Overview of System Design Steps & Parameters

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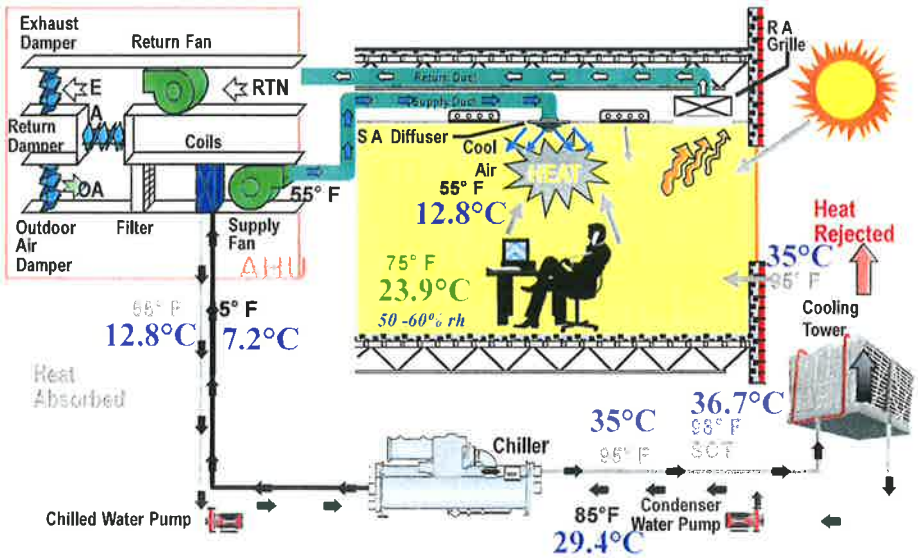
Typical HVAC System



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Comfort Parameters

- Dry Bulb Temperature
- Relative Humidity → 55553 65 %
- Air Motion →
- Mean Radiant Temperature
- Air Cleanliness
- Odor Perception
- and Acoustics (noise)

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Total Comfort Air Conditioning

Comfort is maintained by:

- Heating
- Humidifying
- ➢Cooling
- ➢Dehumidifying
- Ventilating
- Filtering
- Circulating

… air as needed

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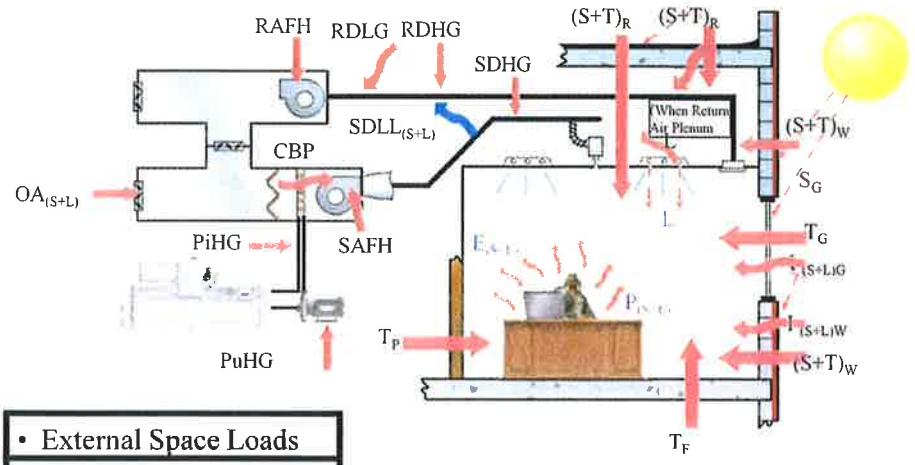
Cooling Load Components



- External Space Loads
- Internal Space Loads
- System Loads

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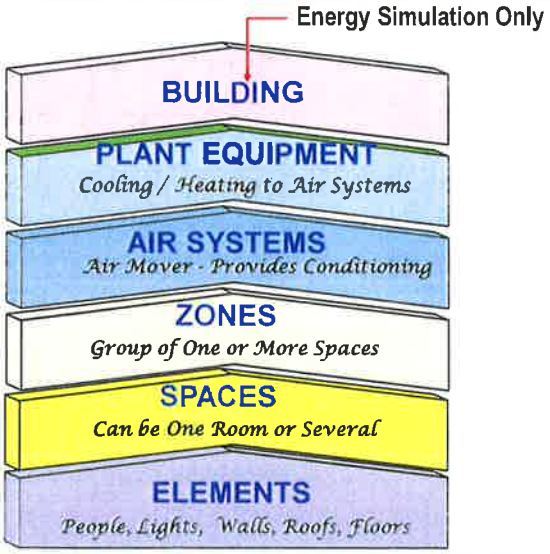
Project Modeling – Air Conditioning Load

