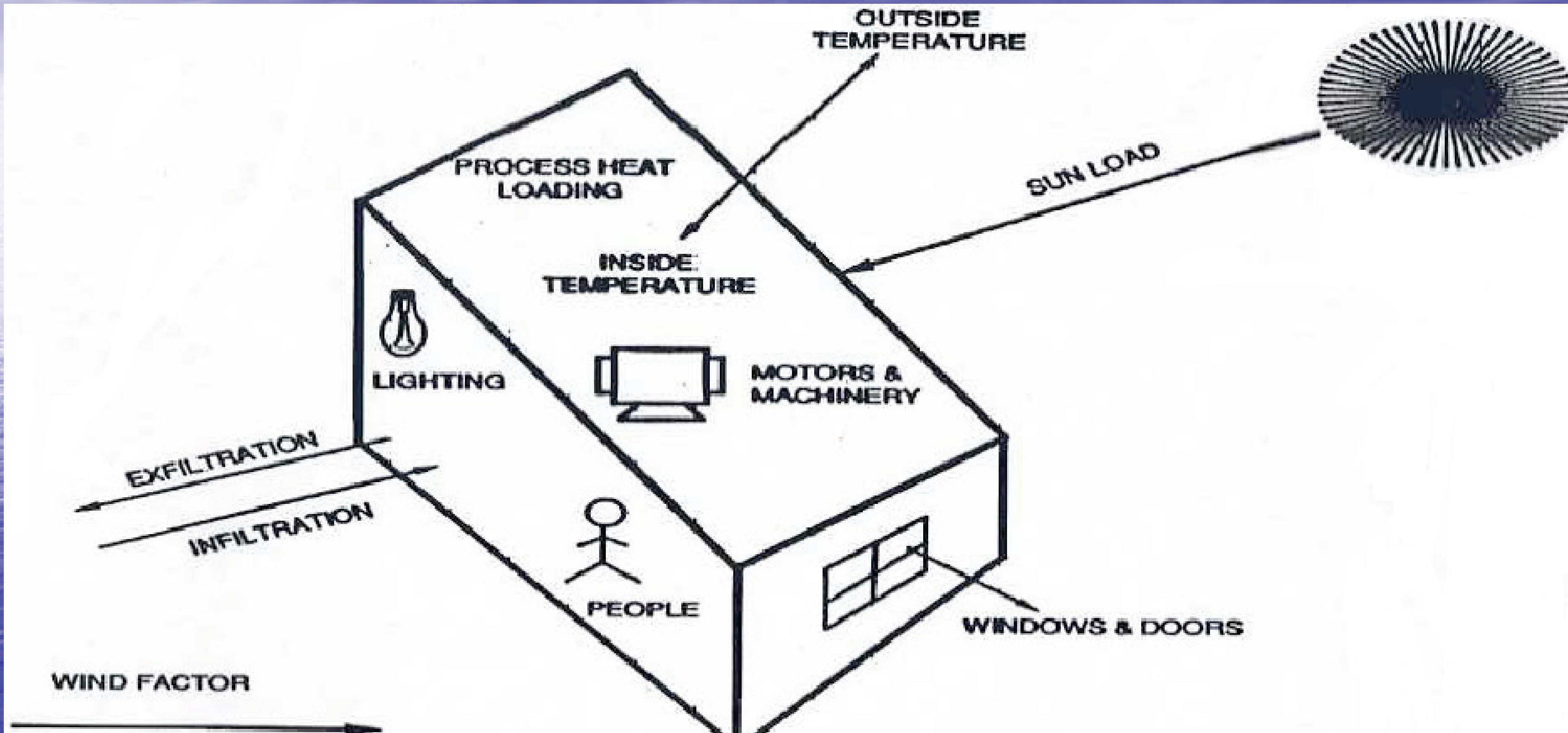
OUTSIDE TEMPERATURE
SUN LOAD
PROCESS HEAT LOADING
INSIDE TEMPERATURE
LIGHTING
MOTORS & MACHINERY
EXFILTRATION
INFILTRATION
PEOPLE
WINDOWS & DOORS
WIND FACTOR

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Typical Design Conditions

- 75 degrees F temperature
- 50% relative humidity
- 30 – 50 FPM air movement
- 15 – 20 CFM outside air per person or CO_2 less than 1,000 PPM

ASHRAE 62 – 1989 Ventilation Standard

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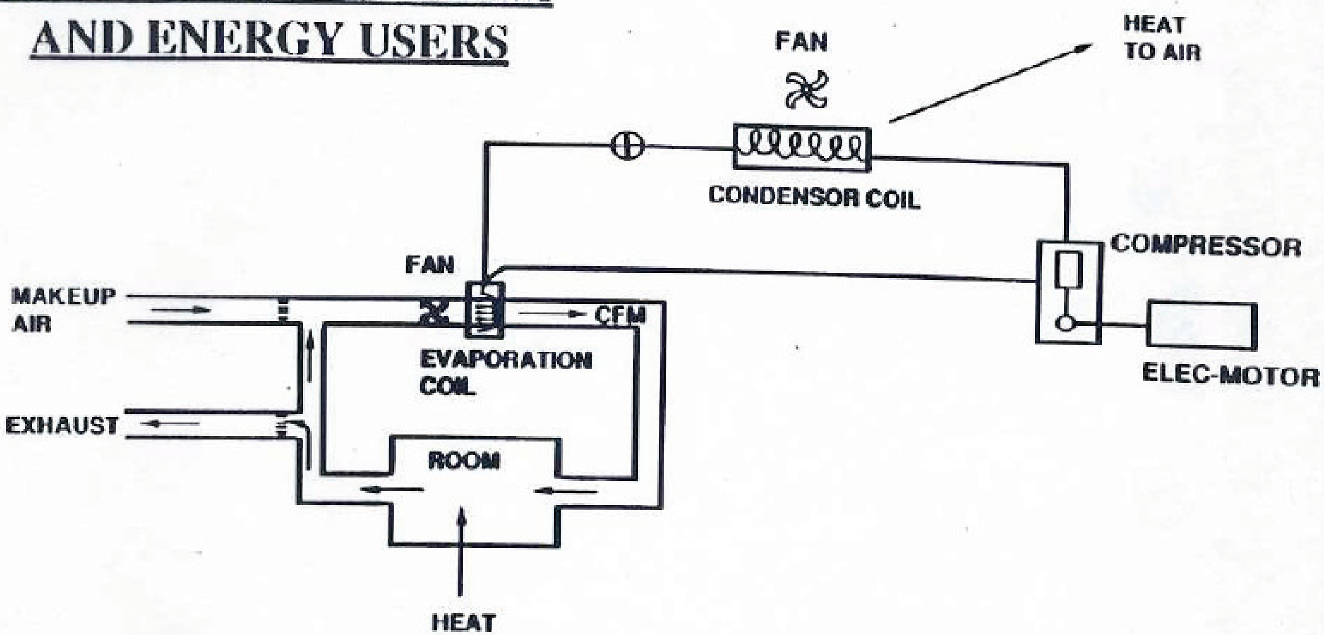
Typical HVAC System and Energy Users

