

# ***ASHRAE Terminology of Heating, Ventilating, Air Conditioning, and Refrigeration***

## **Terms and Definitions**

### **abbreviation**

shortened or contracted form of a word or phrase, used to represent the whole.

### **absorbate**

that substance absorbed by an absorbent.

### **absorbent**

material which, due to an affinity, extracts one or more substances from a liquid or gaseous medium with which it is in contact and which changes physically or chemically, or both, during the process. Calcium chloride is an example of a solid absorbent, while solutions of lithium chloride, lithium bromide, and the ethylene glycols are examples of liquid absorbents.

### **absorber**

1. device containing fluid, or other material, for absorbing refrigerant vapor or other vapors.
2. chill factor part of the solar collector receiving the incident radiation energy and transforming it into thermal energy. It may possess a surface through which energy is transmitted to the transfer fluid; however, the transfer fluid itself can be the absorber.

### **absorber area (in a solar collector)**

1. total heat transfer area from which the absorbed solar irradiance heats the transfer fluid.
2. area of the absorber medium if both transfer fluid and solid surfaces jointly perform the absorbing function; i.e., total area onto which incident solar radiation is absorbed.
3. total area onto which incident solar radiation is absorbed.

### **absorptance (a)**

1. absorbed portion of the radiant energy striking a surface.
2. ratio of the radiant flux absorbed by a body to that incident upon it. Compare reflectance.

### **absorption**

1. process whereby a porous material extracts one or more substances from an atmosphere, a mixture of gases, or a mixture of liquids.
2. transformation of radiant energy to a different form of energy by interaction with matter.
3. absorption of acoustical energy by acoustical materials and air.

### **absorptivity**

absorbed portion of the radiant energy striking unit area of a substance. Compare absorptance.

### **ac**

alternating current.

### **acceleration due to gravity**

rate of increase in velocity of a body falling freely in a vacuum; its value varies with latitude and elevation. The International Standard, derived from the value at sea level and 45° latitude, is 9.806 65 metres per second per second ( $m/s^2$ ), or 32.174 feet per second per second ( $ft/s^2$ )

**acceptance angle**

angular zone within which radiation is accepted by the receiver of a concentrator. Radiation is said to be accepted if radiation incident within this angle reaches the absorber after passing through the aperture.

**access door (access hatch)**

movable panel mounted in a surface of an enclosure in order to permit inspection of the inside.

**accessible**

(as applied to equipment) equipment is accessible when close approach is not prevented by locked doors, elevation, or other effective means. Compare readily accessible.

**readily accessible**

capable of being reached quickly for operation, renewal, or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc. Compare accessible.

**accessory**

part or assembly that aids the effectiveness of equipment without changing its function.

**accumulator**

1. vessel for storing low-pressure-side liquid refrigerant; also known as a low-pressure receiver, surge drum, surge header, or surge tank.
2. pressure vessel whose volume is used in a refrigerant circuit to reduce pulsation.
3. pressure vessel connected to more than one circuit of a pneumatic system to obtain the average pressure of the connected circuits.
4. apparatus to store cold by accumulation of ice on a coil.

**accuracy**

1. conformity of an indicated value to an accepted standard value, or true value. Quantitatively, it should be expressed as an error or an uncertainty. The property is the joint effect of method, observer, apparatus, and environment. Accuracy is impaired by mistakes, by systematic bias such as abnormal ambient temperature, or by random errors (imprecision).
2. degree of freedom from error, that is, the degree of conformity to truth or to a rule. Accuracy is contrasted with precision, e.g., four-place numbers are less precise than six-place numbers; nevertheless a properly computed four-place number might be more accurate than an improperly computed six-place number.
3. ability of an instrument to indicate the true value of a measured physical quantity. Compare precision, reliability, repeatability.

**ACH (ACPH)**

air changes per hour.

**acoustics**

1. science of the production, transmission, and effects of sound.
2. characteristics of a room that determine the qualities of sound therein, relative to hearing.

**acronym**

word formed from the initial letter, or groups of letters or words, in a set phrase.

**activated carbon**

form of carbon made porous by special treatment by which it is capable of adsorbing various odors, gases, and vapors.

**actuator**

device, either electrically, pneumatically, or hydraulically operated, that acts as a motor to change the position of movable devices such as valves or dampers.

**addenda**

set of revisions to a standard in the form of a supplement.

**adiabatic efficiency**

efficiency with which work is done with respect to heat gains or losses.

**adiabatic exponent**

exponent  $k$  in the equation  $pV^k = \text{constant}$ , representing an adiabatic change ( $k$  is the ratio of the specific heat at constant pressure to the specific heat at constant volume).

**adiabatic process**

thermodynamic process during which no heat is extracted from or added to the system.

**adjustable-frequency drive (AFD)**

electronic device that varies its output frequency to vary the rotating speed of a motor, given a fixed input frequency. Used with fans or pumps to vary the flow in the system as a function of a maintained pressure.

**ADPI**

air diffusion performance index.

**adsorbent**

material that has the ability to cause molecules of gases, liquids, or solids to adhere to its surfaces without changing the adsorbent physically or chemically. Certain commercially available solid materials, such as silica gel, activated carbon, and activated alumina, have this property.

**adsorption**

1. process in which fluid molecules are concentrated on a surface by chemical or physical forces, or both.
2. surface adherence of a material in extracting one or more substances present in an atmosphere or mixture of gases and liquids, unaccompanied by physical or chemical change.

**aeration**

exposing a substance, or area, to the circulation of air.

**aerodynamic excitation**

time varying loads acting on the blades of a fan due to nonconformities of the air flow.

*Note:* Spatial nonuniformities of airflow which are steady in time give rise to harmonic excitation at frequencies which are integer multiples of the rotation rate of the fan.

Time excitations of the airflow give rise to random excitation.

**aerosol**

small particles, solid or liquid, suspended in air, e.g., dust, fumes, fog, and smoke.

The diameter of the particles may vary from micrometres (formerly micron) down to less than 0.01 micrometre. See fumes.

**AFD**

adjustable-frequency drive.

**AFUE**

annual fuel utilization efficiency.

**AGA**

American Gas Association.

**agitator**

device to create turbulent motion in a fluid, usually inside a vessel.

**air**

the atmosphere; the mixture of invisible, odorless, tasteless gases (nitrogen, oxygen, and others) that surrounds the earth.

**ambient air**

surrounding air (usually outdoor air or the air in an enclosure under study).

**cleansed air**

air that has been treated to remove pollutants, particulates, and odors.

**combustion air**

air required to provide for the complete combustion of fuel, and usually consisting of primary air, secondary air, and excess air.

**conditioned air (treated air)**

air treated to control its temperature, relative humidity, purity, pressure, and movement.

**cooling air**

1. cooled air used to lower the temperature of a space or products stored in a space.
2. atmospheric air used to remove heat from a device, space, or system.

**dry air**

1. air without entrained water vapor.
2. air unmixed with or containing no water.

*Note:* Composition of dry air is defined in ISO 2533-1975 and shown in the ASHRAE publication *Psychrometrics- Theory and Practice*.

**excess air**

in combustion, percent of air greater than that required theoretically to completely oxidize the fuel.

**exhaust air (extracted air)**

air discharged from a space to the outdoors as differentiated from air transferred from one space to an adjacent one.

**exit air**

air that is ejected from a system and replaced by fresh air.

**first air**

in a clean room, air that issues directly from the HEPA filter before it passes over any work location.

**makeup air**

1. air brought into a building from the outside to replace that exhausted.
2. in a clean room, air introduced to the secondary air system for ventilation, pressurization, and replacement of exhaust air.

**outdoor air**

air outside a building or taken from outdoors and not previously circulated through the system.

**outside air**

external air; atmosphere exterior to refrigerated or conditioned space; ambient (surrounding) air.

**primary air**

1. any air that is mixed with fuel at or in a burner prior to burning.
2. treated air introduced to a terminal device, where it mixes with room air circulated by induction or fan power.
3. in a clean room, air that recirculates through the work space.

**recirculated air**

air taken from a space and returned to that space, usually after being passed through a conditioning system.

**return air**

air extracted from a space, and totally or partially returned to an air conditioner, furnace, or other heat source. Compare recirculated air.

**saturated air**

1. air in which the partial pressure of the water vapor is equal to the vapor pressure of water at the existing temperature.

2. air that holds the maximum water vapor possible at a specified temperature and pressure.

**secondary air**

1. air for combustion supplied to the furnace to supplement the primary air (after ignition).
2. primary air recirculated through an induction unit.

**standard air (I-P)**

dry air at 70°F and 14.696 psia. Under these conditions, dry air has a mass density of 0.075 lb/ft<sup>3</sup>. This is not the same as SI standard air.

**standard air (SI)**

dry air at 20°C and 101.325 kPa absolute. Under these conditions, dry air has a mass density of 1.204 kg/m<sup>3</sup>. This is not the same as I-P standard air.

**supersaturated air**

humid air that contains in a unit mass of dry air a mass of water vapor greater than would be contained in saturated air at the same temperature; the excess water may remain in the form of fog.

**supply air**

air entering a space from an air-conditioning, heating, or ventilating apparatus.

**air age (age of air)**

time of passage of air from one point to another within an indoor space. See also air-exchange effectiveness.

**average age of air**

average of local mean ages of air measured throughout an indoor airspace.

**local mean age of air**

average time for air to travel from an inlet to any point, P, in an indoor space. *Note:* The local mean age of air will be different at different points in the indoor space.

**airborne particles (particulates)**

impurities as solid or liquid particulate matter from whatever source.

**airborne sound**

sound which reaches the point of detection by radiation through the air.

**air-bound system**

introduction of air causing either a flow restriction or a malfunction of the system.

**air change**

introduction of new, cleansed, or recirculated air to a space.

**air changes**

expression of the amount of air movement or air leakage into or out of a building in terms of the number of building volumes or room volumes exchanged.

**air-change effectiveness**

average age of air that exits a building via all routes, divided by the arithmetic average of the local ages of air, measured at breathing height. See also ventilation effectiveness.

**building air-exchange effectiveness**

arithmetic average of air that exits a building via all routes, divided by the building mean age of air.

**air change rate**

airflow in volume units per hour divided by the building space volume in identical volume units [normally expressed in air changes per hour (ACH or ACPH)]. Mean air change rate over a specific period can be measured using ASTM E 741-83, "Test Method for Determining Air Leakage Rate by Tracer Dilution." See also ventilating rate.

**air circulation**

motion of air, either natural or induced.

**forced air circulation**

movement of air by mechanical means.

**air circulation rate (air circulation ratio)**

volume of air circulated within a closed space per unit time divided by the volume of the space.

**air cleaner**

device used to remove airborne impurities from air. Compare filter. See also precipitator.

**air/cloth ratio (feet per minute)**

value used in dust collector calculations to measure air velocity through the bag filter media. *Note:* Calculated by dividing active cubic feet per minute of airflow by the effective area (square feet) of the cloth media.

**air/media ratio**

same as air/cloth ratio, but used where non-cloth bag media, such as paper cartridges, are the filter media.

**air conditioner**

assembly of equipment for the simultaneous control of air temperature, relative humidity, purity, and motion. Compare air-conditioning system.

**air-cooled air conditioner**

one whose refrigerating system has an air-cooled condenser.

**console air conditioner**

packaged air conditioner mounted in a console, the condenser being water-cooled or air-cooled; the air intake passes through the wall.

**free-blow air conditioner (free-delivery-type unit)**

one which takes in air, treats it, and discharges it back to the space being conditioned without external ducts.

**packaged air conditioner (self-contained unit)**

complete air-conditioning unit including refrigeration compressor, cooling coils, fans, filter, automatic controls, etc. assembled into one casing. Compare packaged terminal air-conditioning system (ptac) under air-conditioning system.

**roof-top air conditioner**

packaged air conditioner mounted on a roof, the conditioned air being discharged directly into the rooms below or through a duct system.

**room air conditioner**

packaged air conditioner designed for free air delivery of conditioned air, usually mounted in window frame or in wall opening.

**through-the-wall air conditioner**

two-component air conditioner (split-system); its elements mounted on each side of a wall and in-line with each other. Compare packaged air conditioner.

**unitary air conditioner**

one or more factory-made assemblies which normally may include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function.

**unitary spot air conditioner**

unitary air conditioner that cools a zone within a space and discharges the rejected heat back into that space. Air leaving the evaporator and condenser is discharged into the same space, and there is no physical boundary separating these discharges.

**water-cooled air conditioner**

one whose refrigerating system has a water-cooled condenser.

**window air conditioner**

room air conditioner designed for mounting in window.

**zone air conditioner**

one which conditions the air of adjacent rooms having similar requirements.

**air conditioner capacity**

useful (net) available refrigerating capacity of an air conditioner for removing sensible and latent heat from the space being conditioned.

**useful latent air conditioner capacity (dehumidifying)**

available refrigerating capacity of an air conditioner for removing latent heat from the space being conditioned.

**useful sensible air conditioner capacity**

available refrigerating capacity of an air conditioner for removing sensible heat from the space being conditioned.

**useful total air conditioner capacity**

available refrigerating capacity of an air conditioner for removing sensible and latent heat from the space being conditioned.

**air conditioning process**

in enclosed spaces, combined treatment of the air to control, as specified, temperature, relative humidity, velocity of motion, and radiant heat energy level, including consideration of the need for removal of airborne particles and contaminant gases. Some partial air conditioners that may not accomplish all of these controls are selected for their capability to control specific phases of air treatment.

**comfort air conditioning**

treating air to control its temperature, relative humidity, cleanliness, and distribution to meet the comfort requirements of the occupants of the conditioned space.

**industrial air conditioning (process air conditioning)**

air treatment for an industrial process rather than for the comfort of occupants.

**marine air conditioning**

air conditioning applied on board ships for passengers or crew accommodations.

**residential air conditioning**

air conditioning as applied to private houses or apartments.