- Project Modeling
  - ➢ Building Block Approach



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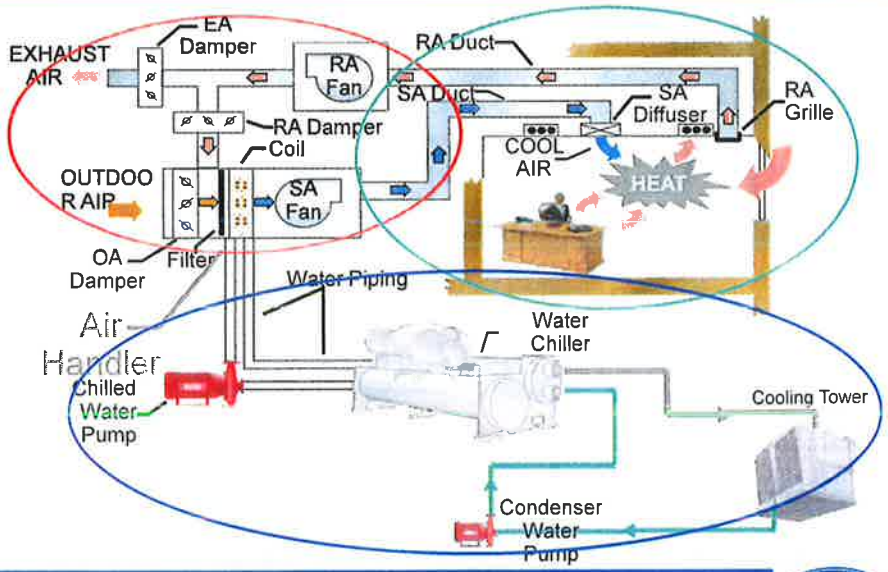
Typical ac system



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Space Requirements

Temperature, Humidity per application according to ASHRAE.

General Category*	Inside Design Conditions*
Office Buildings	70-74F / 50% *21.2 – 23.3C*
Dining & Entertainment	70-74F / 50-60% *21.2 – 23.3C*
Radio / TV Studio	74 – 78F / 40-55% *23.3 – 25.6C*
Transportation Centers	70-74F / 50-60% *21.2 – 23.3C*
Museum / Library	68-72F / 40-55% *20.0 – 22.2C*

* Columns per 1999 ASHRAE Handbook, Table 1

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Comfort Chart (ASHRAE 2001)

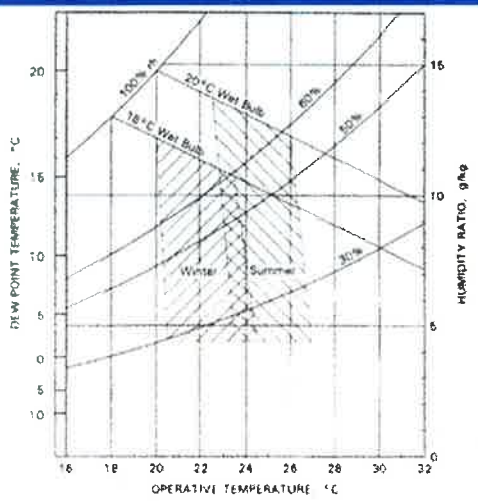

Fig. 5 ASHRAE Summer and Winter Comfort Zones
(Acceptable ranges of operative temperature and humidity for people in typical summer and winter clothing during primarily sedentary activity.)

