



APPENDIX: HEATING AND COOLING SURVEY

Measure Heating and Cooling Loads To Rightsize Systems

This survey will familiarize you with the condition of your heating and cooling systems and enable you to determine whether your heating and cooling equipment needs replacing with rightsized, energy-efficient equipment.

To prepare to rightsize your heating and cooling systems, compile basic information and measurements about the systems and your facility. Next, calculate the required cooling and heating loads for your building.

To get started, recruit a survey team including a building engineer, HVAC technician, boiler operator, and electrician. You will need to evaluate your available staff resources and staff capabilities. If you do not have the means of taking these measurements, you may want to contact an independent *testing, adjusting and balancing* (TAB) firm or seek outside engineering services.

Before You Begin

You will need the following items to complete your survey:

- The latest specifications for the heating and cooling equipment in your building.
- The TAB report for your building's pumping systems.
- "As built" mechanical drawings.
- Operations and maintenance manuals for the boiler, chiller, or unitary system equipment.
- The system logs showing hot and chilled water supply and chilled-water return temperatures and flow rates (if you have an energy management system).
- A data logger (note: for unitary systems only).
- A calculator.





Chiller Systems Survey

Collect the following information:

Chiller Type
(choose one)

- Air-cooled centrifugal
- Water-cooled centrifugal
- Reciprocating
- Helical rotary/screw
- Steam absorption
- Hot-water absorption
- Direct-fired absorption
- Engine-driven

Manufacturer _____

Type of Refrigerant _____

Age _____

Efficiency (kW/ton) _____

Size or Capacity (in tons) _____
(12,000 Btu/hr = 1 ton)

Calculate the maximum cooling load for your building using the following procedure:

What is the maximum cooling load for the building (in tons)? This load will be compared with the chiller capacity recorded above. To determine maximum cooling load, take the following measurements in the afternoon on a typical hot summer day to capture peak load effects on your system. *Note: An energy management system may also log these measurements.*

- 0Temperature of the chilled-water supply (CHWS). A temperature gauge should be found on the pipe at the chiller's supply outlet.
- 0Temperature of the chilled-water return (CHWR). A temperature gauge should be found on the pipe at the chiller's return inlet.
- 0Flow rate (GPM) of the chilled water supply. A flow rate gauge should be found on the supply pipe. If a gauge is not available, the design flowrate from as-built drawings may be used.

Chilled Water System
Measurements

Temperature of CHWS _____

Temperature of CHWR _____

Flow rate (GPM) of CHWS _____



Now, using the measurements, do the following calculations:

$$CHWR - CHWS = \Delta T:$$

$$\Delta T \times 500 \times (\text{GPM} \div 12,000) =$$

Load (in tons):

$$\text{Load} \times 1.1 = \text{Maximum Cooling Load}$$

How much of your existing chiller capacity does your building currently need? To answer this, do the following calculation:

$$\text{Maximum Cooling Load} \div$$

Chiller Capacity =

Percentage of Chiller Capacity Needed

If the required capacity of the chiller is 30 percent less than the installed capacity of your existing chiller, you should seriously consider replacing the chiller. The efficiency of the chiller decreases sharply below 70 percent loading. Also, remember that the chiller is operating most of the time at part-load conditions with your newly reduced loads, which increases your rightsizing potential even further.

Boiler Systems Survey

Collect the following information:

Heating Plant Type	<u>Central hot water boiler</u>
Manufacturer	_____
Fuel (gas, oil, electric)	_____
Age	_____
Efficiency (percent)	_____
Size or Capacity (in MBtu/hr)	_____

Calculate the maximum heating load for your building using the following procedure: What is the maximum heating load for the building (in MBtu/hr)? This load will be compared with the heating system capacity recorded above. To determine maximum heating load, take the following measurements in the morning on a typical cold winter day to capture peak load effects on your system. *Note: An energy management system may also log these measurements.* The following procedure is tailored to typical central hot water boiler systems.

- 0Temperature of the hot water supply (HWS). A temperature gauge should be found on the pipe at the boiler's supply outlet.



- Temperature of the hot water return (HWR). A temperature gauge should be found on the pipe at the boiler's return inlet.
- Flow rate (GPM) of the hot water supply. A flow rate gauge should be found on the supply pipe. If a gauge is not available, the design flow rate from as-built drawings may be used.

