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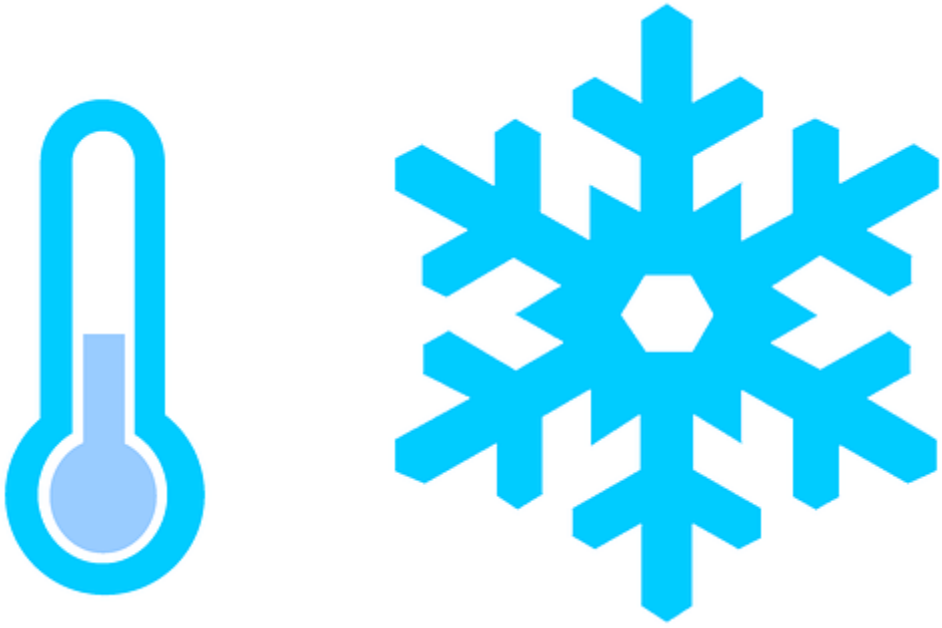
New Air Conditioning Systems



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INTRODUCTION

The requirements to modern buildings are numerous. Energy consumption must be minimized and the necessary building services must be provided in the most sustainable way in order to ensure adequate indoor climate and healthy conditions for the users. Improved energy efficiency is among the fastest and most cost efficient ways of lowering energy consumption but is often not offered the same attention as new and more exotic technologies.

Air conditioning is a combined process that performs many functions simultaneously. It conditions the air, transports it, and introduces it to the conditioned space. It provides heating and cooling from its central plant or rooftop units. It also controls and maintains the temperature, humidity, air movement, air cleanliness, sound level, and pressure differential in a space within predetermined limits for the comfort and health of the occupants of the conditioned space or for the purpose of product processing.

The term HVAC&R is an abbreviation of *heating, ventilating, air conditioning, and refrigerating*. The combination of processes in this commonly adopted term is equivalent to the current definition of air conditioning. Because all these individual component processes were developed prior to the more complete concept of air conditioning, the term HVAC&R is often used by the industry.

AIR CONDITIONING SYSTEMS

An air conditioning, or HVAC&R, system is composed of components and equipment arranged in sequence to condition the air, to transport it to the conditioned space, and to control the indoor environmental parameters of a specific space within required limits.

Most air conditioning systems perform the following functions:

*Provide the cooling and heating energy required

*Condition the supply air, that is, heat or cool, humidify or dehumidify, clean and purify, and attenuate any objectionable noise produced by the HVAC&R equipment

*Distribute the conditioned air, containing sufficient outdoor air, to the conditioned space

*Control and maintain the indoor environmental parameters – such as temperature, humidity, cleanliness, air movement, sound level, and pressure differential between the conditioned space and surroundings within predetermined limits

Parameters such as the size and the occupancy of the conditioned space, the indoor environmental parameters to be controlled, the quality and the effectiveness of control, and the cost involved deter-mine the various types and arrangements of components used to provide appropriate characteristics.

Air conditioning systems can be classified according to their applications as

1) Comfort air conditioning systems, and
2) Process air conditioning systems.

Comfort Air Conditioning Systems

Comfort air conditioning systems provide occupants with a comfortable and healthy indoor environment in which to carry out their activities.

Process Air Conditioning Systems

Process air conditioning systems provide needed indoor environmental control for manufacturing, product storage, or other research and development processes.