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Good IAQ Example (in Singapore)

Good Indoor Air Quality for Office Premises

Parameter	Acceptable limit
Air Temperature	23 – 25 °C
Relative Humidity	≤ 65% for new ≤ 70% for old
Air Movement	< 0.3 m/s
Carbon Dioxide	700 + outdoor ppm
Carbon Monoxide	9 ppm
Formaldehyde	0.08 ppm
TVOC	1 ppm
Respirable Suspended Particle (PM4)	50 µg/m3
Particulate Matter 2.5 (PM2.5)	37.5 µg/m3
Total Bacteria Count	1,000 cfu m³ (colonial forming unit)

SS554: 2016 table 1

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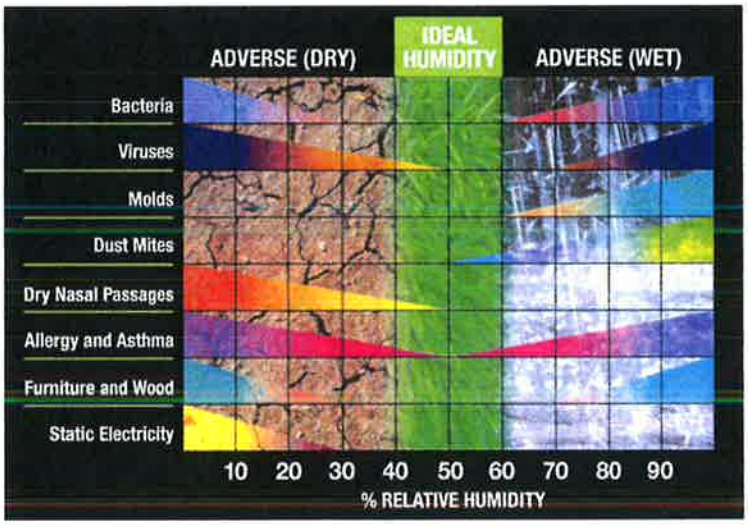
Why Correct Humidity Is Important



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→ room temp.

Do not oversize cooling coil

$Q = \dot{m} c_p \Delta T$, if Q ↑ (oversized), $\Delta T = T_r - T_s$ → supply air temp.

The T_s will drop because Q is not working at that point. Required Q is low.

if T_s ↓ latent heat capacity drops → result in high humidity!!

Humidity

Ratio of Sensible load to total load is the "sensible heat ratio"

Sensible loads	***Latent Loads***
Solar	*People*
Computers	*Kitchens*
Lights	*Pools*
Transformers	
Motors	

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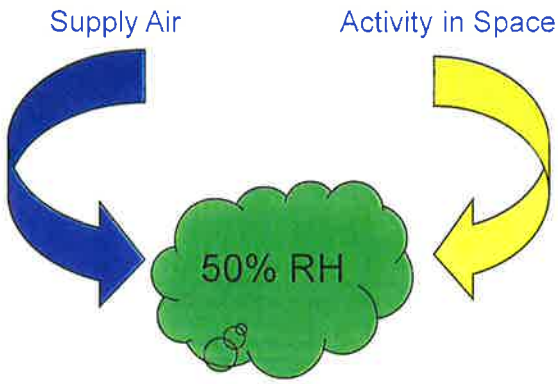
Humidity

To maintain 50% humidity in the space, ***supply air*** *must* ***compensate*** *for humidity produced in the space.*



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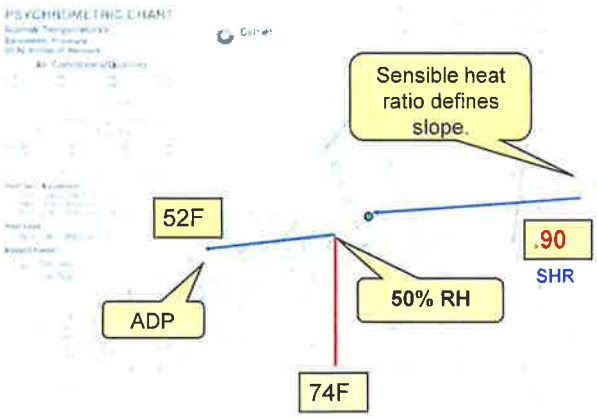
Coil Requirements

Using proven psychometric chart, parallelogram identifies air temperature leaving coil per SHR.