**summer air conditioning**

treating of air in a space when outdoor temperature or relative humidity (outdoor dry-bulb temperature or outdoor humidity ratio), or both, are above those desired in the space.

**winter air**

treating of air in a space when outdoor temperature and relative humidity (outdoor dry-bulb temperature or outdoor humidity ratio), or both, are below those desired in the space.

**air-conditioning system**

assembly of equipment for air treatment to control simultaneously its temperature, humidity, cleanliness, and distribution to meet the requirements of a conditioned space. See air conditioner. Compare air-conditioning process.

**all-air air-conditioning system**

air-conditioning system in which the thermal energy is carried from the central plant by the air itself as against those systems in which another fluid transmits its energy to the air at the points of usage.

**central fan air-conditioning system**

system in which air is treated at a central plant and carried to and from the rooms by one or more fans and a system of ducts.

**cooling (heating) air-conditioning system**

specific air-treating combination, which may consist of means for ventilation, air circulation, humidity control, air cleaning, and heat transfer, with control means for cooling (heating).

**dense air system**

old air system maintained under pressure greater than atmospheric in which air is compressed, heat of compression dissipated, and the air, chilled by expansion and performance of work, can create useful refrigeration.

**dual-duct air-conditioning system**

system of a central plant that produces conditioned air at two temperatures and humidity levels, to supply air through two independent duct systems to the points of usage where mixing may be carried out.

**four-pipe air-conditioning system**

multi-piping arrangement in which each unit is fitted with supply and return pipes separately for hot and chilled water.

**low-pressure air-conditioning system**

system designed to have low pressure losses through the components of the distribution system.

**modular air-conditioning system**

on-site assembly of prefabricated components, each with a functional role in air conditioning (air circulation, air filtration, cooling, heating, humidification, etc.).

**packaged-terminal air-conditioning system (ptac)**

self-contained air-conditioning system for through-the-wall installation. *Note:* A ptac often uses a wall sleeve.

**self-contained air-conditioning system**

(single package) air-conditioning unit having the means for air circulation and heat removal, air cleaning, and the controls thereof, in the same cabinet.

**single-duct air-conditioning system**

system in which the air, having been conditioned in a central plant, is distributed to various zones through a single duct.

**split air-conditioning system**

air-conditioning system consisting of equipment provided in more than one assembly or enclosure, usually with supply air distribution equipment housed separately from refrigerant condensing equipment.

**three-pipe air-conditioning system**

multi-piping arrangement in which each unit is fitted with two supply pipes (hot and chilled water) and a single return pipe common to the central heater and refrigerating system.

**air consumption**

maximum rate at which air is consumed, under steady-state conditions, by a device operating within its design limits.

**air contaminant**

unwanted airborne constituent that may reduce acceptability of the air.

**dust**

solid particles, smaller than 100 micrometres, projected into air by natural forces, or by mechanical processes.

**fog**

fine airborne droplets usually formed by condensation of vapor.

**fume**

solid particles formed by condensation of vapors of solid materials. *Note:* Popularly, the term “fumes” refers to any kind of air contaminant; and many laws and regulations add a qualification that the contaminant have some unwanted action.

**mist**

small airborne droplets of materials, ordinarily liquid, at normal temperatures and pressure.

**smog**

commonly refers to air pollution. Air mixture of smoke particles, mists, and fog droplets of such concentration and composition as to impair visibility, in addition to being irritating or harmful.

**smoke**

1. small solid and/or liquid particles produced by incomplete combustion of organic substances, varying in size often in the range of 0.1 to 0.3 micrometre.
2. airborne solid and liquid particulates and gases evolved when a material undergoes pyrolysis or combustion. *Note:* Chemical smokes are excluded from this definition.

**air cooler (cooling unit; unit cooler)**

encased assembly in which the temperature of air passing through it is reduced.

**dry air cooler**

cooler that removes sensible heat from dehydrated air.

**dry-type air cooler**

forced circulation air cooler wherein heat transfer is not implemented by a liquid spray while in operation.

**forced circulation air cooler**

cooler which uses a fan or a blower for positive air circulation.

**free delivery-type air cooler**

cooler taking air from and discharging it directly to the space to be treated without ductwork external to the cooler that might impose air resistance.

**natural convection air cooler**

one depending on natural convection for air circulation.

**sensible-heat air cooler**

one having a surface temperature higher than the dew point of the entering air.

**spray-type air cooler**

forced-circulation air cooler, in which the coil surface is augmented by a liquid spray during operation.

**wet-type air cooler**

unit bringing air in contact with liquid by bubbling through the liquid or spraying liquid into it.

**air curtain**

controlled stream of air moving across the height and width of an opening with sufficient velocity and volume to reduce the infiltration or transfer of air from one side of the opening to the other; and to inhibit insects, dust, and debris from passing through; or both.

**air-curtain unit**

mechanical air-moving device designed to produce an air curtain.

**air density**

mass per unit volume of air. See standard air.

**air diffusion performance index (ADPI)**

single number rating of the air diffusion performance of a system of diffusers, as installed, at a specified air delivery rate, temperature, and moisture content.

**air discharge coefficient**

ratio of the net area at vena contracta of air flowing through an orifice to the total free area of the opening.

**air distribution envelope**

surface or locus of points of equal velocity which describes an air distribution profile.

**air drop**

vertical distance between the base of an air outlet and the bottom of the airstream at the end of the air throw. *Note:* Drop occurs from the natural expansion of the airstream.

**air duct (trunking)**

major conduit in an air-conveying system, usually rectangular or circular in cross section.

**air dumping**

rapid falling of cold air that occurs when a variable air volume (VAV) box or other device reduces airflow, and the supply air leaves the diffuser at very low velocity.

**air eliminator (air vent)**

in a steam or water distribution system, a device which closes if either steam or water is present in the vent body, and opens when air or noncondensables reach it.

**air entrainment**

capture of part of the surrounding air by an airstream discharged from an outlet; sometimes called secondary air motion.

**air exfiltration**

air leaking outward. See also air infiltration.

**air exhaust**

compare air inlet.

**airflow**

movement of air, usually within boundaries such as ducts.

**stratified airflow**

layers of air, usually at different temperatures or different velocities, flowing through a duct or plenum.

**airflow resistance**

deterrent (due to friction, change of direction, etc.) to the passage of air within a system of airways or an apparatus.

**airflow retarder**

material or construction which adequately impedes transmission of air under specified conditions. Compare structural barrier; water-vapor retarder.

**air gas ratio**

ratio of the air volume to the gas volume. A specified ratio is necessary to achieve a desired character of combustion.

**air handling unit**

device, usually connected to ductwork, to move air, which also may clean and condition the air. See also ventilator.

**central-station air-handling unit**

factory-made, encased assembly consisting of the fan or fans and other necessary equipment, designed to perform one or more of the functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying, and mixing of air; does not include a source of heating or cooling.

**cooling-heating unit**

unit that includes means for cooling and heating, and which may also include means for other air-handling unit functions.

**cooling unit**

unit that includes means for cooling and which may also include means for other air-handling unit functions.

**heating unit**

unit that includes means for heating, and which may also include means for other air-handling unit functions.

**makeup air unit**

factory-assembled fan-heater unit used to supply tempered fresh air to make up for air exhausted. Centrifugal or axial fans are utilized with direct gas-fired, steam, electric, or water heater sections.

**ventilating unit**

unit with means to provide ventilation, and which may also include means for other air-handling unit functions.

**air heater, forced convection (unit heater)**

assembly of a heating element and a distribution fan.

**air horsepower**

air power expressed in horsepower.

**air infiltration (building)**

uncontrolled inward leakage of air (that may contain entrained water vapor) through cracks and interstices in any building element and around windows and doors of a building, caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density. See also specific infiltration.

**air inlet**

device or opening through which air is withdrawn from or discharged into a conditioned space (grilles, registers, diffusers, and slots may be used as air inlets). See also air supply fixtures.

**air inlet core area**

total plane area of the portion of a grille, face, or register bounded by a line tangent to the outer edges of the outer openings through which air can pass.

**air inlet free area**

1. total area through which air can pass in a grille face or register.
2. actual open area between the fins of a grille or register.

**air lock**

compartment whose purpose is to control air exchange into or out of a conditioned space. Two individual closures usually are used to restrict air transfer by keeping one of them closed.

**air main**

1. supply line from air compressor or central pressure-reducing station to branch feeder in a pneumatic control installation.
2. tube carrying the supply of compressed air to the components of a pneumatic control system.
3. pipe carrying air to the laterals supplying ice cans contained in a freezing tank.

**air mass**

totality of gas molecules in a defined volume of air.

**air mass ratio**

ratio of the mass of atmosphere in the actual earth-sun path to the mass which would exist at sea level if the sun were directly overhead.

**air motor**

1. device which converts compressed air into mechanical force.
2. air-operated device that is used primarily for opening or closing dampers.
3. pneumatic operator, a final control device that assumes a position as directed by an input-pressure signal.

**air outlet (distribution outlet)**

see also air inlet; air supply fixtures.

**ceiling outlet**

round, square, rectangular, or linear air diffuser in the ceiling which usually provides a horizontal distribution pattern of primary and secondary air over the occupied zone and induces low velocity secondary air motion through the zone.

**nozzle outlet**

discharge opening suitably shaped to produce a jet of air or other fluid, of regular form and given throw.

**slotted outlet**

long, narrow air distribution outlet, comprised of deflecting members, located in the ceiling, side-wall, or sill, with an aspect ratio greater than 10, designed to distribute supply air in several directions and planes, and arranged to promote mixing of primary air and secondary room air.

**vane outlet**

register, or grille, equipped with vanes to direct the flow of air, or control the rate of flow.

**air pollution concentration****olf**

unit for quantifying the source strength of air pollution. One olf is the emission rate of air pollutants (bioeffluents) from a standard person.

**decipol**

unit for quantifying perceived air pollution. One decipol is the pollution caused by one standard person (one olf), ventilated by 10 L/s of unpolluted air [1 decipol = 0.1 olf (L/s)].

**air power (operational)**

power required to move air at a given rate of flow against a given resistance. The ratio of air power to input power of a fan or blower is termed "efficiency."

**air power (theoretical)**

power required to drive a fan or blower as though there were no losses in the fan or blower (100% efficiency).

**air separation (air fractionation)**

separation of the various components of air through distillation at very low temperature.

**air separation unit**

device used to remove air from another fluid stream. See also purge.

**air spread**

divergence of an airstream after it leaves an outlet.

**air splitter**

blade or blades fitted across an air duct to divide the airstream into a number of streams in parallel. See turning vane.

**air supply fixtures**

devices or openings through which air flows into a room. See air outlet (inlet); diffuser; grille; perforated ceiling; register.

**air terminal device**

device (e.g., a grille) placed in a duct opening to a room, through which controlled air enters or leaves. See also terminal device; VAV box.

**air throw (blow)**

horizontal or vertical axis distance an airstream travels after leaving an air outlet before the stream velocity is reduced to a specific, so-called terminal value.

**air tightness**

qualitative term describing the integrity of the building envelope relative to air permeation; the resistance of the building envelope to the flow of air and entrained moisture. Compare air infiltration.

**air transport factor**

ratio of the rate of useful, sensible heat removal from the conditioned space to the energy input to the supply and return fan motor(s), expressed in consistent units and within designated operating conditions. See load, heating.

**air velocity**

rate of motion of air in a given direction, measured as distance per unit time. See also velocity.

**face air velocity (frontal velocity)**

axial velocity of the air entering or leaving a given effective face area.

**air vent**

manual or automatic device for removing air from circulating hot or chilled water systems; also used for removing air from steam systems.

**air washer**

unit for spraying or atomizing clean water into an air supply system; capable of heating, cooling, humidifying, or dehumidifying the air, depending on whether the water is heated or chilled. See scrubber.

**capillary air washer**

enclosure with an assembly of cells packed with fibrous materials over which water is sprayed and through which air is passed to clean it.

**spray-type air washer**

enclosure in which water is sprayed by nozzles into the airstream to wash it.

**alarm**

1. signal, either audible or visual or both, which alerts an operator to an off-normal condition which requires some form of corrective action.
2. off-normal condition such as a pressure, temperature, etc., that has deviated above or below an established operating range.

**maintenance alarm**

alarm designed to alert operating personnel that maintenance is required.

**alarm point**

that point in the range of a variable which is the threshold of an off-normal condition.

**albedo**

ratio of reflected solar radiation from a surface and the incident solar radiation. See also reflectance.

**algae**

minute freshwater plants which form a scum on the surfaces of recirculated water apparatus, interfering with fluid flow and heat transfer.

**algaecide**

any substance inhibiting the growth of algae.

**algorithm**

prescribed set of well-defined rules, or process, for the solution of a problem in a finite number of steps, e.g., a full statement of an arithmetical procedure for evaluating sine  $x$  to a stated precision.

**alpha K factor**

effective area of an air terminal, equal to the measured airflow rate divided by the velocity reading of a particular instrument used in a prescribed manner.

**ambient air conditions**

characteristics of the environment, for example, temperature, relative humidity, pressure, motion.

**ampacity**

ability of a wire to carry electric current safely without undue heating. Formerly current capacity.

**ampere (A)**

unit of electric current.

**full-load amperes**

1. current that a rotating machine will draw from the power line when the machine is operating at rated voltage, speed, and torque.
2. current in amperes through a device when at maximum demand. Not to be confused with inrush amperes (at start-up) or stall amperes (work exceeds rating).

**amplifier**

1. circuit used to increase the power, voltage, and/or current level of a signal.
2. device whose output is an enlarged reproduction of the essential features of an input signal and which draws power from a source other than the input signal.
3. device that enables an input signal to control power from a source independent of the signal and thus be capable of delivering an output that bears some relationship to, and is generally greater than, the input signal.

**analog display**

1. display of analog data values.
2. display of a physical variable in a continuous form.

**analog indication**

analog display; e.g., a meter, or gage, which shows an analog value to an operator.