Classification of Air Conditioning Systems According to Construction and Operating Characteristics

Air conditioning systems can also be classified according to their construction and operating characteristics as follows.

1. Individual Room Air Conditioning Systems,
2. Evaporative-Cooling Air Conditioning Systems,
3. Desiccant-Based Air Conditioning Systems,
4. Thermal Storage Air Conditioning Systems,
5. Clean-Room Air Conditioning Systems,
6. Space Conditioning Air Conditioning Systems,
7. Unitary Packaged Air Conditioning Systems.

HISTORICAL DEVELOPMENT

The historical development of air conditioning can be summarized briefly

- Central Air Conditioning Systems

As part of a heating system using fans and coils, the first rudimentary ice system in the United States, designed by McKin, Mead, and White, was installed in New York City's Madison Square Garden in 1880.

- Unitary Packaged Systems

The first room cooler developed by Frigidaire was installed about in 1928 or 1929, and the "Atmospheric Cabinet" developed by the Carrier Engineering Company was first installed in May 1931.

- Refrigeration Systems

In 1844, Dr. John Gorrie designed the first commercial reciprocating refrigerating machine in the United States. The hermetically sealed motor-compressor was first developed by General Electric Company for domestic refrigerators and sold in 1924.

AIR CONDITIONING PROJECT DEVELOPMENT

The basic steps in the development and use of a large air conditioning system are the design, construction, commissioning, operation, energy efficiency upgrading, and maintenance. Figure 1 is a diagram which outlines the relationship between these steps and the parties involved. The owner sets the criteria and the requirements. Design professionals in mechanical engineering consulting firms design the air conditioning system and prepare the design documents. Manufacturers supply the equipment, instruments, and materials. Contractors install and construct the air conditioning system. After construction, the air conditioning system is commissioned by a team, and then it is handed over to the operation and maintenance group of the property management for daily operation. Following a certain period of operation, an energy service company (ESCO) may often be required to upgrade the energy efficiency of the HVAC&R system (energy retrofit).