TYPICAL HVAC SYSTEM AND ENERGY USERS



ENERGY USERS

1. Compressor Motor
2. Condenser Fan (Electric Motor)
3. Evaporator/Air Handling Fan (Electric Motor)

HEAT CONTRIBUTORS

1. Room Contents — people, lighting, machinery, building load
2. Amount of Makeup Air
3. Evaporator Fan Heat

EFFICIENCY FACTOR

1. Evaporation Coils — Clean or Dirty
2. Condenser Coils — Clean or Dirty
3. Energy Efficient Motors on Compressors & Fans
4. Freon Line Insulation
5. Duct Insulation & Integrity
6. Amount of Makeup Air

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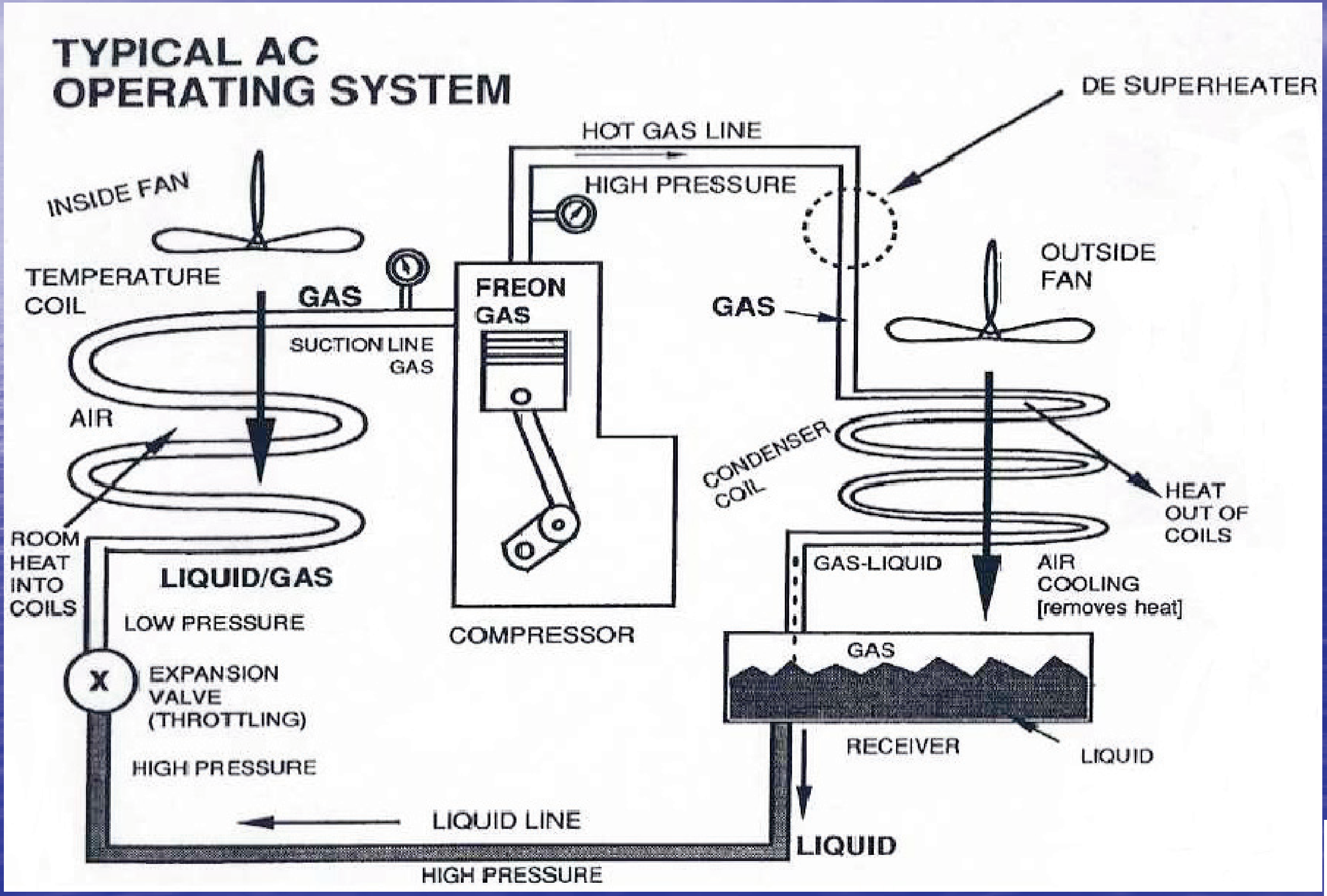
Typical AC Operating System



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HVAC Air Flows

- What were your Design Air Flows (cfm)?
- What are Actual Air Flows (cfm)?
- Where do YOU want the air flows to be?