Boiler System Measurements

Temperature of HWS _____

Temperature of HWR _____

Flow rate (GPM) of HWS _____

Now, using the measurements, do the following calculations:

$$\text{HWR} - \text{HWS} = \Delta T$$

$$\Delta T \times 500 \times \text{GPM} / 1,000 = \text{Load}$$

(in MBtu/hr)

$$\text{Load} \times 1.1 = \text{Maximum Heating Load}$$

How much of your existing boiler capacity does your building currently need?

$$\begin{aligned} &\text{Maximum Heating Load} \div \\ &\text{Heating Plant Capacity} = \\ &\text{Percentage of Heating Capacity Needed} \end{aligned}$$

For other types of heating systems, there are other ways of measuring maximum heating load.

- For systems such as forced-air furnaces and heat pumps that respond to thermostats by cycling on and off, a simple runtime meter will show how much of the time the unit cycles on. Supply-temperature data logged every few minutes by an EMCS or other data logger can also be analyzed to determine how much of the time the unit is cycled on. The percentage of heating capacity needed is the time the unit operates divided by the total time during a high heating load period.
- Measuring steam boiler loading is similar, but more complicated than for a hot water boiler. Instead of the water flow rate, the steam flow rate must be measured. Instead of multiplying a temperature difference by a factor accounting for the heat content of each GPM, the temperature and pressure properties of the supply steam must be recorded from gauges on the supply line and used to determine the heat content of each pound of steam using a steam table.



Other strategies for measuring heating loads include:

- Periodic gas meter readings.
- Oil tank gauge readings or oil deliveries.
- On/off cycle times for systems that operate intermittently.

Unitary Systems Survey

Collect the following information for each type of unit installed in your building:

Boiler System Measurements

- Unitary System Type Packaged rooftop unit
(choose one) Split system
 Vertical packaged unit
 Heat pump

Manufacturer _____

Htg Fuel (gas, oil, elec.) _____

Unit Age _____

Cooling Efficiency (%) _____

Heating Efficiency (%) _____

Size or Capacity (cooling) _____
(in tons)

Size or Capacity (heating) _____
(in MBtu/hr)

Calculate the maximum cooling and heating loads for your building using the following steps:

What are the maximum heating and cooling loads for the building (in MBtu/hr)?
These loads will be compared with the cooling and heating capacities recorded above.
To determine maximum heating or cooling load use the procedure described in the heating section for small systems that cycle on and off.

Time cycled on ÷ Total time = Percentage of Capacity Needed

A data logger can be used to determine how much of the time the unit is cycled on.



GLOSSARY

Recommissioning

air side systems

Equipment used to heat, cool, and transport air within building HVAC systems.

ASHRAE

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

balancing

Process of measuring and adjusting equipment to obtain desired flows. Applies to both air side and water side systems.

boiler

Pressure vessel designed to transfer heat (produced by combustion) or electric resistance to a fluid. In most boilers, the fluid is water in the form of liquid or steam.

British thermal unit (Btu)

A unit of energy equivalent to the amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit.

Btu □

See *British thermal unit*.

calibration

Process of adjusting equipment to ensure that operation is within design parameters.

carbon monoxide

Colorless, odorless, poisonous gas formed during incomplete combustion of fuel.

central plant

Centrally located equipment that satisfies a building's cooling and heating loads.

CFCs □

See *chlorofluorocarbons*.

cfm

Cubic feet per minute.

chiller

Mechanical device that generates cold liquid, which is circulated through cooling coils to cool the air supplied to a building.

chlorofluorocarbons

Chemical compounds consisting of carbon, hydrogen, chlorine, and fluorine, once used widely as aerosol propellants and refrigerants. Believed to deplete the atmospheric ozone layer.

coil, condenser

A heat exchanger used to condense refrigerant from a gas to a liquid.

coil, cooling

Heat exchanger used to cool air under forced convection with or without dehumidification. May consist of a single coil section or several coil sections assembled into a bank.



coil, fan

A device that combines a heat exchanger and a fan in a single unit that conditions air by forced convection.

coil, heating

Heat exchanger that heats air under forced convection. May consist of a single coil section or several coil sections assembled into a bank.

combustion air

Air that supplies the oxygen required to burn fuel.

commissioning

The quality assurance process that ensures design intent is met for new facilities or major rehabilitation.

condenser

Heat exchanger in a refrigeration system that expels building heat absorbed in the evaporator.

conditioned air

Air that serves a space and that has had its temperature and/or humidity altered to meet design specifications.

controls

An instrument or set of instructions for operating or regulating building systems.

control, pneumatic

A control that utilizes air pressure to vary equipment operation.

control, set back

The practice of reducing the thermostat setpoint during unoccupied times.

cooling tower

Device that dissipates heat from water-cooled systems through a combination of heat and mass transfer, whereby the water to be cooled is distributed in the tower and exposed to circulated ambient air.

cycling

The noncontinuous operation of equipment.