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Chilled-water Requirements

8 F *(4.4C)* approach across cooling coil.

General Category*	Design Conditions*	Lvg Air F	Chilled Water
Office Buildings	70-74F *21.2 – 23.3C* 50%	52F *11.1C*	44F *6.7C*
Dining & Entertainment	70-74F *21.2 – 23.3C* 50-60%	52F *11.1C*	44F *6.7C*
Radio / TV Studio	74 – 78F *23.3 – 25.6C* 40-55%	53F *11.7C*	45F *7.2C*
Transportation Centers	70-74F *21.2 – 23.3C* 50 60%	52F *11.1C*	44F *6.7C*
Museum / Library	68-72F *20.0 – 22.2C* 40-55%	50F *10.0C*	42F *5.6C*

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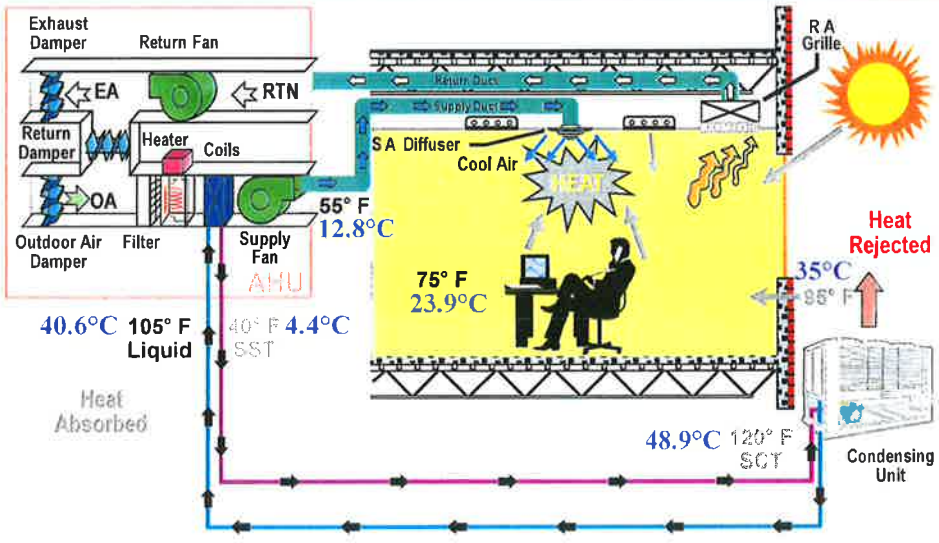
Air-cooled Direct Expansion System



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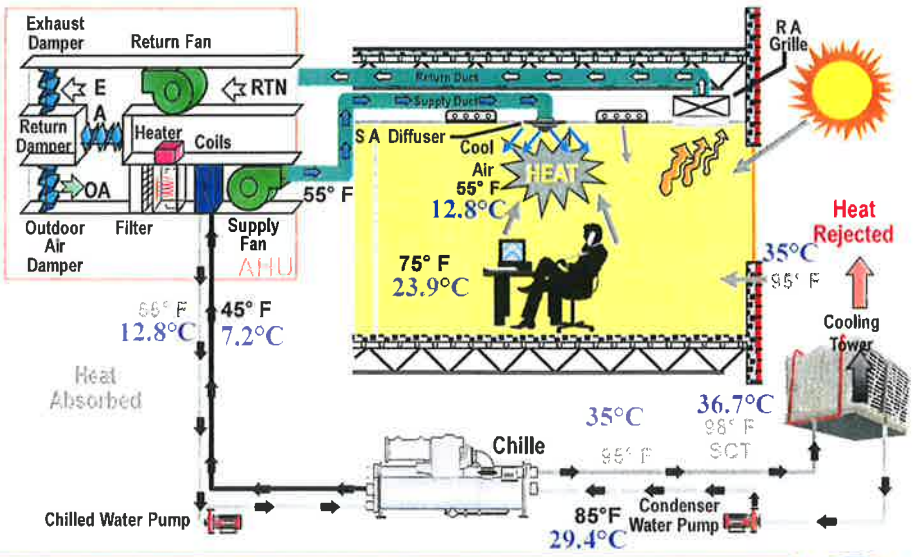
Water-cooled