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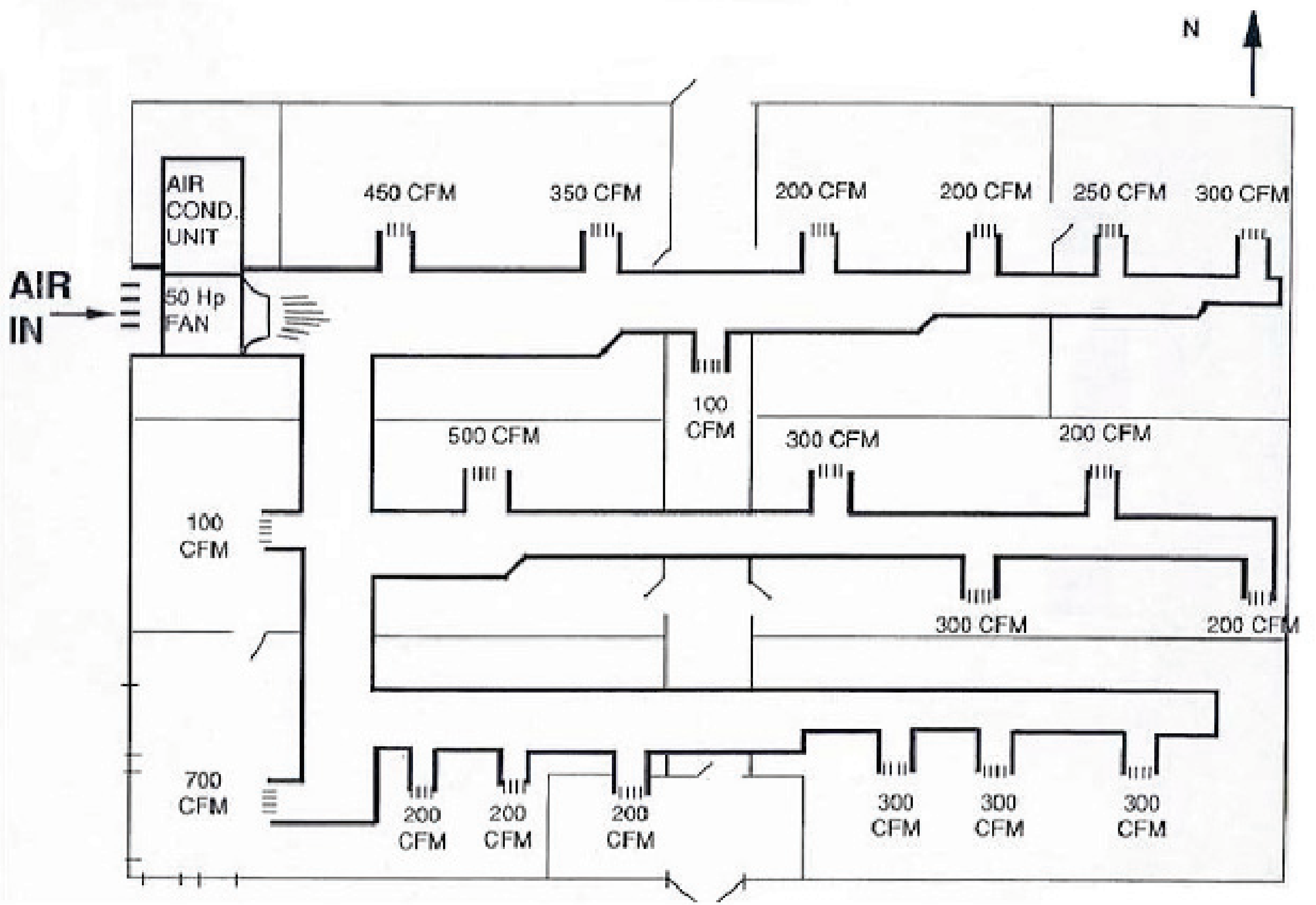

50 Hp Fan @ 7 Days/Wk; @ 24 Hours/Day = $28,000/year

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Fan Law

$$CHANGE\ \ IN\ \ KW = \left[\frac{RPM\,2}{RPM\,1}\right]^3 = \left[\frac{CFM\,2}{CFM\,1}\right]^3$$

$$RPM\ 1 = 100\ RPM$$

$$RPM\ 2 = 90\ RPM$$

$$KW\ 2 = \left[\frac{90}{100}\right]^3 = .73$$

10%

27% Reduction in Energy

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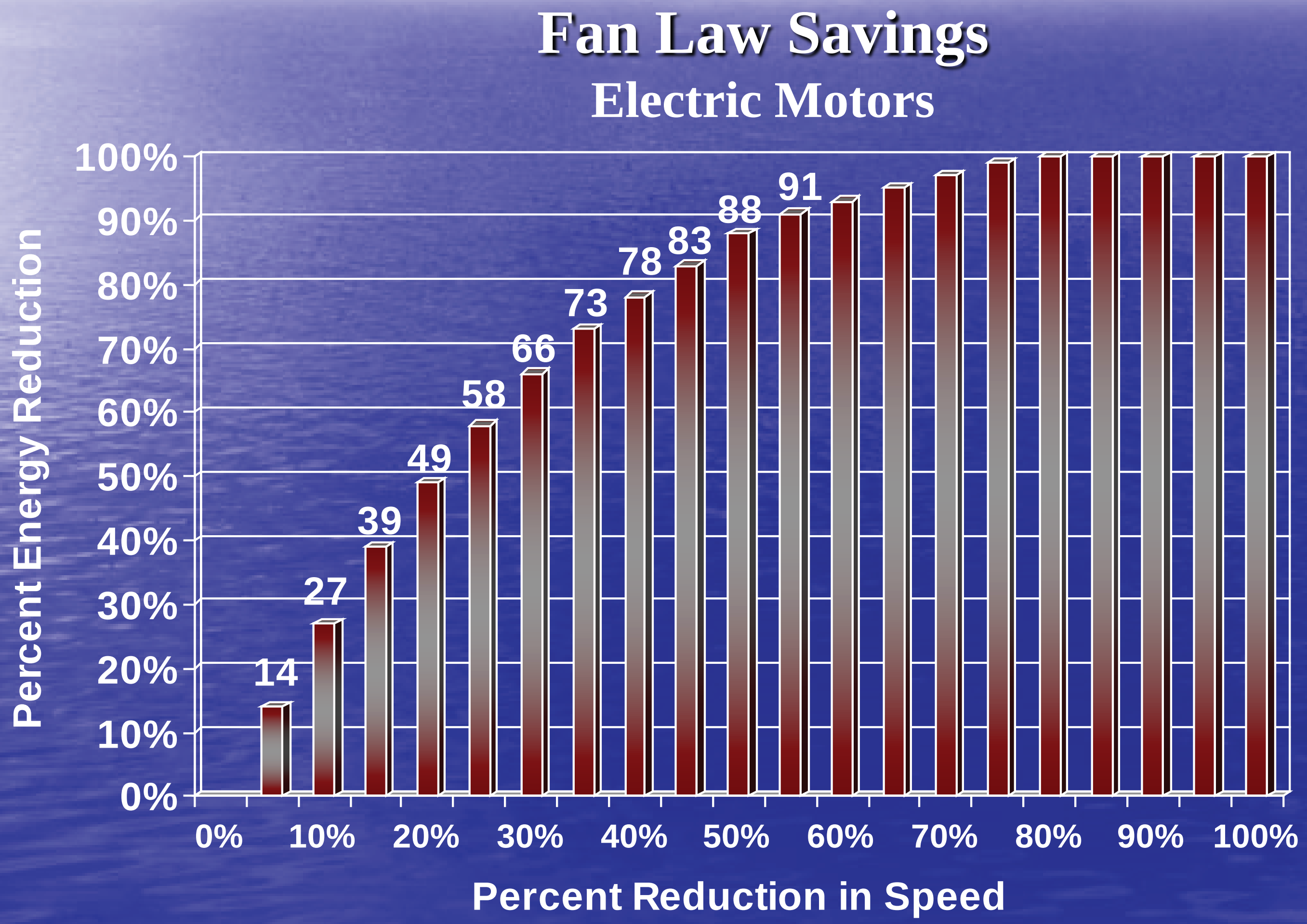
Fan Law Savings