dampers

Single- or multiple-blade devices, either manually or automatically opened or closed, that control the flow of air.

demand charges

Fees levied by a utility company for electric demand.

demand, electric

Electrical power delivered to a system at a given time or averaged over a designated period. Expressed in kilowatts.

diffuser, HVAC

A device that distributes conditioned air to a space.

diffuser, lighting

A device that distributes light produced by lamps into a space.

efficiency

Ratio of power output to input.



energy management system (EMS)

The control system that monitors the environment and energy usage in a building and alters equipment operation to conserve energy while providing occupant comfort.

envelope, building

The outer shell of a building, including walls, roof, windows, and doors.

evaporator

Heat exchanger in a refrigeration system that absorbs heat from chilled water or building air, thus reducing the supply temperature.

fouling

The buildup of a film that reduces heat transfer.

heat exchanger

A device that transfers heat from one fluid to another.

humidistat

A device that responds to humidity changes and controls equipment by seeking a setpoint.

HVAC

Heating, ventilating, and air-conditioning.

kilowatt (kW)

Unit of power equal to 1,000 watts.

kilowatt-hour (kWh)

Unit of electric consumption equal to the work done by 1 kilowatt acting for 1 hour.

kW

See *kilowatt*.

kWh

See *kilowatt-hour*.

load

The demand upon the operating resources of a system. In the case of energy loads in buildings, the word generally refers to heating, cooling, and electrical (or demand) loads.

maintenance

An ongoing process to ensure equipment operates at peak performance.

occupancy sensor

A device that detects heat (passive infrared) or a shift in the frequency of reflected ultrasonic sound waves, to control operation of lights or equipment accordingly.

off-peak

Refers to a utility rate schedule that designates the time of day when energy and demand costs are typically less expensive.

on-peak

Refers to a utility rate schedule that designates the time of day when energy and demand costs are typically more expensive.

packaged unit

A self-contained HVAC unit that provides heating and/or cooling to a building space.

part-load

Condition when equipment operates at less than full capacity to meet the demand placed upon it.



part-load performance

Equipment efficiency at less than full capacity.

pressure drop

The loss in pressure experienced by flowing water or air due to friction and obstructions.

radiator

Device that provides warmth to a space through radiant or convective heat provided by either steam or hot water.

recommissioning

Recommissioning ensures system functionality. It is an inclusive and systematic process intended not only to optimize how equipment and systems operate, but also to optimize how the *systems function together*.

refrigerant □

Substance, such as CFCs, HCFCs, HFCs, air, ammonia, water, or carbon dioxide, used to provide cooling by evaporation and condensation.

reset, chilled water

The practice of increasing chilled water temperature to obtain higher chiller efficiency.

reset, condenser water

The practice of decreasing condenser water temperature to obtain higher chiller efficiency.

rooftop unit □

Air-handling equipment such as *packaged units* located on the roof.

scaling

See *fouling*.

schedule

A control sequence that turns equipment on and off.

setpoint

Desired temperature, humidity, or pressure in a space, duct, etc.

shell, building

See *envelope, building*.

space

The distinct area to which conditioned air is delivered.

steam trap

A device that separates air and condensed water from steam.

TAB □

See *testing, adjusting, and balancing*.

testing, adjusting, and balancing (TAB)

The process of adjusting HVAC system components to supply air and water flows at design or revised specifications.

thermostat

A device that responds to temperature changes and controls equipment by seeking a setpoint accordingly.

ton

Unit of cooling capacity equal to 12,000 Btu/hr.



tubes, condenser

Heat exchanger tubes through which condenser water is pumped to allow heat transfer between the condenser water and the refrigerant.

tubes, evaporator

Heat exchanger tubes through which chilled water is pumped to allow heat transfer between the chilled water and the refrigerant.

tune-up, building

The purposeful sequence of maintenance and operational improvements, undertaken at a specific point in time, designed to reduce energy use, heating loads, and cooling loads of existing facilities.

variable air volume (VAV)

A type of air-handling system that provides air at a constant temperature and varies the air quantity to each zone to match the variation in room load.

VAV□

See *variable air volume*.

water side systems

Equipment used to heat, cool, and transport water to building HVAC systems.

Lighting

ballast

Power-regulating device that modifies input voltage and controls current to provide the electrical conditions necessary to start and operate gaseous discharge lamps.

carbon dioxide

Colorless, odorless, incombustible gas formed during respiration, combustion, and organic decomposition. Increasing amounts of carbon dioxide in the atmosphere are believed to contribute to the global warming phenomenon.