**analyzer**

device in the high side of an absorption system for increasing concentration of refrigerant in the vapor entering the rectifier or condenser.

**anechoic termination**

device placed at the end of a test duct to prevent excessive reflection of the sound waves back into the test duct where they would interfere with the waves to be measured.

**anemometer**

device to sense and measure velocity of airflow at a point.

**acoustic anemometer**

device to sense velocity of air at a point by use of the Doppler effect on the velocity of sound. It may also sense temperature.

**cup anemometer**

device with several (often hemispherical) cups attached to the ends of symmetrical radial arms that rotate by air motion (wind) at a speed proportional to the wind velocity.

**deflecting-vane anemometer**

device containing a pivoted vane that rotates within its casing from the force of air moving through the casing so that the indicated tension in a coil spring, with damping, is related to the velocity of the air at that instant; useful in evaluating air velocities in a room and indicating sources of drafts.

**digital anemometer**

generally a revolving vane anemometer the shaft of which provides impulses (electric, magnetic, etc.) which are picked up by an electronic circuit and transmitted to the indicating apparatus.

**electronic anemometer**

device sensitive to air movement past an electronic circuit to measure air velocity.

**mechanical anemometer**

mechanical instrument which directly measures air velocity; a device which is sensitive to air movement with a calibrated airspeed measuring dial.

**revolving vane anemometer**

device consisting of rotating propeller-type vanes; the air velocity is indicated from the rotational speed of the vanes.

**thermal anemometer**

device that relies on the cooling effect of the airflow to change the temperature of a heated body in proportion to the airspeed. Types include hot-wire anemometer, heated bulb thermometer, heated thermocouple anemometer, and heated thermistor anemometer.

**aneroid capsule**

thin, disc-shaped box or capsule, usually metallic, partially evacuated and sealed, held extended by a spring, which expands and contracts with changes in atmospheric or gas pressure.

**angle of discharge**

largest included angle between centerlines of principal jets of primary air.

**angle of incidence**

angle between the direct solar irradiance and the normal to the aperture plane.

**anion**

ion that is negatively charged; e.g., chloride, silicate, sulfate. Compare cation.

**annealing**

1. process involving controlled heating and subsequent controlled, generally slow, cooling; applied usually to induce ductility in metals.
2. treatment intended to remove internal stresses, alter mechanical or physical properties, produce a definite microstructure, and remove gases.

**annunciation**

1. an "alert" to an operator. Not to be confused with alarm, the operator is informed of a change in a system. This change could require an alarm but not necessarily.
2. displaying of a condition by a visual or audible means.

**anode**

positive electrode in an electrolytic system, such as applied in cathodic protection. The electrode at which oxidation or corrosion occurs, or from which the current is transmitted to the electrolyte. Compare cathode.

**ANSI**

American National Standards Institute.

**antibiotic**

substance produced by a living organism (*i.e.*, fungi, bacteria) that inhibits the growth of, or kills, another living organism. Compare bactericide.

**APLV**

application part-load value. See part-load value.

**appliance**

piece of equipment that draws electric or other energy and produces a desired work-saving or other result, such as an electronic range, a radio, or an air conditioner.

**outdoor appliance**

unit intended for installation out-of-doors; equipped with a weatherized jacket and integral venting means, and labeled for outdoor installation.

**space heating/water heating combination appliance**

unit designed to provide space heating and water heating from a single primary energy source.

**appliance vent connector**

portion of the venting system that connects the gas appliance or its draft hood to the chimney or vent terminal.

**appliance vent pipe**

passage or conduit in a direct vent or direct exhaust system through which gases pass from the combustion chamber to the outdoor air.

**application**

act of putting to a special use or purpose.

**application rating**

rating based on tests performed at stated application conditions other than standard rating conditions.

**approach**

1. in heat exchangers, temperature difference between the leaving fluids.
2. in a water cooling tower or evaporative cooling device, the difference between the average temperature of the circulating water leaving the device and the average wet-bulb temperature of the entering air.

**appurtenance**

an accessory. See also fan appurtenance.

**architectural area (of a building)**

the sum of the areas of the several floors of the building, including basements, mezzanine and intermediate floored tiers, and penthouses of headroom height, measured from the exterior faces of exterior walls or from the centerline of walls separating buildings. *Note:* Discretion is advised in calculating areas of interstitial space; covered walkways, open roofed-over areas that are paved, porches, and similar spaces shall have the architectural area multiplied by an area factor of 0.50; the architectural area does not include such features as pipe trenches, exterior terraces or steps, chimneys, and roof overhangs. Compare gross floor area.

**architectural volume (of a building)**

(cube or cubage) the sum of the products of the architectural areas (using the area of a single story for multistory portions having the same area on each floor) and the height from the underside of the lowest floor construction system to the average height of the surface of the finished roof above for the various parts of the building.

**ARI**

Air-Conditioning and Refrigeration Institute.

**artificial intelligence (AI)**

capability of a device to perform functions that normally are associated with human intelligence, such as reasoning, learning, and self-improvement. See also expert system; knowledge base system; neural-network computers.

**ASCII**

American Standard Code for Information Interchange.

**ASHRAE**

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

**ASHRAE atmospheric dust spot efficiency**

measure of the ability of a device to remove atmospheric dust from the test air.

**ASHRAE arrestance**

measure of the ability of a device to remove ASHRAE atmospheric dust from test air.

**ASHRAE synthetic arrestance dust**

compounded test dust used for arrestance measurement and for loading filters.

**aspect ratio**

1. in any rectangular configuration, the ratio of the longer dimension to the shorter.
2. ratio of the length to width of a rectangular air duct.

**aspiration**

production of movement in a fluid by suction created by fluid velocity. See also venturi.

**ASTM**

American Society for Testing and Materials.

**athermouir barrier**

substance or space that does not allow the passage of radiant heat.

**atmosphere of reference**

reference atmosphere, the characteristics of which are defined by standards for given purposes.

**atmospheric dust**

particulate matter naturally occurring in the air supplied to the test duct. See also air contaminant.

**atomize**

*verb.* to create a fine spray from a liquid.

**authority (of a controller)**

ratio of effect on a manipulated variable of one input signal as compared to that of another.

**automation**

1. implementation of process by automatic means.
2. theory, art, or technique of making a process more automatic.
3. investigation, design, development, and application of methods of rendering processes automatic, self-moving, or self-controlling.

**auxiliary air**

supply or supplemental air delivered to a laboratory fume hood to reduce room air consumption.

**available energy**

synonym for energy.

**average specific infiltration**

value of the specific infiltration that is typical for an average climate in the United States or Canada.

**azeotropic point**

temperature at which a liquid mixture boils and produces a vapor having the same composition as the liquid.

**backflow**

reverse flow in a water system from the normal or intended direction. *Note:* Backflow generally is more evident in an open water system.

**backflow preventer (BFP)**

device designed to prevent reverse flow in a water system. *Note:* Term normally used where back pressure-type backflow is implied.

**double-check valve (DCV) backflow preventer**

device designed for continuous or intermittent pressure where pollutants are involved.

**double-detector check (DDC) backflow preventer**

device designed to serve also as a detector check on fire-protection systems where pollutants are involved. *Note:* DDC includes a line-size, approved double-check valve backflow preventer with a metered bypass, into which has been incorporated a three-quarter inch, approved double-check valve backflow preventer.

**dual-check (DuC) backflow preventer**

device designed for containing water system to residences, mobile homes, etc., as a second line of defense, and for isolating residential systems, such as lawn sprinkler systems, where pollutants are involved.

**intermediate-atmospheric vent (IAV) backflow preventer**

small back-pressure and back siphonage-type backflow-prevention device designed to operate under continuous pressure, for use where certain quasi-contaminants are involved.

**reduced pressure zone (RPZ) backflow preventer**

back pressure and back siphonage-type device designed to operate under continuous pressure, where contaminants are involved.

**reduced pressure-detector check (RPDC)**

back-pressure and back siphonage-type device designed to serve as a detector check on fire-protection systems where contaminants are involved. *Note:* RPDC includes a line-size approved, reduced pressure zone backflow preventer with a metered bypass, into which has been incorporated a three-quarter inch, approved reduced pressure zone backflow preventer.

**backflow prevention**

program, ordinance, or code designed to prevent backflow into a potable water system; and to discover, to eliminate, to prevent all uncontrolled cross-connections, existing or potential.

**cross-connection control backflow prevention**

(first line of defense) installation of a backflow preventer, or a vacuum breaker, at each cross-connection on a premises, to protect both premises system and the main system.

**containment backflow prevention** (second line of defense)

installation of a backflow preventer at the service connection to a premises, to protect the main water system only.

**backflow-prevention device specialist**

person qualified and certified to test and to repair backflow-prevention devices, and who has proved competency to the applicable regulatory agency(s).

**backflow-prevention device tester**

person qualified and certified to test, but not to repair, backflow-prevention devices, and who has proved competency to the applicable regulatory agency(s).

**back pressure**

increase in pressure in a consumer water system, or a branch, above the pressure at the service connection. *Note:* Back pressure generally is caused by pumps, thermal expansion, or reasons other than reduction or loss of incoming pressure. It generally is more evident in a closed water system.

**back siphonage**

reverse flow in a water system caused by negative pressure in an incoming pipe, when the point of use is at atmospheric pressure. *Note:* Back-siphonage generally is more evident in an open water system.

**back-siphonage preventer**

device, installed in a water system, designed to prevent reverse flow where negative supply pressure occurs.

**bacterial decay**

food deterioration caused by microorganisms.

**bactericide**

chemical or physical agent capable of killing bacteria.

**bacteriostatic**

property of a substance capable of inhibiting the growth of bacteria by causing bacteria to form aggregations, without killing them.

**baffle**

surface, usually in the form of a plate or wall, used for separating spaces or deflecting fluids.

**refrigerator baffle**

plate, wall, or partition, which is designed to perform one or more of the following functions: (1) prevent contact of food with refrigerated surfaces; (2) prevent dripping of condensate on food; (3) regulate and/or direct circulation of refrigerated air.

**balancer**

person or firm which performs testing, adjusting, and balancing work on ventilation systems.

**balancing station**

assembly to measure and control fluid flow; composed of a measuring device, a volume control device, and recommended lengths of straight ductwork or pipe leading into and out of the measuring device.

**ballast**

electrical device used with an electric-discharge lamp to obtain the necessary circuit conditions (voltage, current, waveform) for starting and operating.

**ballast factor**

ratio of commercial electric ballast lamp lumens to a reference ballast lamp lumens, used to correct the lamp lumen output from rated to actual.

**ballast losses**

electric power (watts) consumed internally by the ballast components.

**barometer**

device for measuring atmospheric pressure.

**aneroid barometer**

barometer in which the pointer is driven by a capsule containing no liquid. See aneroid capsule.

**barometric effect**

variations in barometric pressure caused by altitude or weather changes.

**BAS**

building automation system. See system.

**base unit power density ( $P_b$ )**

maximum allowed power density, in  $W/ft^2$ , for the listed areas/activities of an ideal space prior to area factor adjustment.

**bearing**

machine part in which another part (as a journal or pin) turns or slides.

**footstep bearing**

thrust bearing used to support the lower end of a vertical shaft.

**needle bearing**

type of roller bearing in which rod-like rollers have small diameters relative to their lengths.

**pedestal bearing**

separate bearing mounted in a pedestal and located adjacent to a reciprocating compressor to provide support, e.g., for an overhung flywheel.

**roller bearing**

bearing consisting of a number of rollers in a cage between the inner and outer races.

**sleeve bearing**

bearing consisting of one or more solid tubular pieces of material of low coefficient of friction.

**thrust bearing**

bearing designed to withstand an axial load. Compare thrust collar.

**bellows**

1. flexible corrugated chamber which converts pressure variation into mechanical movement.
2. flexible fluid-containing vessel that will expand or contract as a result of a change in the pressure of the contained fluid. Can be used to transmit force and/or motion in a pneumatic or hydraulic system or as a sensor of temperature or pressure when the bellows is sealed.

**bias**

tendency of an estimate to deviate in one direction from a true value (a systematic error). See error. Compare precision.

**bimetallic element**

actuating element consisting of two strips of metal with different coefficients of thermal expansion attached so that internal strains caused by temperature changes bend the compound strip to open or close contacts, or a pneumatic device.

**bin**

in the bin method, a statistical class or category (sometimes class interval) for outdoor air temperature, with the class limits expressed in a temperature unit.

**bin method**

energy calculation method, usually used in prediction, in which the annual (or monthly) energy use of a building is calculated as the sum of the energy used for all of the outdoor temperature bins. The bin method allows heat pump (or other heater or cooler) performance, which is different for each bin, to be accounted for.

**binary**

characteristic or property involving a selection, choice, or condition in which there are two possibilities (as binary numbers in a computer, on-off, or open-closed switch position).

**blackbody**

1. body that absorbs all the radiant energy falling on it.
2. body that has the maximum theoretical radiant energy emittance at a given temperature. See also absorber.

**blast area ratio**

blast area divided by the fan outlet area.

**blast gate**

heavy-duty duct closure device.

**bleeder**

pipe attached to a unit, as a condenser, to bleed off liquid refrigerant parallel to main flow.

**blowdown**

1. discharge of water from a steam boiler or open recirculating system that contains high total dissolved solids. The addition of makeup water will reduce the concentration of dissolved solids to minimize their precipitation.
2. in pressure-relief devices, the difference between actuation pressure of a pressure-relief valve, and reseating pressure, expressed as a percentage of set pressure, or in pressure units.

**boiler**

vessel in which a liquid is heated with or without vaporization; boiling need not occur.

**cast-iron sectional boiler**

assembly of individual hollow cast-iron sections connected with push nipples, external headers, or internal seals.

**fire-tube boiler**

boiler with straight tubes surrounded by water through which tubes pass the products of combustion.