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Varying Fan CFM

1. Variable Speed Drives
2. Two Speed Motors
3. Intel/Exhaust Dampers
4. Variable Speed Sheaves
5. Change Standard Sheaves
6. Magnetic Coupling
7. Variable Pitch Fans

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Uses of V.A.V.

1. Varying People Loads
2. Varying Inside/Outside Temperature
3. Time of Day
4. Sun/Wind Position Load Changes
5. Temperature Adjustment (Internal)

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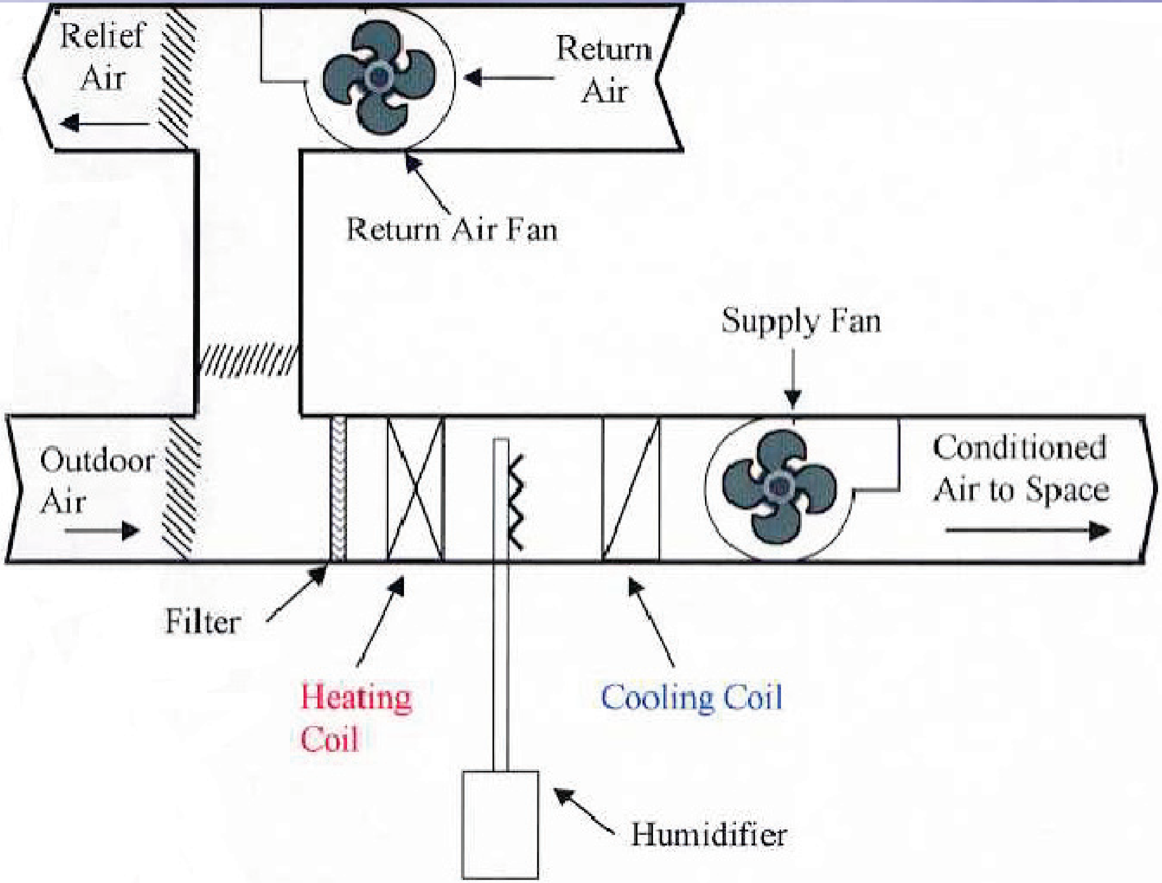
Single Zone System



Single zone systems consist of a mixing, conditioning and fan section. The conditioning section may have heating, cooling, humidifying or a combination of capabilities. Single zone systems can be factory assembled roof top units or built up from individual components and may or may not have distributing duct work.