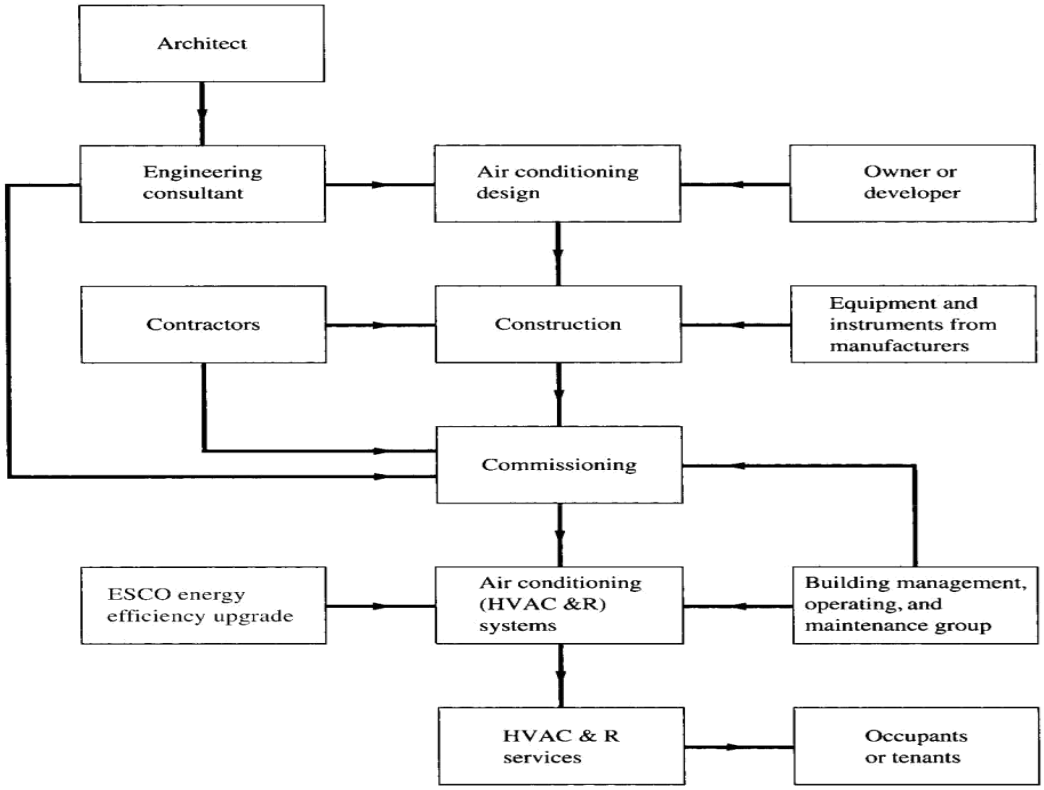
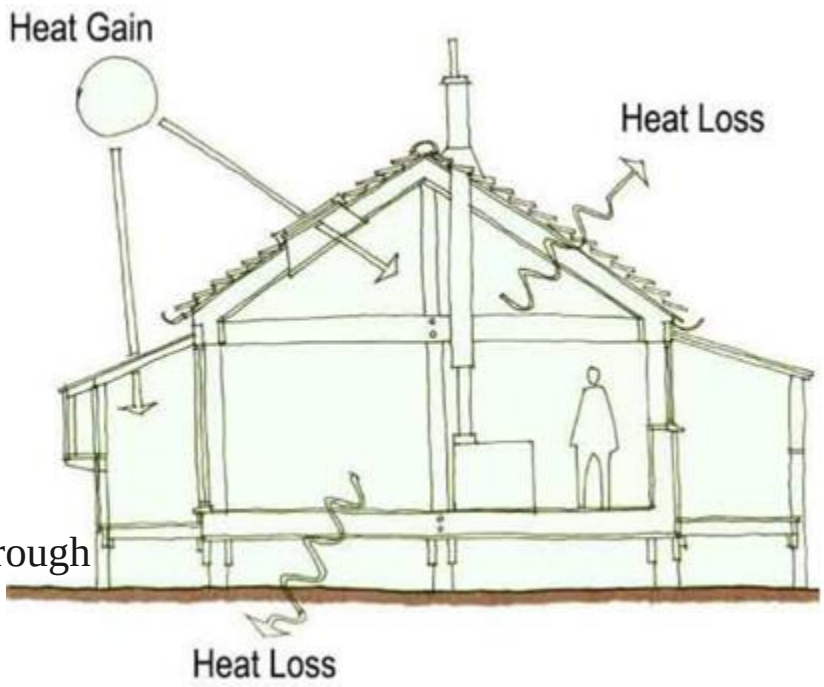


FIGURE 1 Steps in the development and use of air conditioning systems in buildings

Heat Gain vs. Heat Loss (Winter)



Heat Gains

- Solar thru windows/walls
- Summer transfer/infiltration
- Internal
- Electric Use, Lighting
- Body Heat

Heat Loss

- Air Leaks (Infiltration)
- Transfer (conduction & radiant) through

Walls

Roofs

Floor

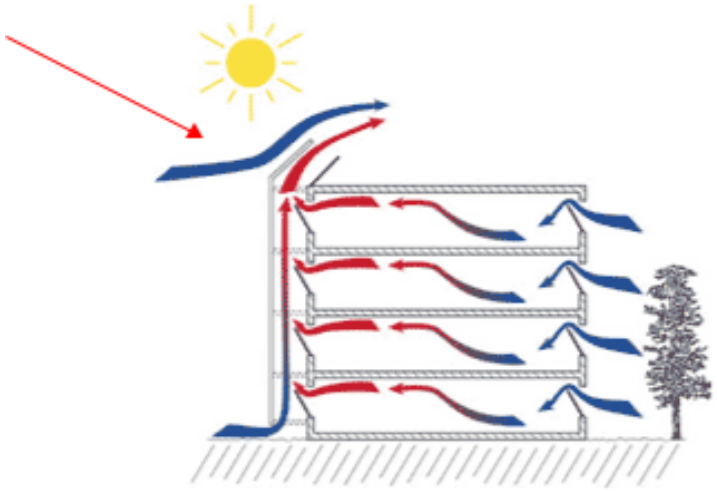
Windows

Difference supplied by: Heater or Air Conditioner

Ventilating

Two types:

A. *Mechanical ventilation*: Fans pull outside air into building for ventilation includes both outside air and recirculated air.
   Requirements are available for minimum outside air, based on occupancy, floor area and number of occupants,
B. *Natural ventilation*: No fans