**high-pressure boiler**

1. boiler for generating steam at pressure in excess of 15 psig [103.4 kPa (gage)].
2. hot-water boiler intended for operation at pressures exceeding 160 psig [1100 kPa (gage)] and/or temperatures exceeding 250°F (120°C).

**hot water supply boiler**

boiler completely filled with water that furnishes hot water to be used externally to itself at pressures not exceeding 160 psig or at temperatures not exceeding 250°F (120°C) at or near the boiler outlet.

**low-pressure boiler (steam or hot water)**

electric, gas, or oil-burning appliance designed to supply low-pressure steam or hot water for space heating application. A low-pressure steam boiler operates at or below 15 psig [103 kPa (gage)] steam pressure; a hot water boiler operates at or below 160 psig [1100 kPa (gage)] water pressure and 250°F (120°C) water temperature.

**modular boiler**

boiler designed and constructed to include increments of capacity as required for the installation.

**packaged boiler**

boiler shipped complete with heating equipment, mechanical draft equipment, automatic controls, and accessories; usually shipped in one or more major sections.

**Scotch boiler**

fire-tube boiler consisting of a cylindrical shell with one or more cylindrical internal furnaces in the lower portion, and a bank of tubes attached to both end closures.

**steam boiler**

enclosed vessel in which water is converted into steam.

**water-tube boiler**

boiler in which tubes contain water and steam, with heat applied to their outside surfaces.

**boiler-burner unit**

boiler designed especially for gas and oil and sold integrally with the burner.

**boiler capacity**

design maximum rate of heat output.

**boiler crown sheet**

part of a boiler forming the top of the furnace in a firebox boiler, or the equivalent surface in other types.

**boiler feedwater**

water supplied to a boiler by pumping.

**boiler feedwater heater**

apparatus for raising the temperature of the boiler feedwater, usually with exhaust steam.

**boiler foaming**

carryover of slugs of water into the piping from overloading of the boiler. Compare boiler priming.

**boiler generator**

part of an absorption machine in which the refrigerant vapor is driven off by heat.

**boiler heating surface**

surfaces of the boiler which are exposed to the products of combustion on one side and water on the other, expressed in area units (of the side receiving the heat).

**boiler horsepower**

equivalent evaporation of 34.5 lb. of water per hour from and at 212°F. This is equal to heat output of  $970.3 \times 34.5 = 33,475$  Btu/h, approximately 9809.5 W.

**boiler priming**

carryover of boiler water with the steam, due to insufficient steam space, faulty boiler design, or operating conditions. Compare foaming.

**boiler rating**

design maximum rating of a steam or water boiler expressed as the total heat transferred by the heating surfaces in Btu/h. Sometimes expressed in horsepower or pounds of steam per hour.

**boiler water leg**

space which contains water, between the outer shell and furnace shell.

**boiler waterline**

level at which water is maintained within a steam boiler.

**boiler water temperature control**

device which senses boiler water temperature and controls boiler burner operation.

**boiling (ebullition) process**

vaporization of a liquid with formation of bubbles.

**nucleate boiling**

boiling in which bubble formation is at the liquid-solid interface rather than from external or mechanical devices.

**pool boiling**

ebullition on a heated surface in contact with a liquid mass which is not agitated except by the process itself.

**boil-off gas**

liquefied gas lost by vaporization during storage in a tank.

**bolometer**

sensitive thermal device for measuring radiant energy.

**bonding (electrical ground)**

connection to ground potential of a metal part on an appliance or component which may become energized by an electrical fault, or develop a static charge.

**booster**

accessory to increase output of, for example, a compressor or a pump, or a header.

**boot**

sheet metal transformation piece used to make connection between round and rectangular ductwork.

**bore**

inside diameter of a hollow cylinder or of a hole.

**boundary conditions**

physical conditions (values of physical quantities, conditions of energy interchange, etc.) imposed on a system at the boundaries separating the system from its surroundings.

**boundary layer**

region of retarded fluid-flow near the surface of a body moving through the fluid, or past which the fluid moves. See also flow (boundary layer flow).

**brake horsepower**

brake power expressed in horsepower.

**brake power**

actual power delivered by or to a shaft (from the use of a brake to measure power).

**branch**

1. in ducts, piping, or conduit; another section of the same size or smaller, at an angle with the main.
2. section of pipe from a main to a register or radiator.
3. (computer) a set of instructions that are executed between two successive decision instructions.

**branch circuit**

electrical wiring between the last overcurrent protection device and the connected outlets.

**branch line**

air supply line connecting a controller and controlled device.

**braze**

*verb.* to join metals by fusion of nonferrous alloys that have melting points above 800°F (425°C), but lower than those of the metals being joined. May be accomplished by means of a torch (torch brazing), in a furnace (furnace brazing), or by dipping in a molten flux bath (dip or flux brazing).

**brazed**

*adj.* joined by fusion using a spelter of brass; considered equivalent to hard soldering.

**breaker**

1. breaker strip, a relatively poor conductor of heat used to join the inner and outer shell of an internally refrigerated container such as a refrigerator.
2. device designed to interrupt the current of an electrical circuit during an overcurrent condition and also used as a disconnecting means for a load.

**breather plug**

removable plug, cap, or other means of venting a space containing insulating material through vaportight sheathing.

**breeching**

passage for conducting the products of combustion from a fuel-fired appliance to a vent or chimney.

**brine**

1. formerly any liquid cooled by a refrigerant and used for heat transmission without a change in its state, having no flash point or a flash point above 150°F (66°C). Now called a secondary coolant.
2. secondary coolant that is a solution of salt in water. (ASME B31.5). See coolant.

**British thermal unit (Btu) (an I-P unit)**

heat energy in a Btu. Related through specific heat to the International Table calorie so that  $1 \text{ cal}/(\text{kg}\cdot\text{K}) = 1 \text{ Btu}/\text{lb}\cdot^\circ\text{F}$  for  $1 \text{ lb} = 453.592 \text{ g}$ . The Fifth International Conference on the Properties of Steam (1956) defined the International Table calorie as 4.1868 J. Therefore, the International Table Btu is exactly  $1.05505585262 \text{ J}$ . The mechanical equivalent energy of a Btu is approximately 778.169 262 ft·lb. The heat energy of a Btu is approximately that required to raise the temperature of a pound of water from 59 to 60°F.

**Btuh**

properly, Btu/h; but an obsolete term.

**buffer**

1. (computer) digital circuit element used to increase fan-out (the number of outputs a circuit can drive) or to convert input or output levels for signal level compatibility. Also, any isolating amplifier stage.

2. salts or other compounds that reduce the changes on the pH of a solution upon the addition of an acid or alkali.
3. storage device used to compensate for a difference in rate of flow or data or time or occurrence of events when transmitting data from one device to another.
4. insulating circuit used to avoid reaction of a drive circuit on any driven circuit.

**leakage area**

equivalent amount of open area (assuming unit discharge coefficient) that would let pass the same quantity of air as would pass collectively through the building envelope at a reference pressure of 4 Pa (ft<sup>2</sup>) [m<sup>2</sup>] (0.016 in. water).

**leakage class**

one of ten divisions of airtightness based on normalized leakage.

**neutral pressure level**

(neutral zone) building height at which there is no difference between inside and outside building air pressure.

**normalized leakage**

dimensionless value calculated from the leakage area, building height, and floor area that describes the relative airtightness of the building.

**building area**

area included within surrounding exterior walls (or exterior walls and fire walls/area separation walls) exclusive of courts. The area of the building not provided with surrounding walls is the usable area under the horizontal projection of the roof or floor above. Compare architectural area.

**building envelope**

outer elements of a building, including walls, windows, doors, roofs, and floors, including those in contact with earth.

**building thermal envelope**

elements of a building which enclose spaces, and which control or regulate heat and mass transfer (air, water vapor, and entrained moisture) between the interior spaces and the building exterior. *Note:* The interior surfaces of insulated floors, walls, windows, and ceilings generally comprise the thermal envelope. Compare thermal envelope. See air infiltration.

**building envelope opaque areas**

all exposed areas of a building envelope which enclose space, except openings for windows, skylights, doors, and building service systems; *i.e.*, all areas of a building envelope which permit passage of radiant energy in or out of the building space.

**building envelope void**

any localized area of the building envelope which has a thermal resistance significantly different from the area surrounding it. The void may be due to partial or complete absence of thermal insulation.

**building height**

vertical distance from level grade or average grade to the highest finish roof surface in the case of flat roofs, or to a point at the average height of the highest roof having a pitch.

**building management system (electric)**

energy management system, usually with additional capabilities, relating to the overall operation of the building in which it is installed, such as equipment monitoring, protection of equipment against power failure, building security, etc.

**building power-line carrier (PLC)**

method of transmitting control signals using existing electrical wiring. Signals are introduced by superimposing on, or altering, existing waveforms. Signals are sensed by detecting these modifications of the waveforms with a remotely controlled receiver. A building PLC uses relatively low communication energy of low radio frequency, generally between 100 and 500 kilohertz, to transmit and/or receive information exclusively over secondary distribution lines whose primary purpose is the distribution of electric power at user facility.

**building project**

building or group of buildings proposed or under construction, including on-site energy conversion or electric-generating facilities, which utilize a single submittal for construction permit or are within the boundary of a contiguous area under one ownership.

**building services**

utilities supplied and distributed within a building, such as electricity, gas, steam, telephone, and water.

**building volume**

[of a building that exchanges air with the outside (ambient) air (cubic feet or cubic metres)] space that is deliberately conditioned for human comfort. See also architectural volume.

**bulb**

1. glass envelope used in the assembly of an electric lamp or electron tube.
2. portion of a thermal-sensing system that is placed in the controlled (or measured) variable.
3. in botany, a modified underground stem, such as that of an onion or tulip. *Note:* Some bulbs are treated and stored in refrigerated conditions.

**bunker**

space in refrigerator for ice or cooling element.

**dry-ice bunker**

in a refrigerated vehicle, a compartment containing dry ice to keep the load cooled.

**refrigerated truck end bunker (end-bunker refrigerated railcar)**

a refrigerated vehicle, where the space given to the ice or cooling element is in the end of the truck or rail car.

**burner**

part of a fuel-burning device (as a stove or furnace) where flame is produced.

**air atomizing burner**

burner in which the oil is atomized by compressed air which is forced into and through one or more streams of oil, breaking the oil into a fine spray.

**atmospheric burner**

gas burner in which air for combustion is supplied by natural draft and the inspirating force created by gas velocity through orifices.

**conversion burner**

burner intended for field installation which changes the fuel of an existing furnace or boiler.

**dual fuel burner**

burner designed to burn either gas or oil but not both simultaneously.

**forced draft burner**

burner which has a fan capable of supplying all necessary air for proper combustion with positive pressure in the firebox.

**intermittent ignition burner**

burner for which ignition is supplied initially to start, not continually, and at timed intervals so long as combustion is required.

**mechanical atomizing burner**

burner supplied with fuel oil under pressure, causing self-atomization.

**natural-draft burner**

burner which depends primarily on the natural draft created in the chimney or venting system to induce the air required for combustion into the burner.

**rotary-atomizing burner (rotary cup burner)**

burner in which atomization is accomplished by feeding oil to the inside of a rapidly rotating cup.

**steam-atomizing burner**

burner in which the firing oil is atomized by steam.

**vaporizing burner**

burner designed to utilize the temperature of the heated combustion chamber to vaporize the liquid fuel fed into such chamber.

**burner flame failure response time**

interval between the occurrence of flame extinction and the activation of safety shutoffs.

**burner ignition**

1. initiation of combustion.
2. process or means of igniting a fuel-air mixture.

**intermittent burner ignition**

ignition source that is automatically ignited or energized when an appliance is called on to operate, and that remains continuously ignited or energized during each period of main burner operation (ANSI *Standard Z 21.13*).

**interrupted burner ignition**

ignition source that is automatically ignited or energized when an appliance is called on to operate, and that remains ignited or energized during the main flame-establishing period. The ignition source is automatically extinguished or deenergized when each main burner flame-establishing period is completed (ANSI *Z 21.13*).

**burner low-fire setting**

setting that determines the fuel firing rate at which burner ignition occurs where low-high-low-off, or modulating combustion controls are used. The firing rate corresponds to approximately one-third or less of the full burner delivery rate for rotary burners. It corresponds to approximately one-fifth or less of the full burner delivery rate of air for mechanical atomizing burners.

**burner register**

series of air-directing vanes (usually adjustable) that are used to direct and/or control the combustion airflow through the burner.

**burner throat**

sleeve, usually formed of refractory, located at the burner exit, within which combustion starts.

**burner window box**

device to introduce secondary combustion air into the furnace in a 360° pattern around the flame and, with an ignition cone, to cause accelerated vaporization of the oil.

**bus (electrical)**

common portion of one or more conductors used for transmitting signals or power from one or more sources to one or more destinations.

**bypass**

pipe or duct, usually controlled by a valve or damper, for conveying a fluid around an element of a system.

**CAD (computer-aided design)**

system in which engineering designs are created graphically on the computer screen, or in the form of a computer printout.

**CAD/CAM**

parts design and manufacturing method utilizing a computer data base where drawings are not needed. Synonymous with computer-integrated manufacturing.

**CADD**

computer-aided design and drafting.

**calculated variable**

1. variable that cannot actually be measured directly, but one which can be calculated by measuring other variables. *Example:* Measure wet-bulb temperature and measure dry-bulb temperature to determine enthalpy.
2. variable which is calculated from one or more inputs.

**calibration**

correcting or determining the error of an existing scale, or of evaluating one quantity in terms of readings of another.

**calorie**

heat required to raise the temperature of 1 gram of water 1°C; specifically from 4 to 5°C. The Fifth International Conference on the Properties of Steam (1956) defined the International Table calorie as 4.1868 J. Mean calorie = 1/100 part of the heat required to raise 1 gram of water from 0 to 100°C. Great calorie or kilocalorie = 1000 calories.

