CAPITAL PARTNERS

"CLIF NOTES" SERIES

*(**C**ompetent **L**everaging of **I**nformation and **F**acts)*

HVAC – Heating, Ventilation and Air Conditioning

What basic information do you need to know about HVAC and why? The Capital Partners' ***HVAC Clif Notes*** will provide you with the buzz words, general definitions and description of the basic types of HVAC systems and their most common applications. You will now have enough information to be dangerous, yet still impress your clients and colleagues.

COMMON TERMS

Air Exchange: *The amount of complete air changes a building space goes through in one hour*. Title 24 requires that the air is "changed" with outside air at a minimum of .15 cfm per s/f or 15 cfm per person for office space. 3 to 5 air exchanges per hour is typical to maintain a non-stuffy air quality and to prevent odors. Title 24 assumes one person per 10'x10' space. There is no requirement for air exchanges in warehouse space unless the warehouse is heated or has a more intensive occupancy load (manufacturing).

Airflow: *The volume of airflow (both outside and conditioned air) into a given space*. Title 24 requires that the building's supply fan be on during all occupied hours for office, no specific requirement for a warehouse. The goal of the airflow is to integrate fresh air with the circulating interior air. Typical % of outside air mixed with re-circulated air is 15% to 20%. Airflow may change based on the type of HVAC system in the building but always requires a minimum of outside airflow to the building. Rule of thumb: The more outside air the more expensive the system is to operate but is generally more healthy for the occupants. The minimum airflow per Title 24 is equal to the minimum required outside air integration (.15 cfm per s/f or 15 cfm per person).

British Thermal Unit (BTU): *The quantity of heat required to change the temperature of one lb. of water by 1°F*. Adding one BTU to a pound of water (roughly an 16-oz. glass of water) will increase the temperature by one degree. Removing one BTU from one pound of water will lower the temperature by one degree. 12,000 BTU's equal one ton.

Cubic Feet Per Minute (CFM): *A unit of measurement for airflow*. For example, 100 CFM is moving 100 cubic feet (about the amount of air in a VW Beetle) of air in one minute. CFM is typically measured at the point of introduction into the space.

Energy Management System (EMS): *A fully-functional electronic control system monitoring and determining how much airflow and at what temperature*. This includes controllers (at the VAV boxes), various communications devices such as thermostats or sensors and the full compliment of operational software necessary to have a fully functioning control system.

Today's EMS systems are often referred to as direct digital control (DDC) systems. DDC systems consist of microprocessor-based controllers with the control logic (brains) performed by software. A DDC system provides many advantages for owners, operators, and managers, and has become the predominant system specified for new buildings and retrofits. DDC system benefits: better climate control with complementing reduced utility costs. Monitoring of the DDC system is provided by the building engineer, occupant or remotely by a service provider. HVAC complaints from building tenants can be investigated, changed and equipment diagnosed (errors or malfunctions) by dialing by phone to the system. An added bonus of a DDC system is the ability to be self-diagnostic (useful for trouble shooting the HVAC system).

First Cost vs. Life Cycle Cost: *Cost analysis comparing the initial capital expenditure to install the HVAC equipment with the short and long term operating costs (utility cost, maintenance and eventual replacement cost).* The cost analysis is typically done for both leased and owner/user facilities and applies to both office and industrial projects where significant temperature control is required.

First Cost: *The initial capital expenditure for the HVAC equipment and airflow delivery system (ducting).* The lowest initial cost may not be the best decision for the building owner or users. Note First Cost vs. Life Cycle Cost Analysis above. Prior to the design of the system, goals and objectives need to be established by the owner/user.

Life Cycle Cost: *A cost model analysis to determine the short and long term cost of operating the HVAC system, including down time*. The model components include initial acquisition/installation costs, utility costs, maintenance and replacement cost. The model usually compares several system alternatives with the objective of selecting the overall most cost effective system to meet the owner/user goals over a desired period of time. The Life Cycle Cost is compared to the initial capital expenditure using present value and payback period approaches. Often on larger buildings, an energy analysis is performed to demonstrate to the ownership that a more efficient system with a higher first cost (initial capital expenditure), will actually be significantly less expensive over the life of the building. Alternatively, less expensive and efficient systems are sometimes selected due the speculative nature of the building or where the maintenance and operating costs are deferred to the tenants.

Plenum: *Definition 1 - The sheet metal box within the duct system that has multiple duct taps (ducting to individual registers).* For example, a small rooftop package unit will have sheet metal duct plenums located at the supply and return outlets of the unit. These plenums drop down through the roof and may be up to 4'-0" long. At the bottom of this plenum would be various duct taps that would go in all different directions to the registers). The advantage to this would be smaller main ducts and less sheet metal fittings. Also, these plenums are normally lined with duct liner (insulation) to help to reduce noise from the units and to retain the temperature of the airflow. Plenums are also used after a VAV box for the same reasons.