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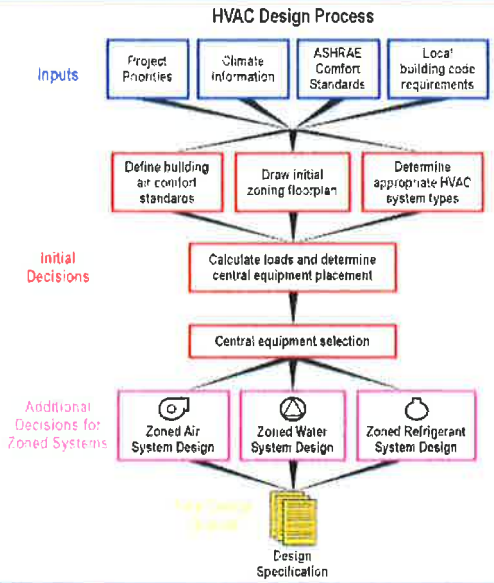
HVAC design process



Steps involved in effective HVAC design

1. **Project priorities and *inputs***
2. ***Initial decisions***
3. **Additional decisions** (for zoned systems)

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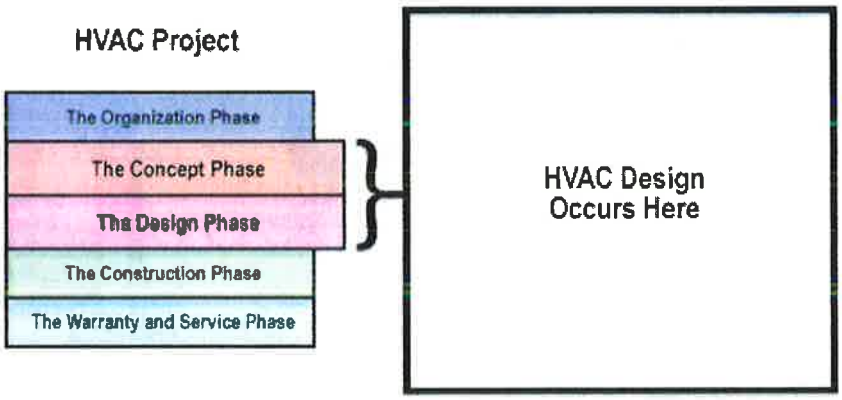
Role of design in an HVAC project

HVAC system design occurs as part of the conceptual and design phases in an HVAC project. Once the design is finalized, construction of the HVAC system begins.



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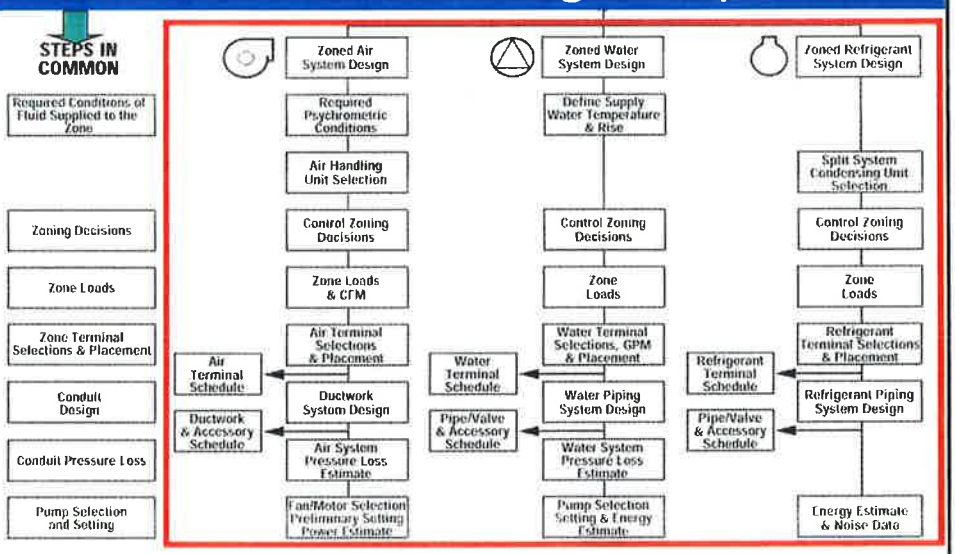
Common design steps