CERCLA

Comprehensive Environmental Response, Compensation and Liability Act (1980) an EPA regulation. Also known as the Superfund law.

color rendering index (CRI)

A measure ranging from 0 to 100 of the accuracy with which a light source renders different colors in comparison to natural light, which has a measure of 100.

controls

An instrument or set of instructions for operating or regulating building systems.

CRI□

See *color rendering index*.

cycling

The noncontinuous operation of equipment.

deadband

A setting in the lighting control that provides a time delay, signaling the lights to switch off only if the light level is somewhat *above* the setting, or on only if the level is somewhat *below* the setting.

DEHP

Di (2-ethylhexyl) phthalate, an insulator used to replace PCBs in ballast capacitors starting in 1979. DEHP is listed as a hazardous waste in its pure form, but, according to *RCLA*, it is no longer considered hazardous once used in a lighting ballast.



demand charges

Fees levied by a utility company for electric demand.

demand, electric

Electrical power delivered to a system at a given time or averaged over a designated period. Expressed in kilowatts.

diffuser, HVAC

A device that distributes conditioned air to a space.

diffuser, lighting

A device that distributes light produced by lamps into a space.

efficacy

The ratio of lamp lumen output to total lamp power input expressed in lumens per watt.

efficiency

Ratio of power output to power input.

EMS□

See *energy management system*.

energy management system (EMS)

The control system that monitors the environment and energy usage in a building and alters equipment operation to conserve energy while providing occupant comfort.

footcandle (fc)

Unit of illuminance equal to 1 lumen per square foot.

heat gain

The rate at which heat enters or is generated within a space at a given instant.

HID

High-intensity discharge.

HVAC

Heating, ventilating, and air-conditioning.

IAQ

Indoor air quality.

IES

Illuminating Engineering Society.

illuminance

Commonly called light level, the light intensity arriving on a surface measured in footcandles.

internal rate of return (IRR)

Compound interest rate at which the total discounted benefits equal total discounted costs for a particular investment.

IRR□

See *internal rate of return*.

kilowatt (kW)

Unit of power equal to 1,000 watts.

kilowatt-hour (kWh)

Unit of electric consumption equal to the work done by 1 kilowatt acting for 1 hour.



kW
See *kilowatt*.

kWh
See *kilowatt-hour*.

load
The demand upon the operating resources of a system. In the case of energy loads in buildings, the word generally refers to heating, cooling, and electrical (or demand) loads.

lumen
Unit measurement of the rate at which a light source produces light per unit time.

luminaire
Complete lighting unit, consisting of one or more lamps together with a housing, the optical components to distribute the light from the lamps, and the electrical components (ballast, starters, etc.) necessary to operate the lamps.

luminance
Commonly referred to as brightness, the light leaving a surface measured in footlamberts. It considers both *illuminance* on the surface and reflectance of the surface.

luminance ratio □
The ratio between the *luminances* of any two areas in the visual field. This is a measure of the uniformity of luminance.

maintenance
An ongoing process to ensure equipment operates at peak performance.

nitrogen oxides
Chemical compounds that contain nitrogen and oxygen. They react with volatile organic compounds in the presence of heat and sunlight to form ozone and are a major precursor to acid rain.

occupancy sensor
A device that detects heat (passive infrared) or a shift in the frequency of reflected ultrasonic sound waves, to control operation of lights or equipment accordingly.

packaged unit
A self-contained HVAC unit that provides heating and/or cooling to a building space.

payback
See *payback, simple*.

payback, simple □
Also known as *payback*. Measurement of the elapsed time between an initial investment and the point at which accumulated savings are sufficient to offset the initial investment.

PCB
Polychlorinated biphenyl. A substance used as an insulator in the capacitor of fluorescent and HID magnetic ballasts prior to 1970. PCBs have been labeled as carcinogenic and can cause skin, liver, and reproductive disorders.

photocell
A device that responds electrically to the presence of light.

power factor
Ratio of real power to total apparent power.

power quality
The degree to which voltage and current wave forms conform to a sinusoidal shape and are in synchronous phase with one another. Poor power quality can have negative impacts on electrical equipment.



RCRA

Resource Conservation and Recovery Act, an EPA Regulation.

reflector□

A device installed in *luminaires* used to direct light from a source via specular or diffuse reflection.

rightsizing

The process of correctly sizing equipment to the peak load.

rooftop unit□

Air-handling equipment such as *packaged units* located on the roof.

schedule

A control sequence that turns equipment on and off.

sulfur dioxide

A heavy, colorless, pungent air pollutant formed primarily by the combustion of fossil fuels such as coal. It is a respiratory irritant and a precursor to the formation of acid rain.