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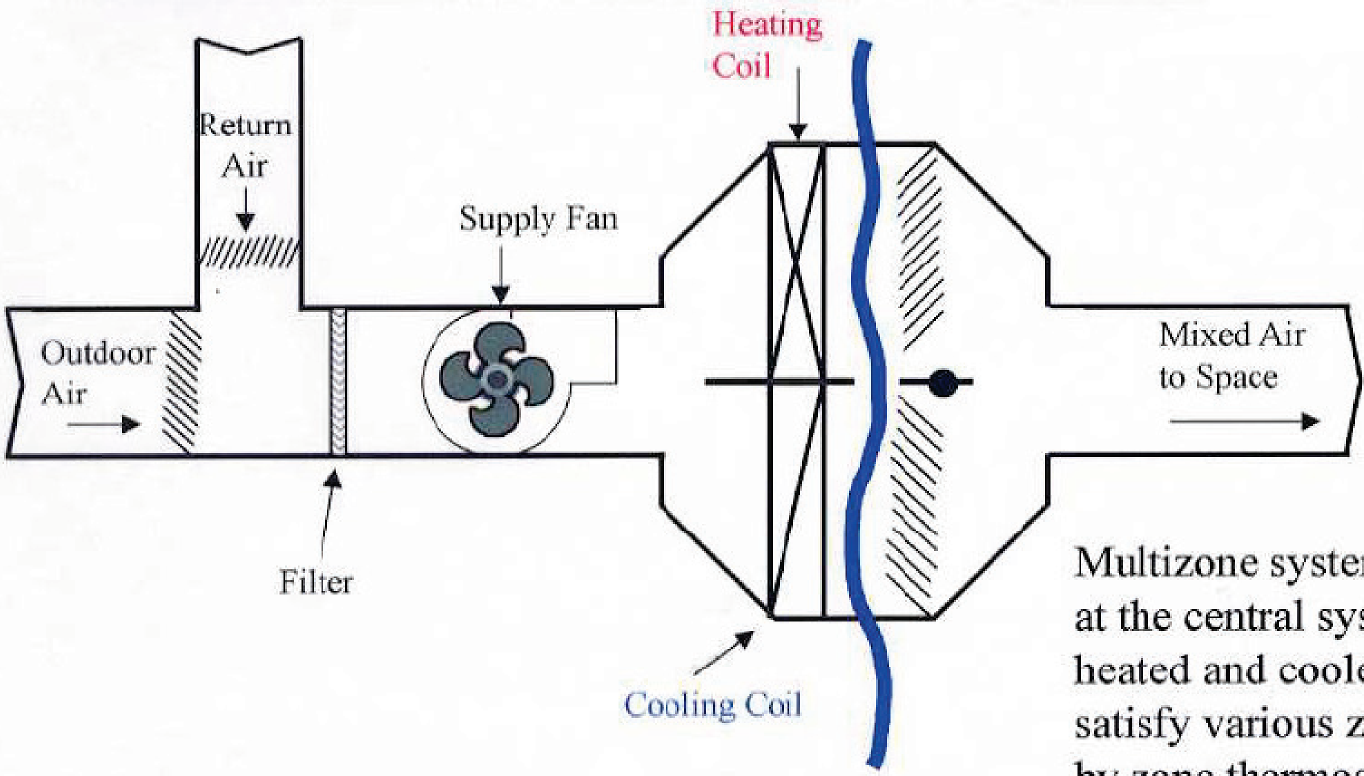
Multi-zone Systems



Multizone systems condition all air at the central system and mix heated and cooled air at the unit to satisfy various zone loads as sensed by zone thermostats. These systems may be packaged roof top units or field fabricated systems.

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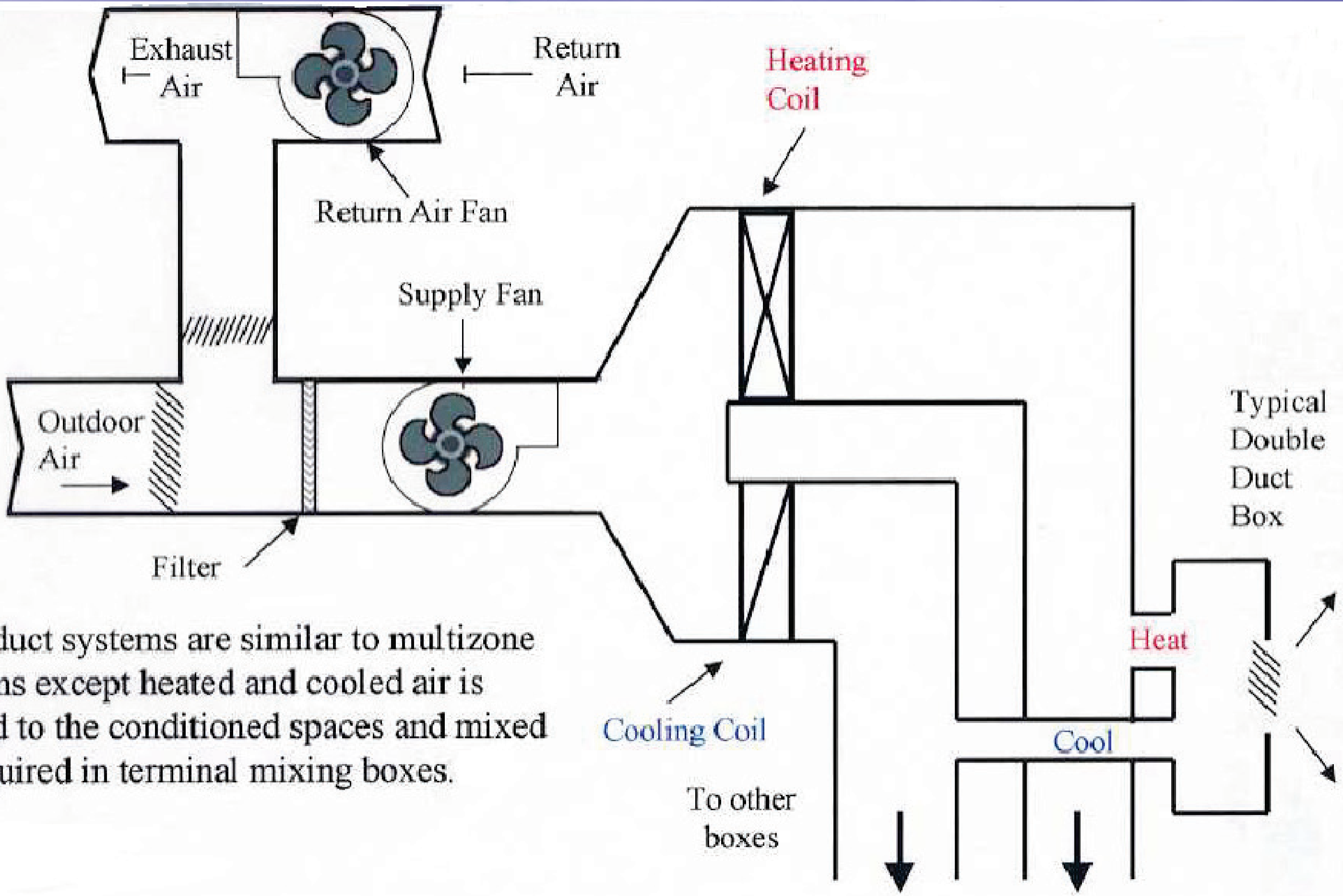
Dual Duct System



Dual duct systems are similar to multizone systems except heated and cooled air is ducted to the conditioned spaces and mixed as required in terminal mixing boxes.