Definition 2 - The area above a ceiling, normally referred to as a return air plenum. This is very common for multiple story buildings where the return air passes above the ceiling back to the unit without a return air duct system. This return air plenum has to be built with non-

combustion materials per the building code for preventing the spread of a possible fire. The advantage for this design is a lower mechanical installation cost. Also, it allows more ceiling space clearance for other contactors to do their work.

Title 24: *A minimum building energy efficiency standard set by the California Energy Commission to encourage energy conservation*. These standards dictate a minimum value for the type of glass or insulation used in a building, etc. Maintaining such standards helps to ensure that new or remodeled buildings maintain a high level of comfort while conserving energy. New HVAC equipment installed in buildings must meet or exceed a minimum energy efficiency value (SEER) based on the unit size. Some electric suppliers will give rebates for using high-efficiency rated equipment. The owner/user benefits not only from the capital expenditure rebates but also the lower operating cost. Title 24 is administered/enforced by the building departments at the local level through building plan check and the permit/inspection process. *Economizer* – Required by Title 24 for systems with over 6 tons: Adds more outside air and less conditioned air when the outside air temperature is less than the desired inside temperature resulting in energy efficiency. *SEER* – (Seasonal Energy Efficiency Rating) Equipment tested and rated for efficiency at the factory, used for Title 24 calculations.

Ton: *A unit of measure. In the air conditioning industry, "1-ton" is equivalent to 12,000 BTU's*. The term "ton" is normally used in air conditioning unit sizing or total building load. For example, a 5-ton air conditioning unit will produce 60,000 BTU's total capacity in one hour. A rule of thumb for typical office space (occupants and equipment = heat load factors) is one ton per 350-400 s/f. One ton produces 400 CFM.

Variable Air Volume Box (VAV): *A device located in the duct system before the air outlets and downstream of the main supply duct*. Its purpose is to vary the airflow to the space. It is essentially a rectangular sheet metal box with a butterfly damper that modulates based on room temperature via a controller. A thermostat located in the room monitors the room temperature signal the controller to open and close the VAV box based on the demand for cooling or heating. The VAV restricts or adds heated /cooled air to the fan driven airflow.

Registers/Return Air Vents: *Registers = Vents = Diffusers: Points of air delivery into a space*. Return air vents return a portion of the air back to the originating HVAC system. Less air is returned due to the on going integration of outside air as well as the intentional positive air pressure that escapes from the building (by design).

Positive Air Pressure: *Greater interior air pressure than the outside air.* HVAC systems are designed to produce more air pressure inside the space compared to the outside air pressure. Thus when a door/window is opened air escapes vs. air intruding the space. Positive air pressure helps control both temperature and the intrusion of contaminants (dirt, unfiltered air).

Zone: *An area served by one temperature-controlling device.* Rules of the thumb: A zone should have like kind space (exterior offices all facing one exposure), exterior group can be one office to 6 offices; interior zones should be comprised of 1,000 - 2,000 s/f.

Variable Frequency Drive (VFD): *A device normally located by the motor it serves*. The VFD varies the speed of the motor based on the demand of the system. They are commonly used in variable air volume systems for fan speed control and piping systems such as chilled water systems for pump speed control. VFD reduces the motor horse power resulting in energy savings and a longer motor life when the system demands are low.

DESCRIPTION OF SYSTEMS AND USAGE

Split-System Unit

A "split system unit" is an air conditioning unit that normally has a separate indoor air handler/heating unit and an outdoor compressor (cooling unit) section. The system is joined together by refrigerant piping. The indoor air handler consists of a fan, cooling coil, and filter section. The outdoor unit consists of a compressor and a condenser section. These systems are normally used for small data rooms or electric rooms. The Split-System Unit is similar to residential units. R-22 refrigerant is commonly used.

Package System Units

A "package system unit" is a fully self-contained unit normally mounted on a roof. The components are factory-assembled into an integrated package including the fan, cooling coil, heating section (if applicable), filters, compressor, condenser, and internal controls. Rooftop package units range in size from 1½-130 tons each. Larger units are available but are considered a custom unit, made to order. Multiple package units are used for smaller buildings where low initial first cost is important. These units would normally be designed to serve small zones, keeping the interior and exterior zones separated. The unit delivers constant volume airflow. One unit per zone unless a VAV system is added. The units can only deliver cool or heated air at one time. R-22 refrigerant is commonly used.