VCP□

See *visual comfort probability*.

visual comfort probability (VCP)

A rating given to lighting systems expressed as the percentage of people who will find light output acceptable in terms of glare due to direct light from luminaires.

voltage, volts

International system unit of electric potential or the amount of electrical flow, also referred to as electromotive force.

Supplemental Load Reductions

AHU□

See *air-handling unit*.

air-handling unit (AHU)

Equipment used to distribute conditioned air to a space. Includes heating and cooling coils, fans, ducts, and filters.

air side systems

Equipment used to heat, cool, and transport air within building HVAC systems.

ASHRAE

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

balancing

Process of measuring and adjusting equipment to obtain desired flows. Applies to both air side and water side systems.

ballast

Power-regulating device that modifies input voltage and controls current to provide the electrical conditions necessary to start and operate gaseous discharge lamps.

British thermal unit (Btu)

A unit of energy equivalent to the amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit.



Btu□
See *British thermal unit*.

calibration
Process of adjusting equipment to ensure that operation is within design parameters.

carbon dioxide
Colorless, odorless, incombustible gas formed during respiration, combustion, and organic decomposition. Increasing amounts of carbon dioxide in the atmosphere are believed to contribute to the global warming phenomenon.

CFCs□
See *chlorofluorocarbons*.

cfm
Cubic feet per minute.

chiller
Mechanical device that generates cold liquid, which is circulated through cooling coils to cool the air supplied to a building.

chlorofluorocarbons
Chemical compounds consisting of carbon, hydrogen, chlorine, and fluorine, once used widely as aerosol propellants and refrigerants. Believed to cause depletion of the atmospheric ozone layer.

coil, condenser
A heat exchanger used to condense refrigerant from a gas to a liquid.

coil, cooling
Heat exchanger used to cool air under forced convection, with or without dehumidification. May consist of a single coil section or several coil sections assembled into a bank.

coil, fan
A device that combines a heat exchanger and a fan in a single unit that conditions air by forced convection.

coil, heating
Heat exchanger that heats air under forced convection. May consist of a single coil section or several coil sections assembled into a bank.

controls
An instrument or set of instructions for operating or regulating building systems.

dampers
Single- or multiple-blade devices, either manually or automatically opened or closed, that control the flow of air.

DEHP
Di (2-ethylhexyl) phthalate, an insulator used to replace PCBs in ballast capacitors starting in 1979. DEHP is listed as a hazardous waste in its pure form, but, according to RCRA, it is no longer considered hazardous once used in a lighting ballast.

demand charges
Fees levied by a utility company for electric demand.



demand, electric

Electrical power delivered to a system at a given time or averaged over a designated period. Expressed in kilowatts.

demand ventilation

Method of controlling the amount of outdoor air intake based on carbon dioxide levels in a space.

desiccant

A material that absorbs moisture from its surrounding environment.

domestic hot water

All hot water consumed in a building that is used for purposes other than heating a space.

efficacy

The ratio of lamp lumen output to total lamp power input expressed in lumens per watt.

efficiency

Ratio of power output to power input.

ENERGY STAR label

EPA's trademark symbolizing excellence in energy efficiency.

envelope, building

The outer shell of a building, including walls, roof, windows, and doors.

exhaust air

Air removed from a building and not reused.

glazing

Glass set or made to be set in frames.

glazing system

A configuration of materials with a transparent or translucent element designed to admit sunlight.

GPM

Gallons per minute. A measure of water flow rate.

heat exchanger

A device that transfers heat from one fluid to another.

heat, latent

The heat required to change the state of matter from a liquid to gas or gas to liquid.

heat pump

Heat pump utilize the vapor compression refrigeration cycle the same that a DX unit or chiller does. The difference is that a heat pump can reverse the direction of heat flow which naturally flows from warmer to cooler areas.

heat, sensible

The heat required to change temperature without changing state of matter. This [temperature](#) change can occur by exposure to radiation, friction between two objects, chemical reaction, or contact with a hotter object.

hp

Horsepower. A unit of mechanical power.

HVAC

Heating, ventilating, and air-conditioning.

IAQ

Indoor air quality.



infiltration

Air that leaks into a building through the building shell.

kilowatt (kW)

Unit of power equal to 1,000 watts.

kilowatt-hour (kWh)

Unit of electric consumption equal to the work done by 1 kilowatt acting for 1 hour.

kW

See *kilowatt*.

kWh

See *kilowatt-hour*.

load

The demand upon the operating resources of a system. In the case of energy loads in buildings, the word generally refers to heating, cooling, and electrical (or demand) loads.

maintenance

An ongoing process to ensure equipment operates at peak performance.

nitrogen oxides

Chemical compounds that contain nitrogen and oxygen. They react with volatile organic compounds in the presence of heat and sunlight to form ozone and are a major precursor to acid rain.

occupancy sensor

A device that detects heat (passive infrared) or a shift in the frequency of reflected ultrasonic sound waves, to control operation of lights or equipment accordingly.

payback

See *payback, simple*.

payback, simple

Also known as *payback*. Measurement of the elapsed time between an initial investment and the point at which accumulated savings are sufficient to offset the initial investment.