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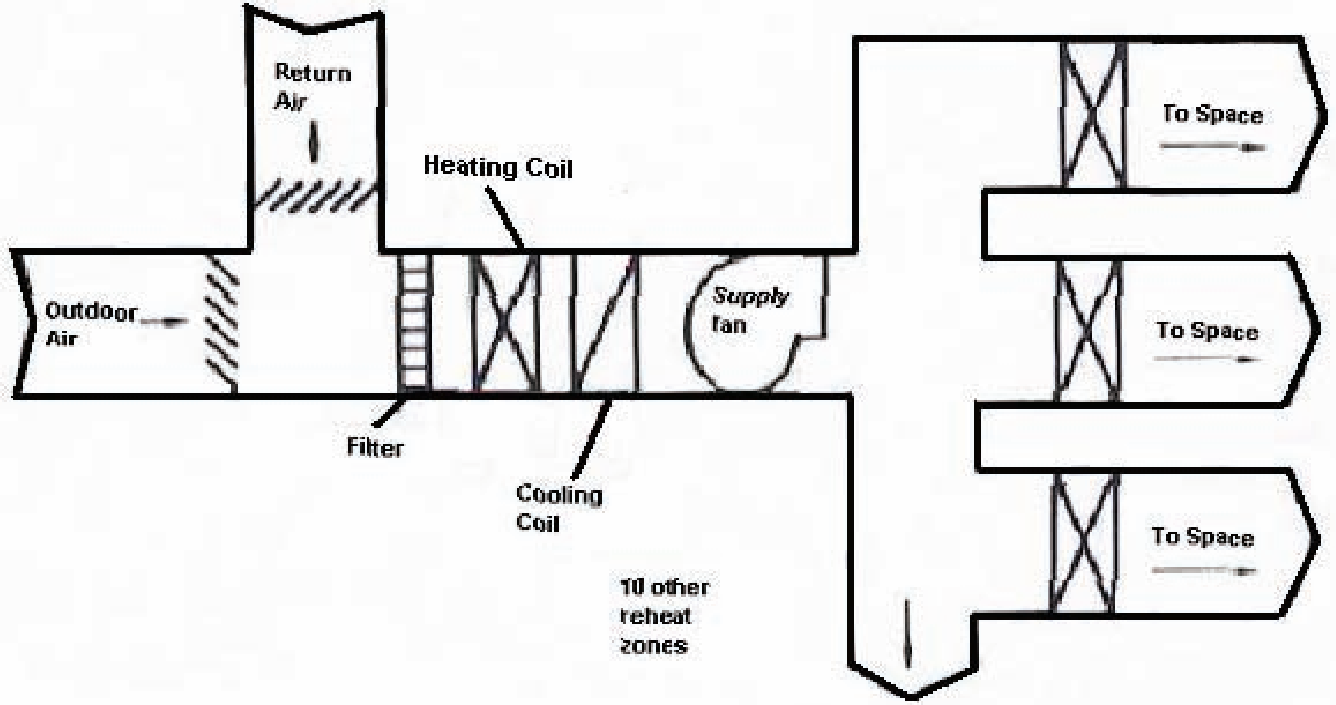
Terminal Reheat System



Reheat systems are modifications of single zone systems. Fixed cold temperature air is supplied by the central conditioning system and reheated in the terminal units when the space cooling load is less than maximum. The reheat is controlled by thermostats located in each condition space.

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HVAC Systems and Controls – Control Strategies

Basic/Typical Control Strategies

- OA closed on night cycle
- OA closed on morning warm up
- Fans off at night (unless heating called for)
- Hot/chilled water temperature reset with respect to OA temperature
- Exhaust fans locked out at night
- SA temperature reset with respect to zone needing most heat/cooling
- Time clock control of equipment (e.g. boiler, pneumatic air, fans, etc.)
- Economizer cycle
- Optimum start/stop
- Demand limiting
- Duty cycling

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Geographic Location/Degree Days/Weather Data

Example

Assume a period of three days when the outside temperature averages 50°F (10°C) each day

The number of HDD for this three-day period would be:

HDD = (65° - 50°) x 3 days = 45 degree days

HDD = (18.33° - 10°) x 3 days = 25 days

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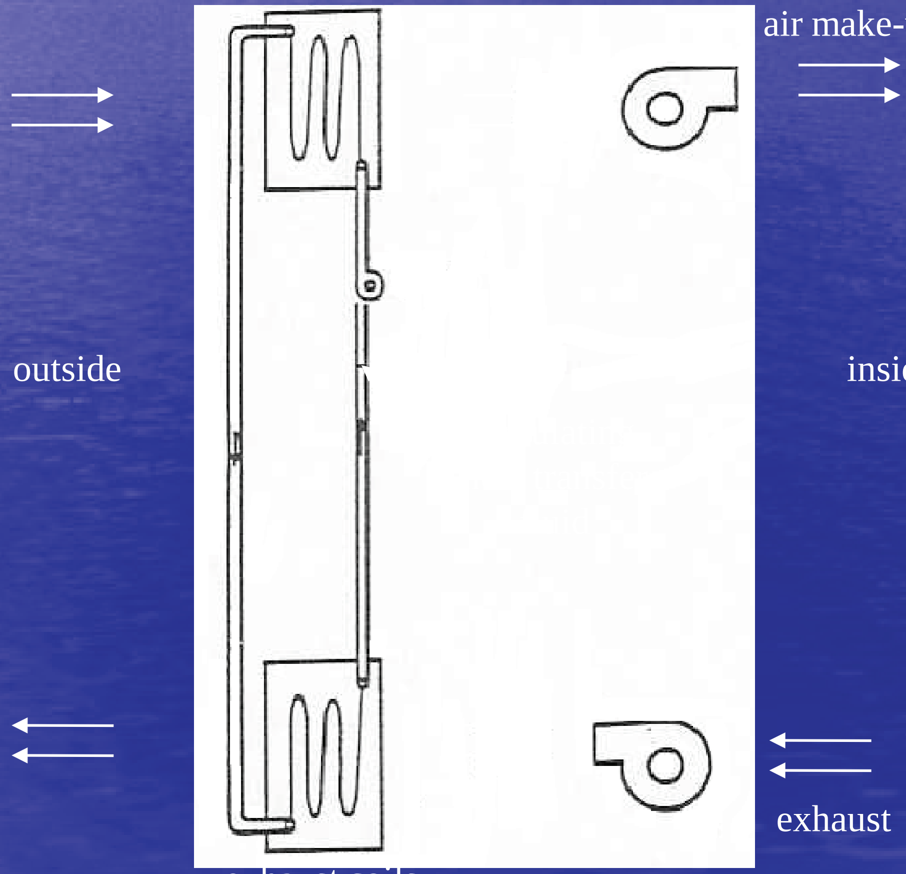
Air-to-Heat Recovery