Variable Air Volume (VAV) Package Units

A "VAV package unit" is a fully self-contained unit normally mounted on a roof. The components are factory assembled into an integrated package including the fan, cooling coil, heating section (if applicable), filters, compressor, condenser, and internal controls. VAV rooftop package units range in size from 20-130 tons each (130 or larger are considered box cars or mammoth units due to their size. Larger units are available but are considered a custom unit, made to order. These units are designed to vary the airflow to the space through a variable speed drive motor or inlet guide vanes. As the building loads change this unit can run at reduced capacities, which in turn reduces energy consumption. The variable air volume boxes work in conjunction with these units. VAV package units are commonly used in 2-4-story office buildings. R-22 refrigerant is commonly used.

Built-up System (VAV)

A “built-up system (VAV)” is a system in which the design engineer will select each component of the system and layout a mechanical penthouse plan. A fan system, chiller, cooling tower, boiler, and pumps are all common components of this type of system. The fan systems will typically be controlled with VFD’s. The system is common for buildings 5 stories and above. *Chiller* – Cools the recirculating water (water used to cool the air in the building) by blowing colder water through the recirculating water filled coils. *Cooling Tower* - Sends and receives water used by the Chiller to cool the recirculating water. The Cooling Tower spays the returning water from the Chiller allowing the now hot water to release the heat into the air (evaporation) to cool it down before it is pumped back to the Chiller (think of a swamp cooler – same principle).

Double Duct VAV System (DDVAV)

A “double duct VAV system” is a system that utilizes separate duct systems for cooling and heating. The cooling system will typically have a cooling-only unit located on the roof. The cooling duct will provide cooling to the entire building. The heating system will typically have a gas furnace unit located on the roof. The heating duct will normally be located next to the main cooling duct. The heating system usually serves the perimeter exposures of a building and not the interior space with this type of system. The main heating loads come from the system serving the exterior of a building to compensate for the heat loss due to the glazing. A cooling-only VAV box would serve the interior spaces of a building, and a cooling/heating VAV box (tied together) would serve the perimeter zones through a common duct system after the VAV boxes.

Hot Water VAV Reheat System

A “hot water VAV reheat system” is a system that utilizes a cold air duct system (similar to the DDVAV), and a hot water piping system that provides heating to the perimeter zones. The heating system will have a boiler and pump on the roof and a hot water supply/return piping system next to the main cooling duct. The perimeter zones will have a reheat coil located after the VAV box. The air from the cooling system, normally at 55°F, will be heated to approximately 100°F to heat a specific zone. The system is generally less efficient than the DDVAV but can deliver spot heat/cold air to infrequently used space like classrooms or court rooms. The hot water is fed to coils in front of the VAV boxes to heat the VAV fed air to increase the temperature of the delivered air.

Liebert System

Specialty equipment used for climate control for computer/telco rooms. Computer and telco equipment require tighter temperature and humidity control than a regular office environment. Intensive applications of this equipment often requires 24/7 operation with emergency back-up in the event of a power failure. Liebert Corporation is the industry leader in this type of specialty equipment that controls both temperature and humidity to exacting tolerances. Often, these units reside in computer rooms instead of on the rooftop. The unit directs conditioned air down under a raised floor which is vented underneath the bottoms of computer equipment, providing focused cooled air directly to the machines. This type of conditioning is over and above the main building HVAC system.

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Warehouse Heating

Heating requirements for warehouses vary from none to extensive depending on the warehouse use and regional weather. Common heating systems are normally gas fired and are described as follows:

Spot Heating:	The use of heaters to warm up small specific areas, usually where employees are working or areas where temperature sensitive products are stored. Radiant heaters are most commonly used for spot heating.
Radiant Heater:	Infrared panel or tube heaters are chain hung or wall mounted at a height of 10 to 14 feet. Radiant heaters are infrared (gas heated ceramic refractory that generate infrared radiation). The infrared heat waves heat the surface (objects) and not the air. Panel Heaters are rectangle and used in small areas. Radiant tube heaters are long and narrow and are effective for assembly lines, corridors or long product racks.
Forced Air Heater:	Fan powered furnaces used to heat larger areas. The interior cool air is forced across a gas fired heat exchanger and blown back into the space. Unlike radiant heaters, forced air heaters heat the air by using blowers to disburse the heated air to the desired space. Stratifying paddle fans are used to stir the heated air that is rising.

A Special Thanks! *Much of this information was provided by Vic Carter and Gus Giranis of Airco Mechanical, Inc. They are available to assist you and your clients for all of their HVAC needs from system design and installation to maintenance and repair.*

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