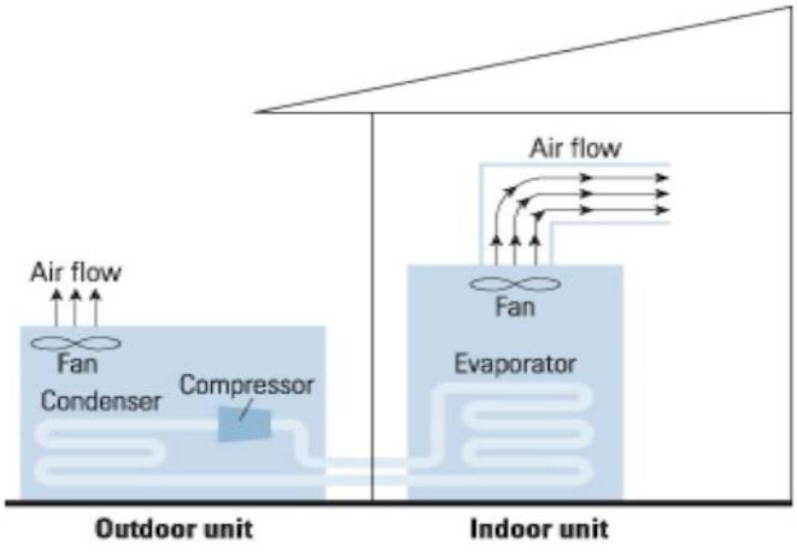
SIMPLE HVAC SYSTEMS

❖ Package Units

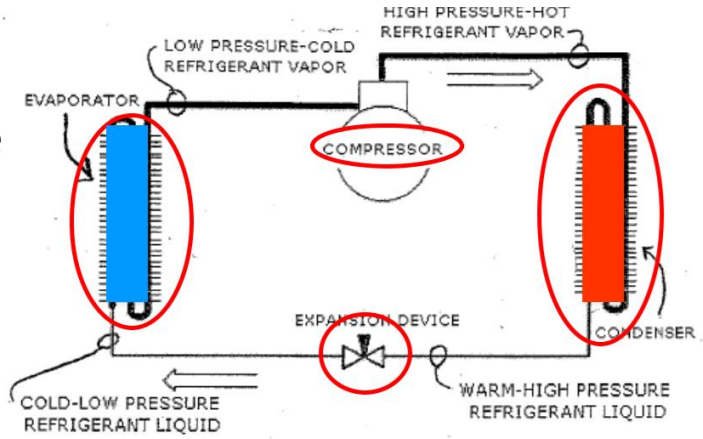
- ➢ Thru-wall air conditioner
- ➢ Package Terminal Air Conditioner (PTAC)
- ➢ Package Terminal Heat Pump (PTHP)

❖ Unitary

- ➢ Air conditioner
- ➢ Furnace
- ➢ Heat Pumps
- ➢ Packaged, split, mini-split
- ➢ Variable refrigerant flow (VRF)