“Run-Around Cycle”



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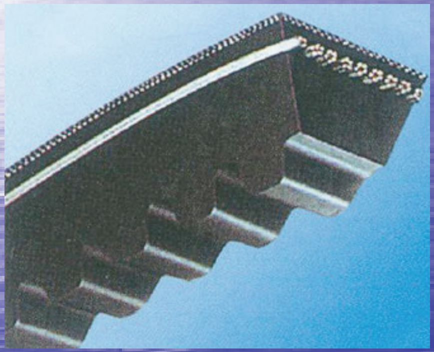
Cogged V Belts

A major N.C. Manufacturer Tested 2-17 Months (yr 1985)

$.052/KWH (.13 EP) 2700 Hours/Year 15 HP



COGGED BELT	$10.67
STANDARD BELT	$ 3.33
PREMIUM BELT	$ 7.34

BRAND A	4.4%
BRAND B	1.0%

AT 4.4% THE POTENTIAL SAVINGS IS $69.50/YEAR

MANUFACTURERS PREDICT 2-6 TIMES LIFE

DO NOT USE ON ROCK CRUSHERS, ETC.

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Waste Heat Recovery

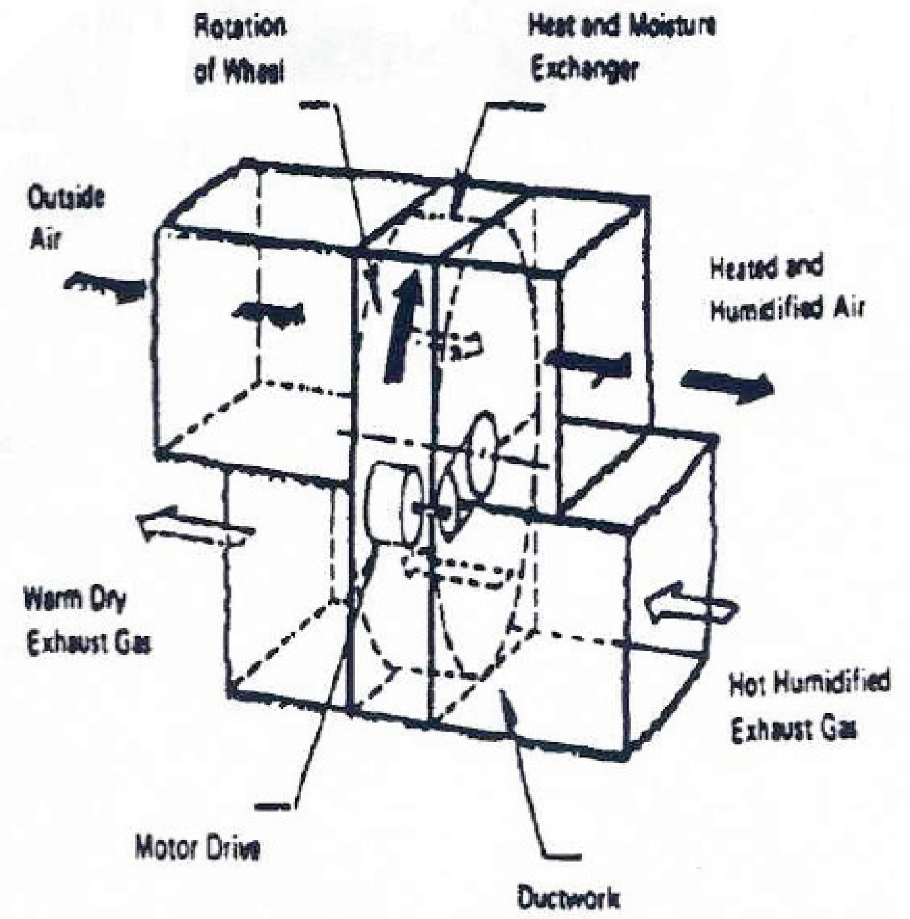

Figure 8-8 Simple heat wheel. (Used with permission of the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, Ga.)

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Psychometric Chart

The Relationship of 8 Properties of Air

1. Dry Bulb Temperature
2. Wet Bulb Temperature
3. Dew Point Temperature
4. Percentage Relative Humidity
5. Moisture Content (weight of water vapor in 1 lb. of dry air, given in grains) (7,000 grains = 1 lb.
6. Enthalpy (quantity of heat in each lb. of dry air, Btu/lb. of dry air)
7. The Volume Occupied by Each Pound of Air
8. Vapor Pressure due to the Presence of Water