PPM

Parts per million. A unit of concentration.

roof curb

A raised and reinforced area on a roof for mounting equipment.

setpoint

Desired temperature, humidity, or pressure in a space, duct, etc.

shell, building

See *envelope, building*.

space

The distinct area to which conditioned air is delivered.

timeclock

The control device used to turn equipment on and off at set times of the day.

ton

Unit of cooling capacity equal to 12,000 Btu/hr.



transformer

A device that reduces the incoming line voltage, usually to a standard level, so that it may be used to operate electrical equipment in a building.

tune-up, building

The purposeful sequence of maintenance and operational improvements, undertaken at a specific point in time, designed to reduce energy use, heating loads, and cooling loads of existing facilities.

W/sf

Watts per square foot.

Fans

AHU□

See *air-handling unit*.

air-handling unit (AHU)

Equipment used to distribute conditioned air to a space. Includes heating and cooling coils, fans, ducts, and filters.

air side systems

Equipment used to heat, cool, and transport air within building HVAC systems.

ASHRAE

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

balancing

Process of measuring and adjusting equipment to obtain desired flows. Applies to both air side and water side systems.

boiler

Pressure vessel designed to transfer heat produced by combustion or electric resistance to a fluid. In most boilers, the fluid is water in the form of liquid or steam.

British thermal unit (Btu)

A unit of energy equivalent to the amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit.

Btu□

See *British thermal unit*.

CAV□

See *constant volume*.

CFCs□

See *chlorofluorocarbons*.

cfm

Cubic feet per minute.

chiller

Mechanical device that generates cold liquid, which is circulated through cooling coils to cool the air supplied to a building.

chlorofluorocarbons

Chemical compounds consisting of carbon, hydrogen, chlorine, and fluorine, once used widely as aerosol propellants and refrigerants. Believed to cause depletion of the atmospheric ozone layer.



coefficient of performance (COP)

A measure of efficiency in which a higher value designates a more efficient system.

coil, condenser

A heat exchanger used to condense refrigerant from a gas to a liquid.

coil, cooling

Heat exchanger used to cool air under forced convection, with or without dehumidification. May consist of a single coil section or several coil sections assembled into a bank.

coil, fan

A device that combines a heat exchanger and a fan in a single unit that conditions air by forced convection.

coil, heating

Heat exchanger that heats air under forced convection. May consist of a single coil section or several coil sections assembled into a bank.

condenser

Heat exchanger used to expel building heat absorbed in the evaporator of a refrigeration system.

conditioned air

Air that serves a space that has had its temperature and/or humidity altered to meet design specifications.

constant volume (CAV, constant air volume)

Type of air-handling system that supplies the conditioned space at a constant air flow and modulate heating and cooling by varying the air temperature.

controls

An instrument or set of instructions for operating or regulating building systems.

cooling tower

Device that dissipates heat from water-cooled systems through a combination of heat and mass transfer, whereby the water to be cooled is distributed in the tower and exposed to circulated ambient air.

COP

See *coefficient of performance*.

cycling

The noncontinuous operation of equipment.

demand charges

Fees levied by a utility company for electric demand.

demand, electric

Electrical power delivered to a system at a given time or averaged over a designated period. Expressed in kilowatts.

downsizing

Process of reducing the size (capacity) of equipment so that it operates efficiently at design load conditions.

ductwork

The distribution system for air in HVAC systems. It is usually made of sheet metal or fiberglass.



efficiency

Ratio of power output to power input.

EMS□

See *energy management system*.

energy management system (EMS)

The control system that monitors the environment and energy usage in a building and alters equipment operation to conserve energy while providing occupant comfort.

evaporator

Heat exchanger in a refrigeration system that absorbs heat from chilled water or building air, thus reducing the supply temperature.

fouling

The buildup of a film that reduces heat transfer.

gasket

Material used to seal a joint against leakage.

GPM

Gallons per minute. A measure of water flow rate.

heat exchanger

A device that transfers heat from one fluid to another.

heat, latent

The heat required to change the state of matter from a liquid to gas or gas to liquid.

heat pump

Heat pump utilize the vapor compression refrigeration cycle the same that a DX unit or chiller does. The difference is that a heat pump can reverse the direction of heat flow which naturally flows from warmer to cooler areas.

heat, sensible

The heat required to change temperature without changing state of matter. This temperature change can occur by exposure to radiation, friction between two objects, chemical reaction, or contact with a hotter object.

hp

Horsepower. A unit of mechanical power.