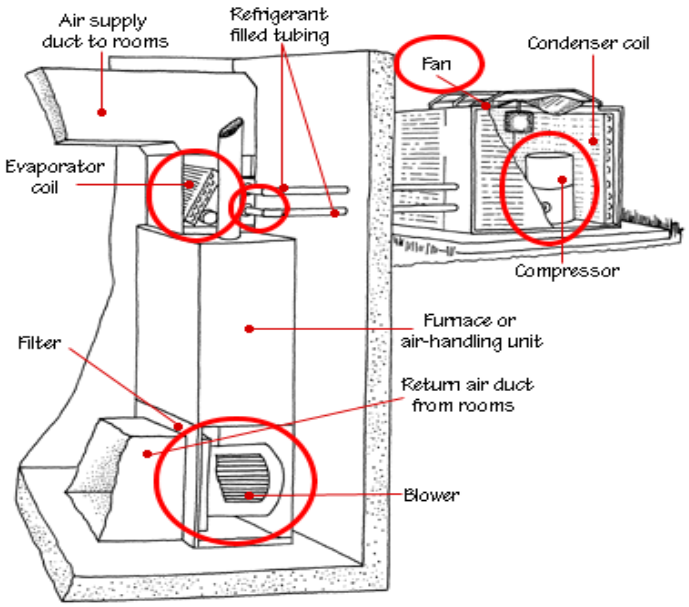


Refrigeration cycle



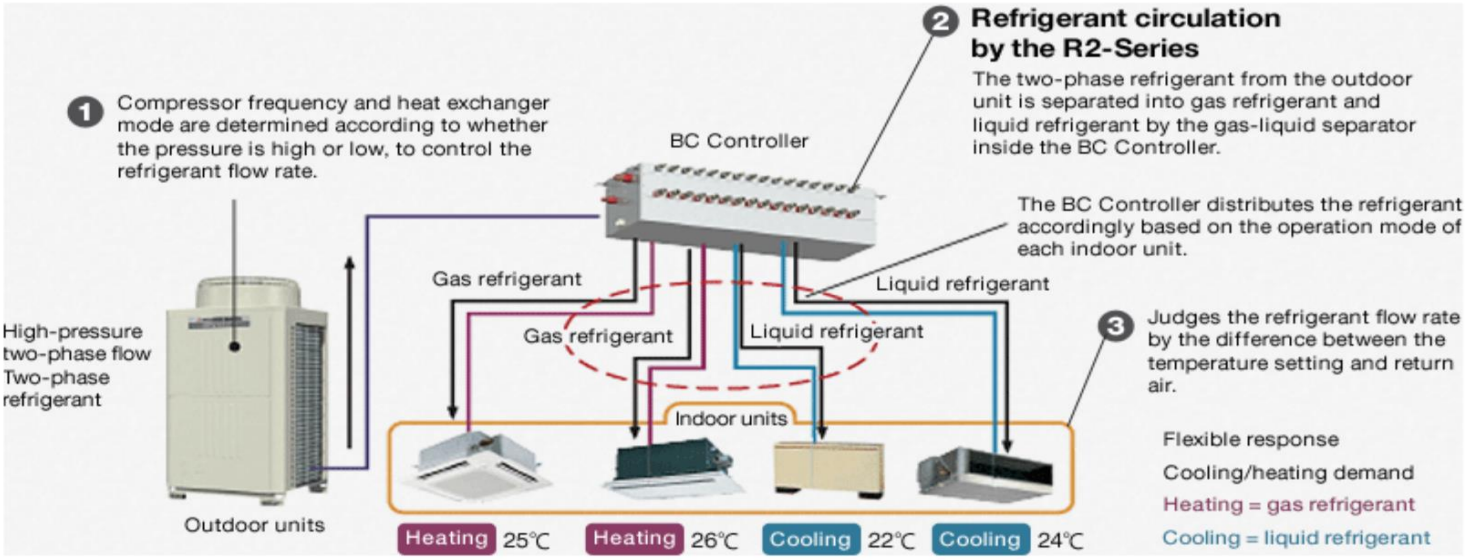
- ❖ Compressor uses electric power to increase pressure of refrigerant
- ❖ Condenser "cools" refrigerant, refrigerant changes from gas to liquid. Removes thermal energy from system

- ❖ Expansion device lowers pressure
- ❖ Evaporator (cooling coil) "heats"
- ❖ refrigerant and cools air, refrigerant ges back to gas. Adds thermal energy to system.
- ❖ Power: compressor, condenser fan, furnace blower, furnace in heating mode



Variable Refrigerant Flow (VRF)

- ❖ Could be single zone (mini-split)
- ❖ Or multiple zone (VRF System)
- ❖ Just a complex heat pump, serving multiple zones



Basic Control of Saving Energy

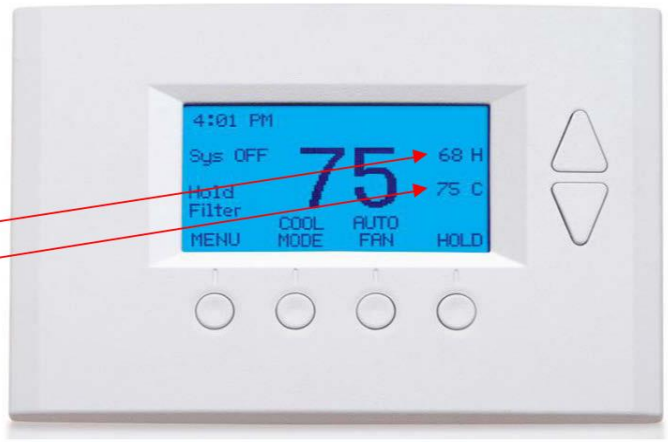
- ❖ Most impactful basic HVAC control measures
  - ➢ Snow and ice melt heater control
  - ➢ Temperature setback scheduling
  - ➢ Full 5degree thermostat dead band
  - ➢ Economizer controls
- ❖ Additional impactful complex HVAC control measures
  - ➢ Full 5degree thermostat deadband
  - ➢ Limits on simultaneous heating and cooling (VAV reheat) VAV ventilation optimization
  - ➢ Supply air temperature & fan static reset controls
- ❖ Other impactful HVAC measures
  - ➢ Exterior ductwork insulation (C403.2.9)
  - ➢ Fan power within limits
  - ➢ Proper equipment sizing