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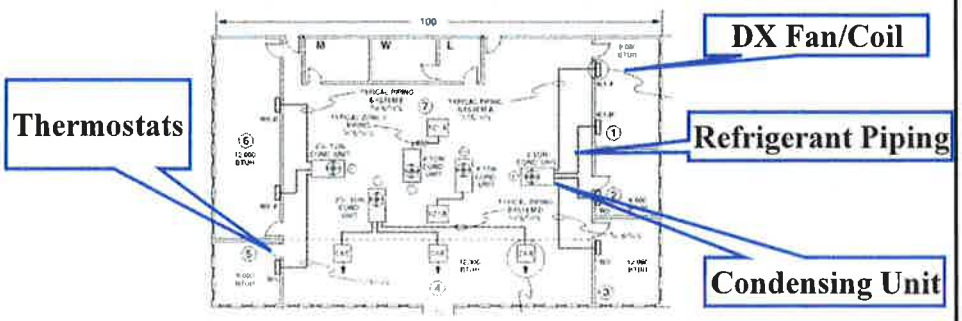
Typical refrigerant system



1- Control Zone Fan/Coil Terminal (DX Coil) - Delivers Cool/Hot Air to Control Zone
2- Condensing Unit - Source of Cooling
3- Refrigerant Piping Delivers Cooling to Terminals
4- Controls in Each Zone (Thermostat in Terminal)

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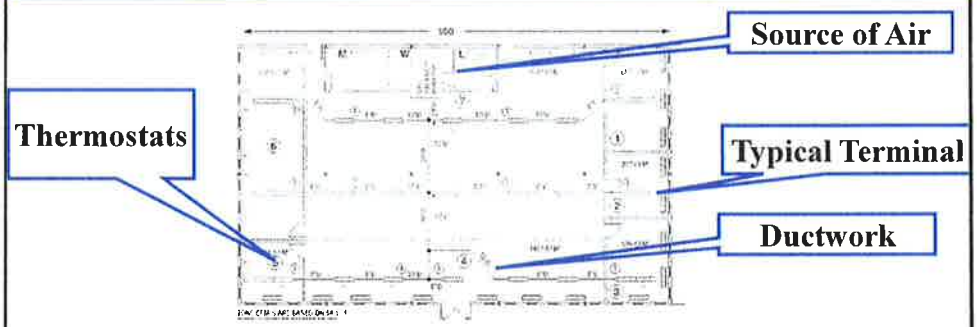
Typical all air system



1- Central Source of Air (Rooftop Unit or Air Handling Unit) ----Fan and Coil (Cooling/Heating)
2- Ductwork System to Deliver Air to Building
3- Air Terminals to Deliver Air to Building Control Zones
4- Controls in Each Zone (Thermostat in This Case)

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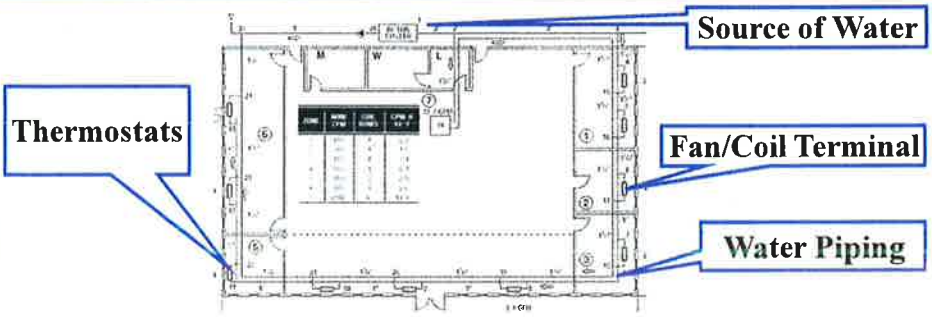
Typical all water system



1- Central Source of Water (Chiller and Pump)
2- Water Piping Delivers Water to Control Zone Terminals
3- Fan/Coil Terminals or Air Handling Units - Delivering Cool/Hot Air to Control Zone
4- Controls in Each Zone (Thermostat Located on Terminal)

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Dedicated Outdoor Air Systems (DOAS)

AHRI Definition

What is a Dedicated Outdoor Air System?

A type of air-cooled, water-cooled, or water source factory assembled product which dehumidifies 100% Outdoor Air to a low dew point, and includes reheat that is capable of raising the dry-bulb temperature of the air to the designed room temperature. This conditioned outdoor air is then delivered directly or indirectly to the Conditioned Space(s). It may pre-condition Outdoor Air by containing an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus.