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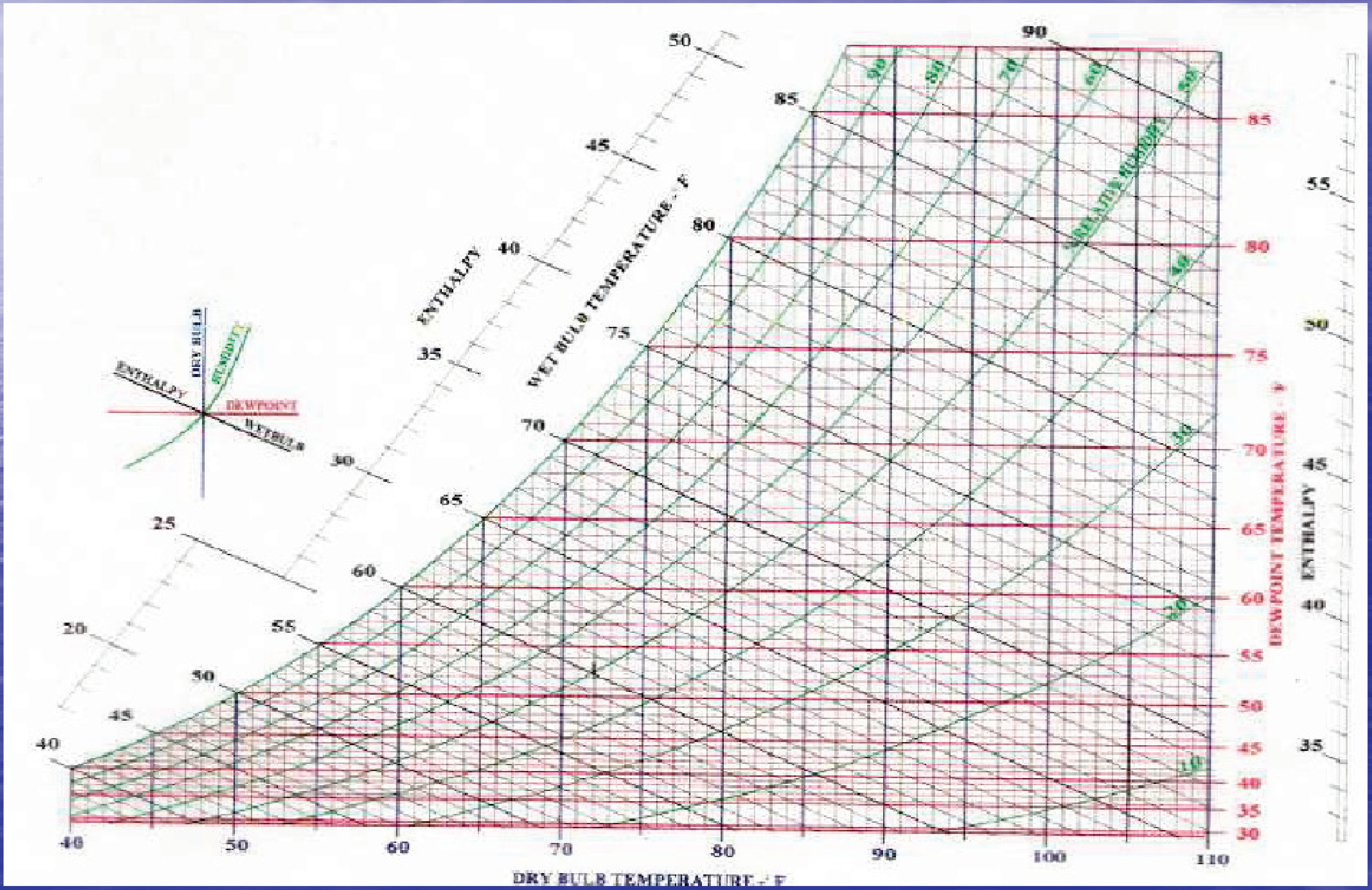
Psychometric Chart



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Waste Energy Checklist

Ventilation

1. Excess outside air intake
2. Outside air damper not properly adjusted
3. Leaking or defective outside air damper seals
4. Clogged filters

Infiltration

5. Broken or cracked window panes
6. Rotted or defective weather stripping
7. Loose or missing caulking
8. Poor window alignment

Infiltration

9. Defective weather stripping
10. Misaligned doors
11. Missing or defective caulking
12. Gaskets or other seals defective
13. Defective door closer
14. No personnel access doors at garage or overhead doors

Heating and Cooling

15. Nonexistent operating schedule – unnecessary heat or cooling in unoccupied spaces
16. Thermostat set too high or low
17. Defective thermostat
18. Defective limit switches
19. Storage areas mixed with office or personnel spaces, which could be maintained at a lower temperature
20. Unnecessary heat in garages, docks or loading platforms
21. Exhaust fans running when not needed
22. Open drapes or shades during cool weather when sun is not shinning
23. Process heat not isolated from personnel spaces
24. Unnecessary extra backup system operation
25. Mixture of fuel and air not properly maintained

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Waste Energy Checklist

Refrigeration Equipment

26. Moisture in refrigerant
27. Leaks in refrigerant system
28. Clogged strainers or filters
29. Worn drive belts
30. Slipping drive belts
31. Insulation missing from suction and liquid lines
32. Dirty heat exchanger or condenser fins and coils
33. Condenser located near hot-process equipment or located in direct sunlight
34. Corrosive or mineral-laden water being used
35. Bent or unbalanced fans
36. Dirty fan blades
37. Clogged nozzles in cooing tower spray bars
38. Missing slats in cooling tower
39. Dirty louvers
40. Restricted flow

BOILERS:

41. Scale deposits in boiler or system
42. Soot accumulation in tubes
43. Defective door gaskets
44. Pressure and temperature set too high
45. Burner out of adjustment
46. Loose or worn linkages
47. Defective fuel solenoid valve
48. Dirty nozzles or cup on oil-fired
49. Defective insulation
50. Leaks in fuel line
51. Dirty oil strainer
52. Defective igniter
53. Air lock in radiators
54. Dirty radiators

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Waste Energy Checklist

55. Obstructed air flow
56. Dirty infrared reflectors
57. Low voltage or heating elements

Humidification or Dehumidification Equipment

58. Dirty dampers or fan parts
59. Defective nozzles or medium pads
60. Leaking ductwork
61. Defective insulation on ducts
62. Obstructed ducts
63. Dumper blades defective
64. Air valves no properly seated
65. Mixing dampers not properly adjusted
66. Dirty grills or diffusers
67. Broken or missing deflector
68. Moisture accumulation in ductwork
69. Air leaks in pneumatic system
70. Low air pressure in supply tank
71. Clogged filter pads on intake