HVAC

Heating, ventilating, and air-conditioning.

impeller

The rotating element of a fan or pump used to circulate the air or water.

internal rate of return (IRR)

Compound interest rate at which the total discounted benefits become equal to total discounted costs for a particular investment.

IRR□

See *internal rate of return*.

kilowatt (kW)

Unit of power equal to 1,000 watts.

kilowatt-hour (kWh)

Unit of electric consumption equal to the work done by 1 kilowatt acting for 1 hour.

kW

See *kilowatt*.



kWh

See *kilowatt-hour*.

load

The demand upon the operating resources of a system. In the case of energy loads in buildings, the word generally refers to heating, cooling, and electrical (or demand) loads.

maintenance

An ongoing process to ensure equipment operates at peak performance.

meter

A device used to measure and display or record data.

nitrogen oxides

Chemical compounds that contain nitrogen and oxygen. They react with volatile organic compounds in the presence of heat and sunlight to form ozone and are a major precursor to acid rain.

off-peak

Refers to a utility rate schedule that designates the time of day when energy and demand costs are typically less expensive.

on-peak

Refers to a utility rate schedule that designates the time of day when energy and demand costs are typically more expensive.

packaged unit

A self-contained HVAC unit that provides heating and/or cooling to a building space.

part-load

Condition when equipment operates at less than full capacity to meet the demand placed upon it.

payback

See *payback, simple*.

payback, simple □

Also known as *payback*. Measurement of the elapsed time between an initial investment and the point at which accumulated savings are sufficient to offset the initial investment.

power factor

Ratio of real power to total apparent power.

pressure drop

The loss in pressure experienced by flowing water or air due to friction and obstructions.

refrigerant □

Substance, such as *CFCs*, *HCFCs*, *HFCs*, air, ammonia, water, or carbon dioxide, used to provide cooling by evaporation and condensation.

reset, chilled water

The practice of increasing chilled water temperature to obtain higher chiller efficiency.

reset, condenser water

The practice of decreasing condenser water temperature to obtain higher chiller efficiency.

rightsizing

The process of correctly sizing equipment to operate efficiently at design load conditions.

rooftop unit □

Air-handling equipment such as *packaged units* located on the roof.



scaling
See *fouling*.

schedule
A control sequence that turns equipment on and off.

seasonal energy-efficiency ratio (SEER)
Cooling capacity (Btu/hr) divided by total input power (watts) requirement where both are seasonal averages.

SEER□
See *seasonal energy-efficiency ratio*.

sheave
(Pronounced shiv.) Pulley.

space
The distinct area to which conditioned air is delivered.

thermostat
A device that responds to temperature changes and controls equipment by seeking a setpoint accordingly.

timeclock
The control device used to turn equipment on and off at set times of the day.

ton
Unit of cooling capacity equal to 12,000 Btu/hr.

tune-up, building
The purposeful sequence of maintenance and operational improvements, undertaken at a specific point in time, designed to reduce energy use, heating loads, and cooling loads of existing facilities.

variable air volume (VAV)
A type of air-handling system that provides air at a constant temperature and varies the air quantity to each zone to match the variation in room load.

VAV□
See *variable air volume*.

VSD□
See *variable-speed drive*.

variable-speed drive (VSD)
A device used to adjust the speed of an AC motor to match load requirements.

Heating and Cooling

AHU□
See *air-handling unit*.

air-handling unit (AHU)
Equipment used to distribute conditioned air to a space. Includes heating and cooling coils, fans, ducts, and filters.



air side systems

Equipment used to heat, cool, and transport air within building HVAC systems.

ARI

Air-Conditioning and Refrigeration Institute.

ASHRAE

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

ASME

American Society of Mechanical Engineers.

boiler

Pressure vessel designed to transfer heat produced by combustion or electric resistance to a fluid. In most boilers, the fluid is usually water in the form of liquid or steam.

calibration

Process of adjusting equipment to ensure that operation is within design parameters.

carbon dioxide

Colorless, odorless, incombustible gas formed during respiration, combustion, and organic decomposition. Increasing amounts of carbon dioxide in the atmosphere are believed to contribute to the global warming phenomenon.

CAV □

See *constant volume*.