Typically utilized to handle latent loads. The remaining sensible loads are handled by ancillary cooling and heating systems…..improve IAQ……lowering energy costs

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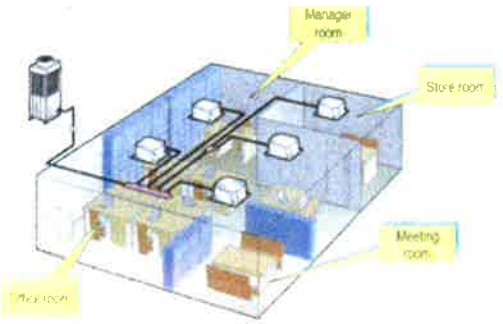
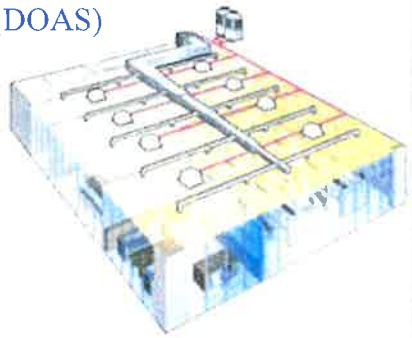
Typical VRF systems



Direct Ventilation System

Dedicated outdoor air system

Common Ventilation System (DOAS)



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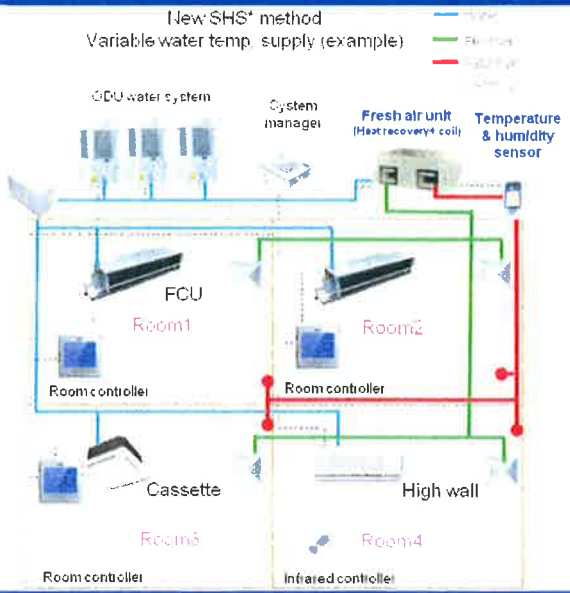
Typical chilled water system



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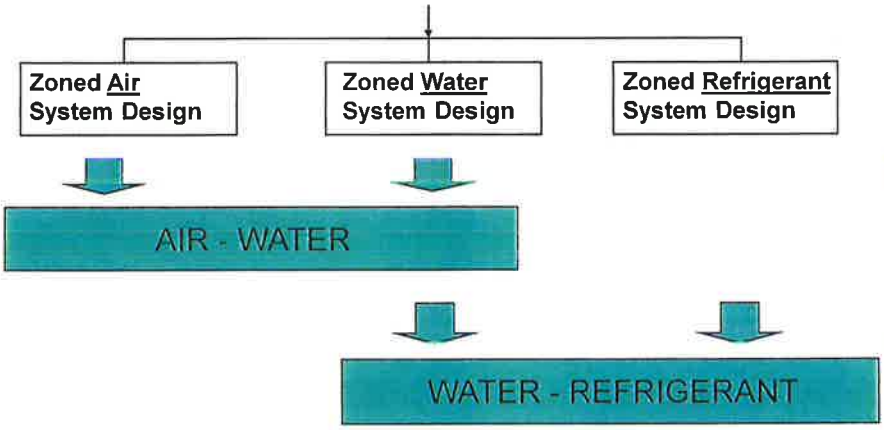
Combination types

A Function of the Delivery Fluid



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System Design Steps

All-Air System

1. Load Estimate
2. Psychrometric Estimate of Coil Entering and Leaving Conditions
3. Coil Selection and Air Handler Sizing
4. Refrigeration Plant Sizing
5. Room Air Distribution Design
6. Air Duct Design
7. Fan Selection
8. Control System Selection

Section 6 – Process Charts © Carrier Corp. 2017