**calorimeter**

1. device for measuring heat quantities, such as machine capacity, combustion heat, specific heat, vital heat, heat leakage, etc.
2. device for measuring quality (or moisture content) of steam or other vapor.
3. equipment for measuring emitted or absorbed heat quantities.

**compressor calorimeter**

apparatus for determining the refrigerant flow rate, and subsequently, the capacity of a refrigerant compressor by measuring the heat input required to balance the refrigerating effect produced in the evaporator by the compressor.

**condensing unit calorimeter**

apparatus for determining refrigerant flow rate, and subsequently the capacity of a condensing unit by measuring the heat input required to balance the refrigerating effect produced in the evaporator by the condensing unit.

**room calorimeter**

1. generally, a room used for the measurement of quantities of heat energy.
2. test facility for small air conditioners, consisting of two contiguous calorimeters with a common partition through which the air conditioner to be tested is mounted.

**CAM (computer-aided manufacture)**

system in which a computer directs the manufacture and assembly of a product.

**canopy**

covered area that extends from a wall of a building, protecting an entrance or a loading dock.

**capacitance**

property of an electric device or capacitor that permits storage of electric energy in an electrostatic field, and the release of that energy at a later time.

**capacitor (condenser)**

in an alternating electrical system, a device that will store an electric charge used to change a power factor.

**capacity**

1. maximum load for which a machine, apparatus, device, or system is designed or constructed.
2. measure of the maximum amount of energy or material that may be stored in a given system. See also nameplate rating; air-conditioner capacity; instantaneous capacity; integrated thermal storage capacity.

**gross capacity**

load (uncorrected) that a machine, apparatus, device, or system is designed to carry.

**net capacity (effective capacity)**

1. capacity (volume) of a room after deducting the loss of space due to coils, columns, air ducts, dunnage, and other dedicated space required to provide air circulation.
2. (equipment) maximum load that a machine, apparatus, device, or system is capable of carrying under service conditions.

**capacity factor (of a machine, equipment, or thermal storage)**

ratio of the average load required, in the time considered, to the capacity in mass, volume, or energy terms. Reciprocal of storage factor.

**capacity reducer**

in a compressor, a device, such as a clearance pocket, movable cylinder head, or suction bypass, by which compressor capacity can be adjusted without otherwise changing the operating conditions.

**capillarity**

action by which the surface of a liquid in contact with a solid (as in a small bore tube) is raised or lowered proportional to surface wetting.

**carbonation**

absorption of injected CO<sub>2</sub> into a liquid, usually preceded or accompanied by liquid cooling.

**carbonator**

apparatus for injecting CO<sub>2</sub> into water for preparing carbonated beverages.

**carbonization**

formation of carbonaceous deposits which may be produced by decomposition of lubricating oil or other organic materials.

**cargo**

freight carried by a ship, airplane, or other vehicle.

**chilled cargo**

cargo maintained at an assigned cold temperature above its freezing point.

**dry cargo**

unrefrigerated cargo.

**refrigerated cargo**

cargo maintained at an assigned temperature by means of refrigeration.

**cargo batten**

series of protection members applied permanently to the interior of a refrigerated compartment to provide airspace between the stowed cargo and the sides of the compartment.

**cargo dunnage**

strips of wood or other suitable material used in stowing cargo to provide airspaces between pieces, packages, or between them and walls and floors.

**Carnot cycle**

ideal reversible thermodynamic cycle comprising two isothermal processes and two adiabatic processes. The cycle represents the maximum theoretical conversion of heat energy into mechanical energy. Compare reverse Carnot cycle. See second law of thermodynamics.

**carrier frequency**

1. in a periodic carrier, the reciprocal of its period. *Note:* The frequency of a periodic pulse carrier often is called the pulse repetition frequency in a signal transmission system.
2. (modulated amplifier) the frequency that is used to modulate the input signal for amplification.

**cathode**

negative electrode in an electrolytic system; e.g.,  $\text{Fe}^{++}$ ,  $\text{Cu}^{++}$ ,  $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ . Compare anode.

**cathode-ray tube (CRT)**

1. electronic vacuum tube containing a screen on which information may be shown by modulated beam of electrons (a beam of cathode rays).
2. electronic storage tube.
3. oscilloscope tube.
4. picture tube.

**cathodic protection**

technique to minimize corrosion of a metal surface by coating the cathodic surface of an electrochemical cell.

**cation**

positively charged atom or group of atoms, or a radical that moves to the negative pole (cathode) during electrolysis. Compare anion.

**cavitation**

1. formation of cavities on a surface of a solid by liquid moving over it with velocity high enough to induce erosion of the surface when the cavity collapses.
2. formation by mechanical forces of vapor in liquids; specifically, the formation of vapor cavities in the interior or on the solid boundaries of liquids in motion, where the pressure is reduced to a critical value without a change in ambient temperature.

**CDD**

cooling degree-day.

**ceiling**

overhead interior lining of a room. See false ceiling; suspended ceiling.

**cell (in a cooling tower)**

smallest tower subdivision which can function as an independent heat exchange unit. It is bounded by exterior walls or partitions. Each cell may have one or more fans or stacks and one or more distribution systems.

**central processor**

data processor which compiles, processes, and stores information gathered from peripheral field gear.

**centrifuge**

device for separating substances of different densities by centrifugal force.

**CER**

cooling efficiency ratio.

**C factor (thermal conductance)**

time rate of steady-state heat flow through a unit area of a material or construction induced by a unit temperature difference between the body surfaces.  $C = q/\Delta T$ .

**CFC**

chlorofluorocarbon.

**cfm**

cubic feet per minute.

**cfs**

cubic feet per second.

**changeover**

1. change from one set of controls to another.
2. change from heating to cooling, or vice versa.

**automatic changeover**

changeover from one operation to another without operator intervention; e.g., a thermostat which changes from heat to cool without need for manual operation of levers or set points.

**manual changeover**

changeover from one operation to another by means of operator intervention.

**semiautomatic changeover**

selection of heating or cooling operation by means of a combination of manual and automatic switches, which usually are located at the room thermostat.

**channel**

1. output of a load-management system; usually corresponding to a specific relay.
2. (computer) path along which signals can be sent, e.g., data channel, output channel.
3. portion of a storage medium that is accessible to a given reading station, e.g., track, band.

**charge (thermal storage)**

*verb.* to supply cooling or heating to storage.

**load-leveling**

charging a thermal storage system at a constant rate during a complete cycle.

**charging connection**

device to enable a refrigerating system to be charged with refrigerant. Also, the tube or hose through which charging is accomplished.

**chill**

*verb.* to apply refrigeration moderately to products without freezing them.

**chiller**

1. refrigerating machine used to transfer heat between fluids.
2. complete, indirect refrigerating system of compressor, condenser, and evaporator with all operating and safety controls.

**absorption chiller**

refrigerating machine using heat energy and absorption input to generate chilled water.

**mechanical chiller**

refrigerating machine using mechanical energy input to generate chilled water.

**spin chiller**

rotary-type chiller for poultry, in which the birds are conveyed and tumbled in ice water.

**chiller barrel**

shell-and-tube evaporator used to cool water or a secondary coolant. *Note:* Term applies only to water-chilling packages, not to heat exchangers.

**chiller drip tray**

drawer located directly beneath the refrigerated surfaces of a manual or semiautomatic defrosting refrigerator for food chilling and/or water collecting during defrosting. It may also serve as a baffle to regulate compartment temperature.

**chiller drip tray volume**

product of the mean inside width and length of the tray and the mean height between the inside bottom of the tray and the outside bottom of the surface of the refrigerated plate or coil when the tray is in its lowest position.

**chill factor (wind chill factor)**

temperature of relatively calm (4 mph or 6.4 km/h) air that would produce the same chill effect on bare flesh as the combination of wind and temperature.

**chilling (cooling)**

process of lowering of the temperature of a substance to a specific temperature above freezing. See supercooling; superchilling.

**contact icing**

process of chilling in which finely crushed ice is placed in contact directly with the product in its unpacked or packed state.

**chilling injury**

cold injury to foodstuff (produce) occurring at temperatures above the freezing point.

**chilling room**

room refrigerated to chill a product without freezing it.

**chimney**

one or more passageways, vertical or nearly so, for conveying flue gases to the outside atmosphere.

**low-temperature chimney**

one intended to handle the products of combustion with a temperature at the point of leaving equipment, of 600°F (315°C) or less under normal operating conditions.

**medium-temperature chimney**

one intended to handle the products of combustion, at the point of leaving equipment, with a temperature between 600 to 1000°F (320 to 540°C) under normal operating conditions.

**chlorofluorocarbon (CFC)**

generally any of several compounds comprised of carbon, fluorine, chlorine, and hydrogen, used chiefly as refrigerants and as blowing agents in plastic foams. Compare fluorocarbon; halocarbon.

**fully halogenated chlorofluorocarbon**

CFC compound in which all of the hydrogen atoms are replaced by chlorine and fluorine atoms.

**circuit**

1. complete path of an electric current in or into a building, including usually the source of electric energy.
2. assemblage of electronic components.

**duplex circuit**

1. circuit that has two separate sources of supply.
2. pair of circuits with either one usable when failure occurs in the other.

**four-wire circuit**

1. two-way circuit using two paths so arranged that the electric waves are transmitted in one direction only by one path and in the other direction only by the other path.  
*Note:* The transmission paths may or may not use four wires.
2. circuit that is fed from both ends of the line and enables any device to transmit back with a single break in both conductors.

**refrigeration circuit**

assembly of refrigerant-containing parts used in a refrigerating cycle.

**simplex circuit**

1. circuit derived from a pair of wires by using the wires in parallel with a ground return.
2. single circuit.

**two-wire circuit**

metallic circuit formed by two adjacent conductors insulated from each other. It is possible to use the two conductors as a one-way transmission path, a half duplex path, or a full duplex path.

**circulator**

a pump.

**clean room**

specially constructed, enclosed area environmentally controlled with respect to airborne particulates, temperature, humidity, air pressure, air pressure flow patterns, air motion, vibration, viable organisms, and lighting.

**as-built clean room**

one that is complete and ready for operation, with all services connected and functional, but without production equipment or personnel within the room.

**at-rest clean room**

one that is complete and has the production equipment installed and operating, but without personnel within the room.

**conventional flow clean room**

one with non-unidirectional or mixed airflow patterns and velocities.

**laminar flow clean room**

one having airflow nominally in one direction.

**operational clean room**

one in normal operation with all services functioning, and with production equipment and personnel present and performing normal work functions.

**clean room critical surface**

in a clean room, the surface of the work part to be protected from particulate contamination.

**clean room workstation**

open or closed work surface in a clean room, with direct air supply.

**laminar flow workstation**

one with airflow nominally in one direction through the work area.

**nonlaminar flow workstation**

one without uniform airflow patterns and velocities.

**clean space**

in a clean room, a defined area in which the concentration of airborne particles is controlled within specified limits.

**clearance**

1. space in a cylinder not occupied by the piston at the end of the compression stroke or the volume of gas remaining in a cylinder at the same point, measured in percentage of cylinder volume at the end of the expansion stroke.
2. clearance for maintenance or repair; the distance between the item requiring maintenance and the closest interfering surface.

**clearance volume**

space existing between the cylinder head and the top of the piston after completion of compression stroke.

**CLF**

cooling load factor.

**clo**

non-SI unit of clothing insulation, defined as the thermal insulation necessary to keep a sitting person comfortable in normally ventilated room at 70°F (21°C) and 50% relative humidity. In physical terms, the thermal resistance of one clo =  $.88^{\circ}\text{F}\cdot\text{ft}^2\cdot\text{h}/\text{Btu}$  ( $0.155 \text{ K}\cdot\text{m}^2/\text{W}$ ).

**clock**

1. device that generates periodic signals used for synchronization.
2. device that measures and indicates time.
3. equipment that provides a time basis for a transmission system to control the timing of certain functions, such as the duration of signal elements, sampling, etc.

**closed process**

series of changes of state in a system at the termination of which the system is reverted to its original state.

**coal**

black to brownish-black combustible solid formed by the decomposition of ancient vegetation in the absence of air, under the influence of biochemical action, moisture, pressure, and heat.

**anthracite coal**

dense, hard coal with a very high percentage of fixed carbon, usually above 90%.

**bituminous coal**

soft coal containing from 10 to 20% hydrocarbons yielding pitch or tar when distilled.

**lignite coal**

soft coal having a bed moisture of 30 to 45%, non-caking and non-coking.

**coaxial cable (coax)**

specially constructed single or multiconductor cable which provides shielding from electrostatic fields.

**coefficient**

1. (mathematics) number or letter, especially the former, put before a mathematical expression to indicate that the expression is to be multiplied by that number; as in the expression,  $4ab$ , 4 is the coefficient of  $ab$ ; in  $4abx$ ,  $4ab$  is the coefficient of  $x$ .
2. (physics) number indicating the degree of a quality possessed by a substance, either always or under fixed conditions; as, the coefficient of expansion of iron.  
*Examples:* **coefficient of expansion**, a number that, when multiplied into the number expressing the rise of temperature, gives the resulting expansion of a body; **coefficient of friction**, a number that, when multiplied into the number expressing the pressure between two bodies, gives the resulting friction; **coefficient of restitution**, a fraction that, when multiplied into the relative velocity of two colliding bodies just before impact, gives their relative velocity just afterward; **differential coefficient**, ratio of the infinitesimal increase of a function to that of a variable on which the function depends; a derivative.

**coefficient of discharge**

ratio of the net area at vena contracta of air flowing through an orifice to the total free area of the opening.

**coefficient of performance (COP)**

1. ratio of the rate of net heat output to the total energy input expressed in consistent units and under designated rating conditions.
2. ratio of the refrigerating capacity to the work absorbed by the compressor per unit time.

**cogeneration**

sequential production of either electrical or mechanical power and useful thermal energy (heating or cooling) from a single energy form. See also electric power cogeneration.

**coil**

cooling or heating element made of pipe or tube that may or may not be finned, formed into helical or serpentine shape.