Temperature Setback Scheduling

- ❖ Simple control systems
  - ➢ Programmable thermostats
    - Seven different daily schedules/week
    - Manual override
  - ➢ Occupant sensor is an alternative
- ❖ DDC (direct digital control) systems
- ❖ Central scheduling of all units

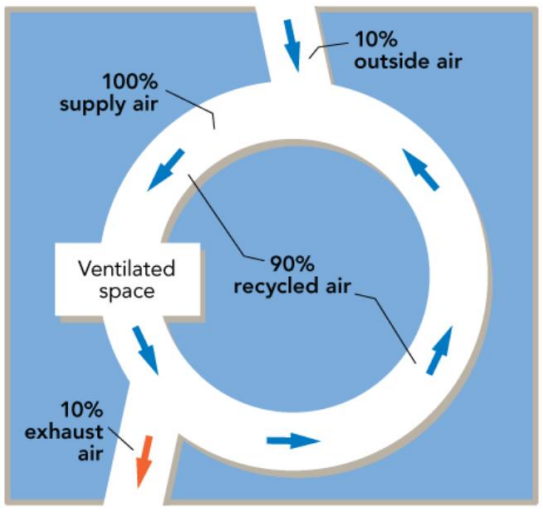
Full 5 Degree Temperature Deadband

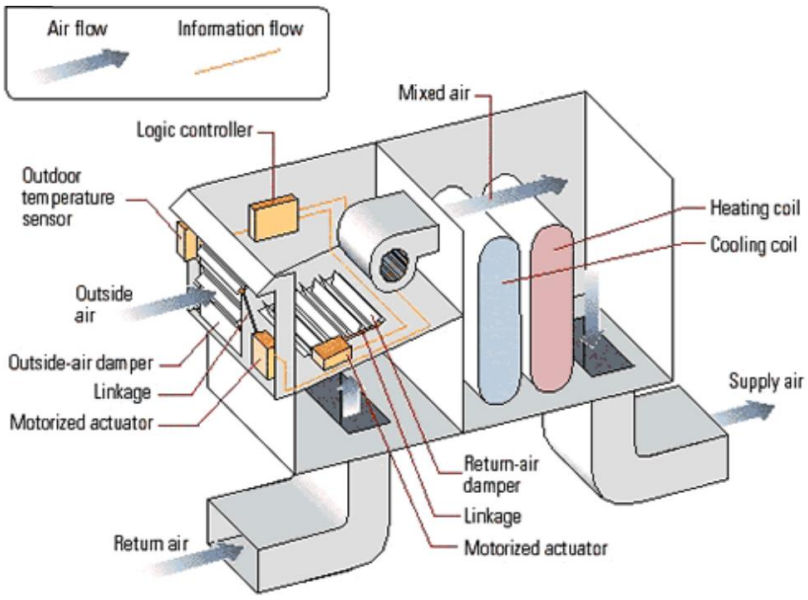
- A most significant control feature is temperature deadband
- If heating is set at 70°F,
- then cooling should be ≥ 75°F
- Should be the found condition
- during an inspection



HVAC –Economizers "Free Cooling"