CFCs □

See *chlorofluorocarbons*.

chiller

Mechanical device that generates cold liquid, which is circulated through cooling coils to cool the air supplied to a building.

chlorofluorocarbons

Chemical compounds consisting of carbon, hydrogen, chlorine, and fluorine, once used widely as aerosol propellants and refrigerants. Believed to cause depletion of the atmospheric ozone layer.

coefficient of performance (COP)

A measure of efficiency in which a higher value designates a more efficient system. For example, Chiller efficiency measured in Btu output (cooling) divided by Btu input (electric power), measured at full or part load.

coil, condenser

A heat exchanger used to condense refrigerant from a gas to a liquid.

coil, cooling

Heat exchanger used to cool air under forced convection, with or without dehumidification. May consist of a single coil section or several coil sections assembled into a bank.

coil, heating

Heat exchanger that heats air under forced convection. May consist of a single coil section or several coil sections assembled into a bank.

condenser

Heat exchanger used to expel building heat absorbed in the evaporator of a refrigeration system.



constant volume (CAV, constant air volume).

Type of air-handling system that supplies the conditioned space at a constant air flow and modulate heating and cooling by varying the air temperature.

controls

An instrument or set of instructions for operating or regulating building systems.

cooling tower

Device that dissipates heat from water-cooled systems through a combination of heat and mass transfer, whereby the water to be cooled is distributed in the tower and exposed to circulated ambient air.

COP □

See *coefficient of performance*.

dampers

Single- or multiple-blade devices, either manually or automatically opened or closed, that control the flow of air.

demand charges

Fees levied by a utility company for electric demand.

direct expansion system

Cooling system in which the refrigerant runs in the cooling coil to cool the air directly; that is, there is no water loop between the refrigerant and the air to be cooled.

downsizing

Process of reducing the size (capacity) of equipment so that it operates efficiently at design load conditions.

EER

Energy Efficiency Ratio. Cooling capacity (Btu/hr) divided by total input power (watts) requirement.

efficiency

Ratio of power output to power input.

EMS □

See *energy management system*.

energy management system (EMS)

The control system that monitors the environment and energy usage in a building and **alters equipment operation to conserve energy while providing occupant comfort**.

fan, cooling tower

Fans that are used to draw air through the cooling tower to carry away water vapor.

gasket

Material used to seal a joint against leakage.

GPM

Gallons per minute. A measure of water flow rate.

heat-exchange area

Area where heat is transferred from one medium to another.

heat pump

Heat pump utilize the vapor compression refrigeration cycle the same that a DX unit or chiller does. The difference is that a heat pump can reverse the direction of heat flow which naturally flows from warmer to cooler areas.



HVAC

Heating, ventilating, and air-conditioning.

IEEE

Institute of Electrical and Electronic Engineers.

internal rate of return (IRR)

Compound interest rate at which the total discounted benefits become equal to total discounted costs for a particular investment.

IRR□

See *internal rate of return*.

kilowatt (kW)

Unit of power equal to 1,000 watts.

kilowatt-hour (kWh)

Unit of electric consumption equal to the work done by one kilowatt acting for one hour.

kW

See *kilowatt*.

KWh

See *kilowatt-hour*.

load, cooling

Cooling (typically measured in Btu/hr or tons) required to maintain an indoor design temperature.

part-load conditions

Time when equipment is operating at less than design loads; represents the majority of the time equipment is operating.

payback

See *payback, simple*.

payback, simple□

Also known as *payback*. Measurement of the elapsed time between an initial investment and the point at which accumulated savings are sufficient to offset the initial investment.

peak (cooling) load

Maximum cooling required to maintain an indoor design temperature under the most adverse summertime outdoor air conditions.

pump, chilled-water

Device that circulates chilled water.

pump, condenser-water

Device that circulates condenser water.

refrigerant□

Substance, such as CFCs, HCFCs, HFCs, air, ammonia, water, or carbon dioxide, used to provide cooling by evaporation and condensation.

seasonal energy-efficiency ratio (SEER)

Cooling capacity (Btu/hr) divided by total input power (watts) requirement where both are seasonal averages.

SEER□

See *seasonal energy-efficiency ratio*.



setpoint

Desired temperature, humidity, or pressure in a space, duct, etc.

space

The distinct area to which conditioned air is delivered.

strainer screen

Filtering device used in water side systems to protect equipment from dirt, rust, and other particles.

TAB□

See *testing, adjusting, and balancing*.

ton

Unit of cooling capacity equal to 12,000 Btu/hr.

variable air volume (VAV)

A type of air-handling system that provides air at a constant temperature and varies the air quantity to each zone to match the variation in room load.

variable-speed drive (VSD)

A device used to adjust the speed of an AC motor to match load requirements.

VAV□

See *variable air volume*.

VSD□

See *variable speed drive*.

water side systems

Equipment used to supply heating and cooling for air side systems. Includes pumps, chillers, boilers, and other devices.



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