**blast coil**

heat transfer surface, most frequently of an extended surface arrangement, over which air is blown to be heated or cooled, depending on the temperature of the fluid within the coil.

**ceiling coil (ceiling grid; overhead coil)**

heating or cooling coil fitted in the ceiling of a room or space.

**condenser coil**

condenser constructed of pipe or tubing, not enclosed in a pressure vessel.

**cooling coil**

coil that uses refrigerant or secondary coolant to provide cooling, or cooling with dehumidification.

**desuperheating coil**

heat exchanger, preceding the condenser or incorporated in it, for removing all or part of the superheat.

**direct expansion coil**

coil used in direct refrigerating method.

**domestic water coil**

coil of tubing within a boiler to heat potable water for household use; usually a hot water tank is used for hot water storage.

**drier coil**

additional length of pipe or coil added to direct expansion evaporator in order to provide superheat at thermostatic expansion valve sensing bulb without using evaporator tubing.

**evaporator coil**

evaporator constructed of pipe or tubing not enclosed in a pressure vessel.

**expansion coil**

evaporator constructed of pipe, plate, or tubing.

**heating coil**

coil that uses a heat transfer fluid, condensing refrigerant, or direct electrical resistance elements to provide heating.

**holdover coil**

apparatus to store cold by fusion of ice or eutectic on a refrigerated coil.

**pipe coil**

cooling or heating element made of pipe or tubing (more particularly made from one or more bent pipes).

**preheat coil**

heating coil installed upstream of cooling coil, or at the front of an air-handling system to preheat air.

**reheat coil**

heating coil installed downstream of cooling coil.

**wall coil (wall grid)**

cooling coil fitted in a wall of a room or a space.

**coil deck**

insulated horizontal partition between refrigerated space and bunker.

**coil depth**

number of rows of the tubes in the direction of airflow.

**coil face area**

product of the length and width of the coil face.

**coil height**

dimension of the vertical face of the coil as installed, including only the height over tubes and fins exposed to the flow of air. *Note:* Some steam coils have vertical tubes.

**coil length**

dimension of the face of the coil in the direction of the bare tubes or finned tubes, or both, exposed to the flow of air.

**coil width**

dimension of the face of the coil exposed to the flow of air perpendicular to the direction of the tubes.

**coke**

solid substance remaining after the partial burning of coal in an oven distillation or in a retort.

**Colburn mass transfer equation**

dimensionless mass transfer equation consisting of the Sherwood number divided by the Reynolds number and the Schmidt number to the 1/3 power. The symbol is  $j_D$ .

**Colburn heat transfer equation**

dimensionless heat transfer equation used in calculating natural convection movement of heat from vertical surfaces or horizontal cylinders to fluids (gases or liquids) flowing past these surfaces. The symbol is  $j_H$ .

**cold box**

in a gas separation unit, the insulated section which contains the low-temperature heat exchangers and distillation columns.

**cold chain**

continuity of means successively employed to provide the refrigerated preservation of perishable foodstuffs from the production to the consumption stage.

**cold injury (low-temperature injury)**

storage at a temperature below which physiological disorder in produce will manifest itself. This temperature will vary with the produce.

**cold room (cold chamber)**

insulated structure served by a refrigerating system.

**jacketed cold room**

cold room which is entirely surrounded by insulated cavities or corridors in which cold air is circulated.

**sectional cold room**

cold room constructed from factory prefabricated insulated sections which are assembled on-site.

## **cold room doors**

### **cold room flexible door**

two-way push-through type door made of thick plastic sheeting.

### **cold room flush-fitting (infitting) door**

door that does not protrude beyond the face of the wall.

### **cold room sliding door**

single or multiple door that is movable laterally, usually in guides.

### **cold room swinging door**

door pivoting on a vertical axis and which can be either pulled or pushed open.

## **cold room door dike**

projection on the door which extends into the refrigerated compartment(s) and which functions primarily as a barrier to minimize heat flow to the interior of the cabinet.

## **cold shrink fitting**

process for assembling two precision-machined parts by cooling the inner member so that it can be inserted into the outer member; the members fit tightly together when both are at the same temperature.

## **cold storage**

trade or process of preserving perishables by refrigeration.

## **cold storage disease (storage disorder)**

injury to produce occurring during storage.

## **cold storage locker**

cold storage establishment containing food storage boxes or lockers for individual users.

## **cold storage room**

cold room designed to receive and store produce sometimes already cooled down to approximately the desired storage temperature.

## **cold store**

refrigerated warehouse.

### **dispatching cold store**

one sited in or near a consumption center, serving as a holding depot prior to the distribution of foodstuffs.

### **high-rise cold store**

single-story store, which is too high for normal forklift truck operation and which contains some other form of load lifting mechanism.

### **multipurpose cold store**

one which can stock all kinds of perishable goods generally at different temperatures.

### **multistory cold store**

one in which the rooms are located on several floors.

### **single-story cold store**

one in which all the rooms are located at ground or loading dock level.

### **specialized cold store**

one used for storing one kind of perishable goods only.

## **cold store facility (cold store complex; cold store combine)**

warehouses and food processing plants grouped with a central refrigerating installation.

## **cold trap**

apparatus in which the walls are cooled in order to condense and trap vapors; can be used to reduce pressure.

**colloidal particle**

particles dispersed in a medium and having a state of subdivision, at least in one direction, in dimension roughly between 1 nm and 1  $\mu\text{m}$ .

**color rendition**

effect of a light source on the color appearance of an object, in a conscious or unconscious comparison with the color appearance observed under a reference light source, usually daylight.

**combustible gas (or vapor) detector**

instrument for determining concentration of combustible gas or vapor.

**combustion**

chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light either as a glow or flame.

**incomplete combustion**

burning with an insufficient supply of air so the burning substance is only partially consumed and could have been burned further with additional air supply. See stoichiometric reaction.

**perfect combustion**

fuel burning condition in which all combustibles are consumed with no excess air so that only the theoretical amount of oxygen is used.

**combustion chamber**

enclosure, with or without lines or baffles, into which fuel or gaseous derivatives of fuel are discharged so that combustion can occur.

**combustion control**

device or series of devices that control the flow of fuel and combustion air in the desired ratio to provide efficient combustion.

**full-modulation combustion control**

adjustment of the fuel rate and air-fuel mixture ratio, in response to heating load and the temperature and excess air condition of the flue gas, over the full range of the burner capacity from some preset minimum to 100%.

**combustion detector**

part of primary safety control which is responsive directly to flame properties.

**combustion products**

effluents from the combustion of a fuel including the inerts, but excluding excess air.

**combustion (gas) tests**

sampling of combustion products to determine the percentage of constituents and their temperature.

**combustion volume**

space provided for the burning of fuel.

**comfort chart**

chart showing operative temperatures with dry-bulb temperatures, relative humidities, and air motion by which the effects of the various conditions on human comfort may be compared.

**comfort index**

index combining the properties of an environment for evaluating the sensation of comfort of occupants; equal to 15 plus 0.4 times the sum of the dry-bulb and wet-bulb temperatures in degrees Fahrenheit. See also thermal comfort.

**commissioning (of an installation)**

process for achieving, verifying, and documenting the performance of buildings to meet the operational needs of the building within the capabilities of the design and to meet the design documentation and the owner's functional criteria, including preparation of operator personnel.

**commissioning authority**

qualified person, company, or agency that plans and carries out the overall commissioning process.

**commissioning plan**

overall document, usually prepared by the commissioning authority, which outlines the organization, scheduling, allocation of resources, documentation, etc., pertaining to the overall commissioning process.

**communications-based system**

energy management system in which a computer is the central controlling device.

**compliance**

act of complying with the rules or requirements of a standard.

**certified compliance**

demonstrated compliance as judged by an agency or authority not within ASHRAE.

**compound compression**

compression which is accomplished by stages as in two or more cylinders in series.

**compressibility**

1. relative variation of the departure from the perfect gas laws.
2. ease with which a fluid may be reduced in volume by the application of pressure. It depends on the state of the fluid as well as the type of the fluid itself.

**coefficient of compressibility (compressibility factor)**

coefficient required to correct the perfect gas equation when applied to real gases.

**compression**

process by which the pressure of a gas is increased by reducing its volume.

**adiabatic compression**

compression of a gas during which no heat is exchanged with the surroundings.

**dry compression**

compression of initially dry saturated or superheated vapor.

**dual compression**

compression of refrigerant entering a single cylinder from two sources at different suction pressures.

**multistage compression**

compression in two or more stages; usually the low stage compressor discharges to the suction of a higher stage compressor.

**polytropic compression**

compression of a fluid involving heat exchange with temperature change and temperature variation (not isothermal).

**single-stage compression**

compression from evaporator to condenser pressure by passing through one compressor stage only.

**wet compression**

compression of vapor that initially is not saturated or superheated.

**compression ratio**

ratio of the absolute pressure after compression to the absolute pressure before compression.

**compression stage**

each part at compression whereby the total compression of a gas is accomplished by several compressors in series to reduce the compression ratio for each stage.

**compression stroke**

that movement of a piston in a compressor cylinder during which the gas is compressed and discharged.

**compression volume ratio**

ratio of volume of compression chamber at intake of gas to volume at discharge in positive displacement compressors.

**compressor**

1. device for mechanically increasing the pressure of a gas.
2. specific machine, with or without accessories, for compressing refrigerant vapor (ASME *Standard* B31.5).

**axial-flow compressor**

turbocompressor in which the compressed fluid flows generally in a direction parallel to the axis of rotation.

**booster compressor**

compressor for raising the pressure of a gas delivered to a following compressor.

**centrifugal compressor**

nonpositive displacement compressor which depends for pressure rise, at least in part, on centrifugal forces. A turbocompressor.

**closed crankcase compressor**

one in which the crankcase is completely sealed from the atmosphere, but connected with the low-pressure side of the system.

**compound compressor**

compressor in which compression is accomplished by stages, as in two or more cylinders.

**diaphragm compressor**

type of oil-free compressor in which flexion of a diaphragm creates compression.

**double-acting compressor**

compressor which has two compression strokes per revolution of crankshaft per cylinder, *i.e.*, both faces of the piston are working faces.

**double-suction compressor**

split suction valving arrangement on compressor for carrying two suction pressures.

**dry-piston compressor**

type of oil-free compressor in which no lubricating oil is used in the cylinder; the piston is usually equipped with low friction labyrinth rings.

**dual-effect compressor**

compressor in which the cylinders have an additional suction inlet partway along the compression stroke which enables refrigerant to be drawn in at two different suction pressures.

**flexible-shaft centrifugal compressor**

impeller and shaft are a one-piece assembly, the latter of a small diameter so that it can flex and spontaneously balance the inertial forces resulting from rotation.

**multistage compressor**

compressor in which compression is accomplished in more than two stages in separate cylinders.

**multivane rotary compressor**

sliding vane compressor with several vanes, sliding in slots in the rotor, and maintaining continuous contact with the inner periphery of the fixed casing.

**non-positive displacement compressor**

rotary compressor in which the compression is obtained without reduction of internal volume of the compression chamber.

**oil-free compressor**

compressor in which no oil is used in the compression chamber. See dry piston compressor.

**open-type compressor**

refrigerant compressor with a shaft or other moving part extending through its casing to be driven by an outside source of power, thus requiring a shaft seal or equivalent rubbing contact between fixed and moving parts.

**positive displacement compressor**

machine that increases the pressure of refrigerant vapor by reducing the volume of the compression chamber through work applied to the mechanism.

**reciprocating compressor**

positive-displacement compressor in which the change in internal volume of the compression chamber(s) is accomplished by the reciprocating motion of one or more pistons.

**return flow compressor**

compressor in which the suction valve is located in the cylinder head of the compressor.

**rolling piston compressor**

special type of small rotary compressor having a rotor aligned eccentrically within the stator, used in domestic refrigerators.

**rotary compressor**

positive displacement compressor in which the change in internal volume of the compression chamber(s) is accomplished by the rotary motion of a positive displacement member(s).

**screw compressor**

rotary compressor relying on the intermeshing of two helical rotors to produce compression.

**scroll compressor**

positive-displacement compressor in which the reduction in internal volume of the compression chamber is accomplished by an orbiting scroll (involute spiral) within a mating stationary scroll.

**sealed unit compressor (hermetic compressor)**

motor-compressor assembly having the compressor contained within a gas-tight casing through which no shaft extends. Drive is usually by a motor within the same casing but may be induced by external means.

**semihermetic compressor**

compressor directly coupled to an electric motor and contained within a gas-tight bolted casing.

**single-acting compressor**

compressor having one compression stroke per revolution of the crank for each cylinder.

**single-vane rotary compressor**

sliding vane compressor with one vane, sliding in a slot in the fixed casing, maintaining continuous contact with the rotor, and separating the suction and the delivery ports.

**sliding vane compressor**

rotary compressor having a rotor aligned eccentrically within a cylindrical housing, with one or several vanes located in slots in the rotor or in the housing.

**stepped piston compound compressor (differential piston compressor)**

single-acting compressor for compound operation, the lower stage of which is compressed in a chamber in which the larger diameter of the stepped piston moves and the higher stage is compressed in a chamber in which the smaller diameter of the piston moves.

**stiff shaft centrifugal compressor**

impeller and the shaft are a one-piece assembly with the shaft of large diameter so that it cannot flex.

**subsonic compressor**

turbocompressor in which the speed of fluid flow is subsonic in all parts of the compressor.

**supersonic compressor**

turbocompressor in which the fluid flow, in certain parts of the machine, attains supersonic velocity.

**swash plate compressor (wobble plate compressor)**

compressor in which the pistons move parallel to the crankshaft, actuated by a cam or by a plate mounted axially on the shaft and inclined to it.

**tandem compressor (dual compressor)**

1. two compressors driven by the same motor mounted on the same base or frame.
2. assembly of two semihermetic compressor units having a common suction chamber.