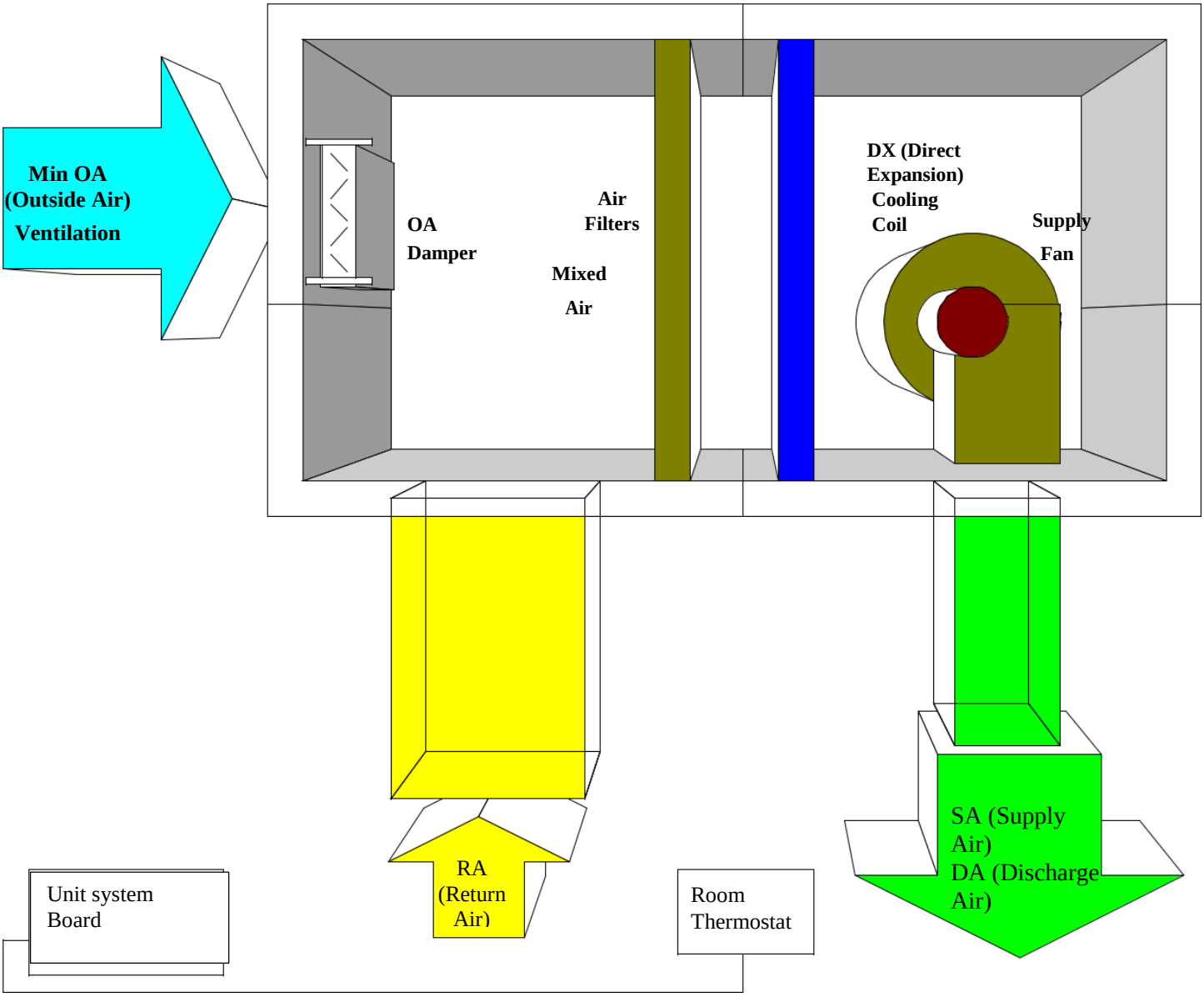
- Quantity of OSA: Meet Minimum Ventilation Requirement
- Economizer Function: Flush out building heat with cool outside