**turbocompressor**

turbine-driven compressor, usually a centrifugal compressor.

**twin-cylinder compressor**

reciprocating compressor with two identical operating cylinders.

**uniflow compressor**

compressor in which the suction gas passes through the piston.

**vertical compressor**

compressor with a vertical cylinder or, in small sizes, with a vertical crankshaft.

**compressor capacity (refrigerating)**

design maximum rate of heat removal by the refrigerant assigned to the compressor in a refrigerating system. This is equal to the product of the mass rate of refrigerant flow produced by the compressor and the difference in specific enthalpies of the refrigerant vapor at its thermodynamic state entering the compressor and the refrigerant liquid at saturation temperature corresponding to the pressure of the vapor leaving the compressor.

**compressor capacity reducer**

device, such as a clearance pocket, movable cylinder head, or suction bypass, by which compressor capacity can be adjusted without otherwise changing the operating conditions.

**compressor clearance pocket**

space of controlled volume to give the effect of greater or less cylinder clearance, thereby changing compressor capacity.

**compressor discharge**

that part of the compressor at the high-pressure side.

**compressor discharge stroke**

that part of the piston stroke between the opening of the discharge valve and the top dead center.

**compressor displacement**

actual volume of gas or vapor at compressor inlet conditions moved by a compressor, per revolution or per unit of time. Compare piston displacement.

**compressor economizing**

process whereby a side port in the compressor (usually a screw compressor or multiwheel centrifugal compressor) is used to provide refrigerant sub-cooling, resulting in an improvement in overall system efficiency.

**compressor heating effect (heat pump)**

rate of heat delivery by the refrigerant assigned to the compressor in a heat pump system; equal to the product of the mass rate of refrigerant flow produced by the compressor and the difference in specific enthalpies of the refrigerant vapor at thermodynamic state leaving the compressor and saturated liquid refrigerant at the pressure of the vapor leaving the compressor.

**compressor motor, sealed (hermetic type)**

compressor and motor enclosed in the same housing without external shaft or shaft seals, with the motor operating in the refrigerant.

**compressor oil return**

transport of oil from the evaporator to the compressor.

**compressor piston displacement**

volume swept by a piston during one stroke, or one revolution of the crankshaft.

**compressor refrigerating effect**

rate of heat removal by the refrigerant assigned to the compressor in a refrigerating system. This is equal to the product of the mass rate of refrigerant flow produced by the compressor and the difference in specific enthalpies of the refrigerant vapor at its thermodynamic state entering the compressor and refrigerant liquid at saturation temperature corresponding to the pressure of the vapor leaving the compressor.

**compressor starting****no-load start (unloaded start)**

practice of starting a compressor after equalizing pressures in high- and low-side pressures.

**compressor unloader**

1. device on or in a compressor for equalizing the high- and low-side pressures for a brief period during starting in order to decrease the starting load on the motor.
2. device for controlling compressor capacity by rendering one or more cylinders ineffective.

**compressor surge**

condition achieved in a centrifugal compressor when the momentum of the refrigerant gas through the compressor is insufficient to overcome the thermal lift requirement. Direction of flow temporarily reverses through the compressor until the lift requirement decreases. The condition repeats until the operating condition is corrected. Accelerated wear and damage can eventually result.

**compressor theoretical displacement**

total volume swept by the working strokes of all the pistons of a compressor per revolution of the crankshaft or per unit of time.

**compressor unit**

a refrigerating component designed to compress a specific refrigerant vapor, consisting of compressor, prime mover, and regularly furnished accessories.

**compressor volume ratio**

ratio of volume of compression chamber at intake of refrigerant gases to the volume at discharge in positive displacement compressors.

**compressor work**

mechanical energy required by, or load imparted to, the piston of a compressor or shaft of a centrifugal compressor.

**compressor work (theoretical)**

enthalpy difference along an isentrope.

**effective compressor work**

net work input absorbed at the shaft of a compressor, irrespective of time.

**indicated compressor work**

work equivalent of indicator card area for a reciprocating compressor or engine. See also indicator diagram.

**computer**

1. machine for carrying out calculations.
2. by extension, a machine for carrying out specified transformations on information.
3. stored program data-processing system.
4. device capable of solving problems by accepting data, and supplying the results of these operations. Various types of computers are calculators, digital computers, and analog computers.
5. in information processing, usually, an automatic stored program computer.

**computer based system**

energy management system in which a computer is the central controlling device.

**computer code**

set of symbols or abbreviations used to represent data.

**symbolic computer code**

code which expresses computer programs in source language, *i.e.*, by referring to storage locations and machine operations by symbolic names and addresses which are independent of their hardware-determined names and addresses.

**computer hardware**

physical entities such as computers, circuit boards, CRTs (cathode-ray tubes), and printers.

**computer input**

1. data to be processed.
2. state or sequence of states occurring on a specified input channel.
3. device or collective set of devices used for bringing data into another device.
4. channel for impressing a state on a device or logic element.
5. process of transferring data from an external storage to an internal storage.

**analog input**

1. a verifying quantity; e.g., pressure, voltage, or temperature, which can have any value between a minimum and a maximum, used as the initiating part of a control system.
2. input of a physical variable in a continuous form such as a voltage input to a voltmeter.

**computer memory**

general term for the computer equipment that holds information in any usually binary language in electrical, optical, or magnetic form. This equipment also receives information for storage and gives out the stored information for storage and later use. The word "memory" usually means storage inside the computer, while "storage" refers to optical and electrical media storage outside of the computer.

**electrically erasable programmable read-only memory (EEPROM)**

erasable in-socket (requires no batteries).

**erasable programmable read-only memory (EPROM)**

field erasable via exposure to ultraviolet light, and reprogrammable (requires no batteries).

**programmable read-only memory (PROM)**

not field-modifiable, nonvolatile (requires no batteries).

**random-access memory (RAM)**

memory providing access time that is independent of the address, and is addressable for both reading from and writing into memory.

**read-only memory (ROM)**

memory with stored data that can be read but not changed or written into.

**computer overflow**

1. condition that arises when the result of arithmetic operation exceeds the capacity of the storage space allotted in a digital computer.
2. digit arising from this condition if a mechanical or programmed indicator is included, otherwise the digit may be lost.

**computer printer**

device capable of producing printed copy.

**computer printout**

hard copy output of a printer.

**computer reset**

1. *verb.* to return a memory or storage element to its "standard" state, usually "0". Also called clear.
2. *verb.* to restore a storage device to a prescribed state, not necessarily that denoting zero.
3. computer-control state in which integrators are held inoperative and the proper initial condition voltages or charges are applied or reapplied.
4. *verb.* to place a binary cell into the "zero state."

**computer run**

performance of one program to its end on a computer thus the performance of one routine, or several routines linked so that they form an automatic operating unit during which manual manipulations by the computer operator may be zero or minimal.

**computer significant digit**

digit that contributes to the precision of an accurate numeral. The number of digits is counted beginning with the digit contributing the most value, called the "most significant digit," and ending with the one contributing the least value, called the "least significant digit."

**computer simulation**

1. computer-aided decision process in which proposals are tested in a computer before one or more of the proposals are considered for use.
2. (general) representation of an actual system by analogous characteristics of some device easier to construct, modify, or understand.
3. (physical) the use of a model of a physical system in which computing elements are used to represent some but not all of the subsystems.

**computer software**

1. programs and instructions put into a computer.
2. totality of programs and routines used to extend the capabilities of computers, such as compilers, assemblers, narrators, routines, and subroutines.

**computer software library**

1. general collection of software packages available for a particular data-processing system.
2. computer programs and called into a routine to perform a special assignment.

**computer sort**

*verb.* to arrange items of information according to rules dependent on a key or field contained in the items or records; e.g., to digital sort is to sort first the keys on the least significant digit, and to resort on each higher order digit until the items are sorted on the most significant digit.

**computer space**

1. site intended for the storage of data, e.g., a site on a printed page or a location in a storage medium.
2. basic unit of area, usually the size of a single character.
3. one or more blank characters.

4. *verb.* to advance the reading or display position according to a prescribed format, e.g., to advance the printing or display position horizontally to the right or vertically down.
5. open-circuit condition in a 5-level or 8-level (ASCII) signal code. Also the shift down in a frequency shift key (FSK) telemeter system.

**computer storage**

1. device into which data can be entered and from which it can be retrieved later.
2. loosely, any device that can store data.

**computer storage buffer**

1. element between two different forms of storage, usually between internal and external.
2. input device in which information is assembled from external or secondary storage and stored ready for transfer to internal storage.
3. output device into which information is copied from internal storage and held for transfer to secondary or external storage. Computation continues while transfers between buffer storage and secondary or internal storage or vice versa, take place.
4. device that stores information temporarily during data transfers. Clarified by buffer.

**computer subroutine**

1. in a routine, the set instructions that cause a computer to carry out a well-defined mathematical or logical operation.
2. routine which is part of a larger routine and whose action is dependent on findings or manipulations prior to reaching the subroutine.
3. subunit of a routine. A subroutine is often written in relative or symbolic coding even when the routine to which it belongs is not.
4. routine which is arranged so that control may be transferred to it from a master routine and so that, at the conclusion of the subroutine, control reverts to the master routine. Such a subroutine is usually called a "closed subroutine."
5. a single routine may simultaneously be both a subroutine with respect to another routine and a master routine with respect to a third. Usually control is transferred to a single subroutine for more than one place in the master routine; the reason for using the subroutine is to avoid having to repeat the same sequence of instructions in different places in the master routine.

**computer switch**

point in a programming routine at which two courses of action are possible, the correct one determined by a condition prevailing elsewhere in the routine or by a physical disposition of the system.

**computer time division multiplex**

1. device which samples all data input from different low-speed devices and retransmits all the samples in an equal amount of time.
2. process or device in which each modulating wave modulates a separate pulse subcarrier, the pulse subcarriers being spaced in time so that no two pulses occupy the same time interval. *Note:* Time division permits the transmission of two or more signals over a common path by using different time intervals for the transmission of the intelligence of each message signal.

**computer time sharing**

use of a device for two or more purposes during the same overall time interval; accomplished by interspersing component actions in time.

**concentration ratio**

1. ratio of the quantity of one constituent to the total mixture.
2. process in which the proportion of a substance is increased.

**condensate**

liquid formed by condensation of a vapor. In steam heating, water condensed from steam; in air conditioning, water extracted from air, as by condensation on the cooling coil.

**condensation**

change of state of a vapor into a liquid by extracting heat from the vapor.

**droplet condensation**

phenomenon encountered when the condensate does not wet the cold surface, but settles in the form of separate droplets.

**film-forming condensation**

phenomenon encountered when the condensate wets a cold surface to form a continuous film that separates this surface from the vapor.

**solid phase condensation**

direct formation of the solid phase by cooling a vapor below the triple point.

**condenser**

heat exchanger in which vapor is liquefied by the rejection of heat to a heat sink. See also condensing unit.

**air-cooled refrigerant condenser**

refrigerant condenser in which heat removal is accomplished entirely by heat absorption by the air flowing over condensing surfaces.

**air-cooled unit**

condensing unit which utilizes refrigerant-to-air heat transfer means.

**atmospheric condenser**

condenser in which the pipes in open air are cooled by water flowing over them.

**barometric condenser**

apparatus in which steam is condensed at reduced pressure by direct contact with water.

**coaxial condenser**

water-cooled condenser in which water and refrigerant flow in parallel paths but in opposite directions.

**double bundle condenser**

condenser that contains two separate tube bundles allowing the option of either rejecting the heat to the cooling tower or to another building system requiring heat input.

**double pipe condenser (tube-in-tube condenser)**

condenser constructed of concentric tubes in which the refrigerant circulates through the annular space and the cooling medium through the inner tube.

**evaporative condenser**

condenser in which the removal of heat from the refrigerant is achieved by the evaporation of water from the exterior of the condensing surface, induced by the forced circulation of air and sensible cooling by the air.

**multishell condenser**

condenser consisting of a number of closed shell-and-tube units.

**natural convection condenser**

condenser cooled by natural circulation of atmospheric air.

**open shell-and-tube condenser**

condenser in which the water passes in a film over the inner surfaces of the tubes, which are open to the atmosphere.

**plate-type condenser**

1. air-cooled condenser consisting of plates between which are arranged channels for the circulation of refrigerant.
2. water-cooled condenser consisting of a coil through which the refrigerant circulates, arranged between two plates, water circulating between coil and plates.

**receiver condenser**

water-cooled condenser comprising a shell with the bottom located below the heat-exchanging elements to form a receiver; in principle designed to hold the entire refrigerant charge of the installation.

**secondary condenser**

condenser cooled by the evaporator of a secondary system.

**shell-and-coil condenser**

condenser in which the cooling medium circulates in a coil located in a shell containing the condensing refrigerant.

**shell-and-tube condenser**

condenser consisting of an outer shell containing multiple tubes.

**split condenser**

condenser comprising several heat exchanging components operating on one or several refrigeration systems.

**submerged coil condenser (submerged condenser)**

condenser in which the piping is submerged in a vessel containing cooling water.

**tube-in-tube condenser**

condenser consisting of a tube inserted in a second tube in a helical coil, serpentine coil, or parallel tubes.

**water-cooled condenser**

condenser in which heat of the refrigerant is removed by water flowing over condensing surfaces.

**water-cooled units**

condensing units which transfer heat from the refrigerant to water.

**condenser heat-rejection effect (condenser duty)**

amount of heat energy rejected to its surroundings by a condenser.

**condensing unit**

machine specifically designed to condense refrigerant vapor to a liquid by compressing the vapor in a positive-displacement compressor and rejecting heat to a cooling medium. The unit consists usually of one or more positive-displacement compressors, motors, condensers, liquid receivers (when required), and necessary accessories, mounted on a common base.

**hermetically sealed condensing unit**

sealed compressor unit in which the housing is permanently sealed by welding or brazing and is not provided with means of access for servicing internal parts in the field.