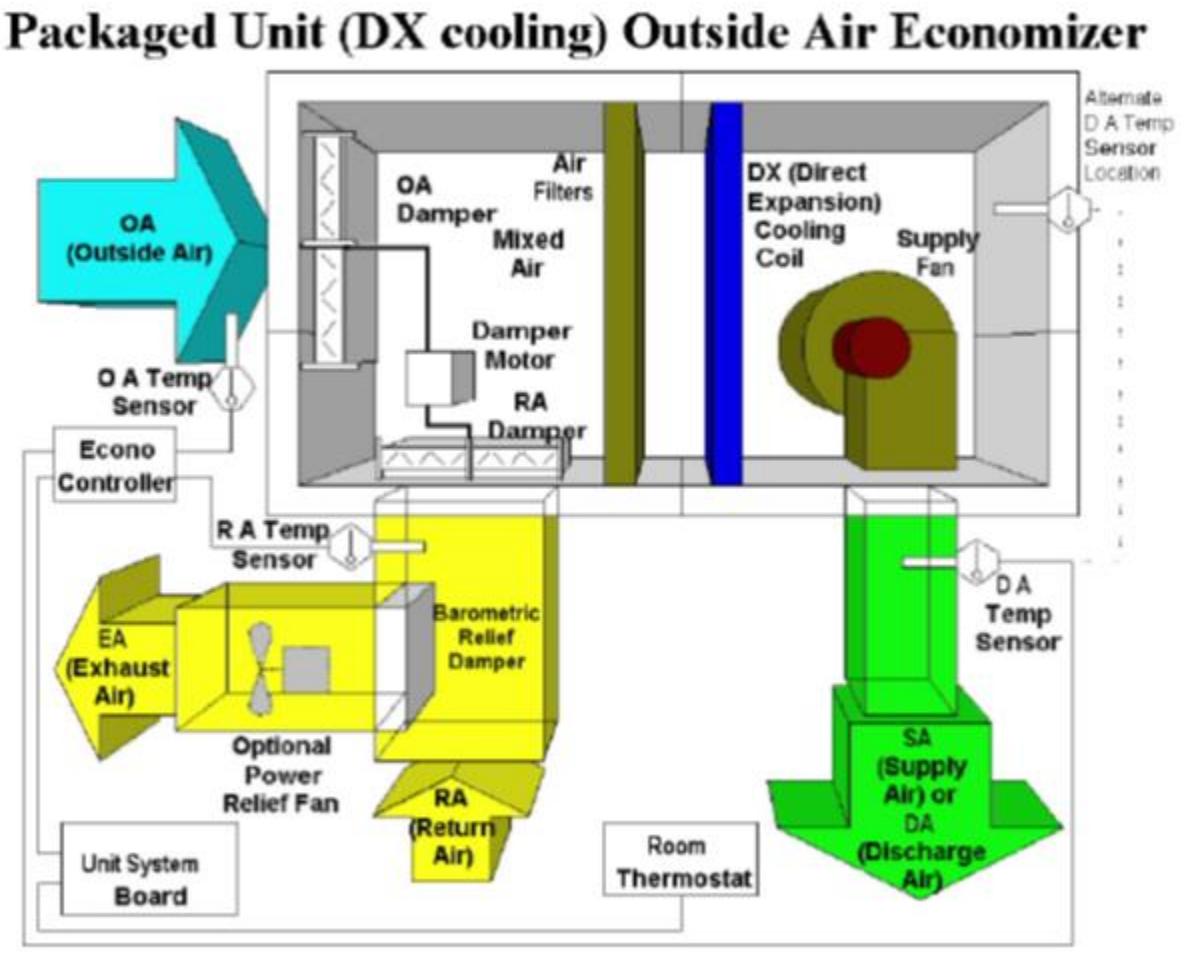


Packaged Rooftop Cooling Unit

Packaged Unit (DX cooling) Outside Air Ventilation



Basic OSA Economizer Idea



Economizer Components

- ❖ Dampers (not shown)
- ❖ Damper Motors
- ❖ MAT/DAT sensors
- ❖ Solid State Controller
- ❖ OAT/RAT sensors
  - ➢ Dry bulb
  - ➢ Enthalpy
- ❖ Code econo requirements
  - ➢ OSA ductwork =large enough
    Relief damper
  - ➢ provided Integrated
- Operates with compressor
- Coordinated with cooling

Complex Building Energy Use- HVAC

- ❖ Categories of HVAC systems:
  - Central Plant
    - ➢ Boilers, chillers, cooling towers
    - ➢ A few pieces of large equipment
- ❖ Distribution Systems
  - ➢ Pumps
  - ➢ Pipe and control valves
  - ➢ Ductwork, diffusers and registers
- ❖ Secondary & Zonal HVAC Systems
  - ➢ Air handlers, with coils & economizers
  - ➢ Fan coils, VAV boxes

Chiller

- ❖ Selected based on:
  - ➢ Space temperature and humidity requirements
  - ➢ First cost, operating cost, and maintenance cos
  - ➢ Spatial constraints
  - ➢ Redundancy

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