**sealed condensing unit**

mechanical compressor unit in which the compressor and compressor motor are enclosed in the same housing with no external shaft or shaft seal, and the compressor motor operating in the refrigerant atmosphere.

**service-sealed condensing unit**

sealed compressor unit in which the housing is sealed by one or more gaskets, and means of access are provided for servicing internal parts in the field.

**condensing unit capacity****condensing unit refrigerating effect**

rate of heat removal by the refrigerant assigned to the condensing unit in a refrigerating system. This is equal to the product of the mass rate of refrigerant flow produced by the condensing unit and the difference in the specific enthalpies of the refrigerant vapor entering the unit at a specified superheat, and the refrigerant liquid leaving the unit at a specified subcooling.

**conditioned floor area**

horizontal projection of interior space within exterior walls that is conditioned directly or indirectly.

**conditioned space**

space within a building provided with heated or cooled air, or both (or surfaces); and, where required, with humidification or dehumidification means, to maintain conditions for an acceptable thermal environment. Compare unconditioned space.

**condition line**

on a psychrometric chart the infinite number of wet- and dry-bulb temperatures which will satisfy the requirements of an air supply for a given room temperature.

**conductor**

1. substance or body capable of transmitting electricity, heat, etc.
2. substance or body that allows a current of electricity to pass continuously along it.
3. wire or combination of wires not insulated from one another, suitable for carrying an electric current.
4. portion of a lightning-protection system designed to carry the lightning discharge between air terminal and ground.

**conduit**

1. tube or pipe used for conveying fluid.
2. tube or pipe in which wires may be enclosed for protection.

**connecting rod**

part of a compressor that connects the piston to a crank used to interchange rotating motion and reciprocating motion.

**connection-in-parallel**

system in which flow is divided among two or more channels from a common starting point or header.

**connection-in-series**

system in which flow through two or more channels is in a single path entering each succeeding channel only after leaving the first or previous channel.

**consensus**

substantial agreement reached by concerned interests according to the judgment of a duly appointed authority after a concerted attempt at resolving objections. It implies much more than a simple majority, but not necessarily unanimity.

**consensus process**

procedures adopted by a standards-developing organization to reach consensus.

**consensus standard**

in ASHRAE, a standard developed by the consensus process reflecting a consensus of professional opinions of the members of a committee of balanced interests, with the support of other experts who review and comment on drafts during open public review.

**conservation of energy law**

see thermodynamics laws.

**constant**

mathematical value that does not change during a particular process.

**contact**

conducting part that coacts with another conducting part to complete or to interrupt a circuit.

**contact-closure input**

1. signal sent to the coil of a relay causing it to change the position of its contacts.
2. input in which the input device is a normally open contact which closes on operation.

**contactor**

electromagnetic switching device.  
container see thermal storage container.

**contaminants (refrigerating system)**

most important and universal contaminant is moisture. Other contaminants include dirt, waxes, metal particles, and organic materials such as acids, sludges, or other products of chemical reactions taking place while the system is operating. See also air contaminants; refrigerating system contaminants; water contaminants.

**contraction coefficient**

1. ratio of the minimum cross-sectional area of a jet of liquid discharging from an orifice, to the area of the orifice.
2. ratio of the net orifice of the vena contracta of a fluid flowing through an orifice, to the total free area of the opening.

**contractor**

in construction terminology, the person or entity responsible for performing the work and identified as such in an owner-contractor agreement.

**licensed contractor**

person or entity certified by governmental authority, where required by law, to engage in construction contracting.

**prime contractor**

contractor on a project having a contract directly with the owner.

**subcontractor**

person or entity who has a direct contract with the contractor to perform any of the work at the site.

**control/controller/control system**

1. device for regulation of a system or component in normal operation, manual or automatic. If automatic, the implication is that it is responsive to changes of pressure, temperature, or other variable whose magnitude is to be regulated.
2. (industrial) broadly, the methods and means of governing the performance of any apparatus, machine, or system; system governing the starting, stopping, direction of motion, acceleration, speed, and retardation of the moving member; designation of how the equipment is governed; *i.e.*, by an attendant, by automatic means, or partially by automatic means and partially by an attendant; frequently, one or more of the components in a mechanism responsible for interpreting and carrying out manually initiated directions.
3. *verb.* to execute the function of control as defined above.
4. in a digital computer, those parts that affect the retrieval of instructions, and the application of the proper signals to the arithmetic unit and other parts in accordance with this interpretation. Compare controller. See also thermostat.

**ambient-compensated control**

one designed to negate the effects of ambient conditions surrounding the body of the control, thereby not affecting the control output.

**anticipating control**

one which, by artificial means, is actuated sooner than it would be without such means to produce a smaller differential of the controlled variable.

**application-specific control**

digital controller dedicated to a specific application such as a VAV box or water-source heat pump.

**automatic sequence control**

one in which successive operations are carried out in a sequence either predetermined or resulting from the correct execution of each successive operation.

**capacity control (capacity regulator)**

1. variation of the quantity of refrigerant circulated by the compressor in order to vary the refrigerating capacity.
2. in a refrigerating compressor, a device by which capacity can be adjusted without otherwise changing the operating conditions.

**cascade control**

complex control system in which the set value of one or more controllers is altered by one or more controlling equipment devices.

**central control**

1. location from which more than one control action can be manipulated.  
Computerized data processors are not a prerequisite.
2. ability to control all functions from one central location, thereby enabling the operator to request and respond to all commands from one location.

**changeover control**

control used to change a system over from one mode of operation to another, using automatic or manual devices.

**closed loop control (feedback control)**

1. control system in which the effect of the control action on the controlled variable is sensed and used by the controller to provide a new output (feedback control).  
Compare open-loop control.
2. signal path which includes a forward path, a feedback path, and a summing point, and forms a closed circuit.

**combination control**

control device in which one or more control variables are being monitored, such as a combination high- and low-pressure control for a refrigerant system.

**cycling control**

control which functions by automatic cycling between desired limits as differentiated from a limit control and a continuous control.

**defrost control**

act of controlling the refrigerating cycle or heating cycle to periodically melt the unacceptable accumulation of ice on evaporator tubes, windows, etc.

**derivative control**

control action in which the output is based on the rate of change of the input.

**differential controller**

1. device used to maintain a given difference in pressure or temperature between two pipelines or spaces.
2. controller reactive to the difference between values of two variables.

**differential pressure control**

1. method of maintaining a given pressure difference in two pipelines or spaces.
2. device that maintains a set difference in pressure between two reference points.

**direct digital control (DDC)**

mode of control wherein digital outputs are used to control a process or element directly.

**dual-effect control**

device responsive to temperatures of two zones or to two variable conditions.

**dual-pressure control**

1. two pressure controls in one enclosure.
2. use of a single device to accomplish some form of pressure control at two distinct set points, such as a dual-pressure switch.
3. combined pressure regulating device, one part connected to the low-pressure side of the system and one part to the high-pressure side of the system, with a common switch mechanism.

**fixed-setting control**

control in which the set point cannot be altered.

**flame safeguard control**

system for sensing the presence or absence of flame and for indicating, alarming, or initiating control action.

**floating control**

mode of control in which the final control element moves at a predetermined rate in a corrective direction until the controller is satisfied or until a movement in the other direction is called for.

**flow control**

modulation of a fluid flow rate through a system of piping, ductwork, or variable devices.

**freeze-up control**

1. control device to prevent failure of a refrigerating system due to formation of ice at the expansion device or from frost formation on a coil.
2. thermostatic device that senses the approach of a freezing condition and takes corrective action.

**head pressure control**

pressure-operated control which opens an electrical circuit if the high side pressure on a refrigerating machine becomes excessive. Also called high-pressure cutout. See high-pressure control.

**high event control**

control action that occurs at the higher value of the activating variable being sensed.

**high-low control**

two-level action in which both levels are controlled within defined limits.

**high-pressure control**

pressure-responsive device which cycles and/or stages condensers, cooling tower fans, and pumps to control head pressure.

**humidity control (humidistat, hygrostat)**

device which responds directly or indirectly to deviation from a desired humidity by actuating a control or initiating a control sequence.

**ice-bank control**

control of the thickness of a bank of ice for off-peak cool storage; also for use with milk coolers and other refrigerating cabinets in which refrigerating capacity is stored by means of ice.

**limit control**

control device used to limit the desired maximum or minimum state of the controlled variable, or to provide an alarm if those limits are exceeded.

**low-pressure control**

1. pressure-responsive device actuated directly by refrigerant vapor pressure in the low side.
2. electric switch and pressure-responsive element connected into the suction side of a refrigerating system to control the operation of the system.

**master controller**

1. instrument whose variable output is used to change the set point of a submaster controller.
2. central device that develops corrective action, in response to the area control error, for execution at one or more generating units.
3. controller that contains the necessary circuits to operate slave controllers.

**modulating control**

method of control in which the output of the controller may vary infinitely over its range. Compare two-position control.

**numerical control**

control in which digital computers are used for the control of operations, particularly of automatic machines; e.g., drilling or boring machines, wherein the operation control is applied at discrete points in the operation or process.

**oil pressure cut-out (differential oil pressure switch; oil failure switch)**

safety device used to stop the compressor when the oil pressure reaches a preset, abnormally low value.

**oil temperature cutout**

safety device used to stop the compressor when the oil temperature reaches a preset, abnormally high value.

**open-loop control**

control system in which the effect of the control action is not felt by the sensed variable; e.g., outside air when it is used for reset. Compare closed-loop control.

**pneumatic electric control**

1. control device which interfaces pneumatic to electric systems.
2. control device with a pneumatic input and an electric output.

**pressure control**

device which responds directly or indirectly to deviation from a desired pressure by actuating a control or initiating a control sequence.

**process control**

1. control for automatic regulation of operations or processes, or both.
2. closed loop control as applied to processes or operations, or both. *Note:* HVAC systems may be considered as processes.

**programming control**

control system that provides for performing various operations in predetermined sequences related to time or other variables.

**remote control**

control of a device or system from a location other than at site of operation, using direct wire, carrier current, microwaves, supervisory control, or mechanical means.

**reset control (integral control; automatic reset)**

control method using a remote or external signal to modify the set point of a controller.

**safety (safety cut-out) control**

control that causes equipment to cease operation when adverse or excessive conditions occur.

**self-powered control (self-operated control; system-powered control)**

method of control which requires no external or auxiliary power supply.

**sequence control**

1. group of devices which act in series or in a time order.
2. operation of two or more final control elements in separate stages as opposed to unison.

**servo control**

mechanism which automatically actuates a system according to the variation of input. The device is designed so that a small input power controls a much larger output power.

**snap action control**

1. control that makes or breaks a circuit in a positive two-position manner.
2. mechanism operation requiring low operating forces, high repeat accuracy, and fast operating time.

**step controller**

multiple-switch assembly in which a moving element trips multiple output steps successively.

**submaster controller**

1. controller whose set point is automatically readjusted from a remote location over a predetermined range by variations in an applied signal from a master.
2. controller whose set point may be automatically reset at the command of either a conventional or master controller.

**temperature controller**

device which responds directly or indirectly to deviation from a desired temperature by actuating a control or initiating a control sequence.

**two-position control**

control that is either ON or OFF (or OPEN/CLOSED or some similar pair of states). Compare modulating control.

**control action (of a controller or a controlling system)**

nature of the change of the output produced by the input.

**creep action**

slow make/break action of a switch mechanism in a controller, as differentiated from snap action or toggle action.

**snap action**

response of a switch to very small movements of its actuating button or lever, changing rapidly and positively from one contact position to the other. See also snap-action control under control.

**toggle action**

action of a switch to change to an alternate contact position as in a flip-flop.

**control channel**

communication link that carries electrical signals directing performance of a digital system but does not carry main power.

**control detecting element**

in a control measuring unit, the element which responds directly to, or senses, the variable to be measured.

**control device**

individual device used to execute a control function.

**control element (final)**

mechanism that directly acts to change the value of the controlled variable.

**control functions**

processes of maintaining building environmental conditions by HVAC systems.

**controlled atmosphere storage (gas storage; CA storage)**

in food storage rooms, the addition of carbon dioxide to the atmosphere, particularly in large concentrations, with no attempt to regulate the amount of oxygen.

**controlled device**

one that receives a signal from a controller and acts on the process plant to vary its operating condition in accordance with the information received. In HVAC&R systems, controlled devices typically are valves, dampers, and motors.

**controlled medium**

substance that is to be maintained at a specific value of temperature, concentration, or flow rate.

**controller**

device that accepts the sensed value of a variable, compares it with a set point to determine an error signal, and provides an output which is a result of that comparison. The output is sent to a controlled device but may also be used for rest or other purposes.

**controller error signal**

difference between the control point (actual value of the controlled variable) and the set point. This quantity may have a plus or minus sign.

**controller gain (gain of a controller)**

ratio of change in controller output to the change in the value of the sensed value.

**controller proportional band**

range of controller output as it goes from one extreme to the other.

**control concentration level (in a laboratory fume hood)**

average concentration of gas, parts of tracer gas per million parts of air by volume (ppm), that is not exceeded at the hood face at given release rate.

**control measuring element**

element used to measure the status of a controlled variable.

**control panel**

assembly of the indicating devices and remote control units required for the operation of a system.

**unit control panel (UCP)**

location where one or more accessory panels are grouped to serve a single remote system. Contains both accessory devices and local loop controls.

**control point**

value of a directly controlled variable at which the instrument is controlling. Set point plus offset is equal to control point.

**control power element**

actuator in an automatic control.

**control modes****derivative control mode**

one that contributes to the output of the controller an amount equal to the derivative of the error signal, multiplied by the derivative gain.

**integral control mode**

one that contributes to the output of the controller an amount equal to the integral of the error signal over time, multiplied by the integral gain.

**proportional control mode**

one that requires offset from the desired set point to move the controlled device through its proportional band.

**control point**

mean value of a controlled temperature maintained by a thermostat under specific operating conditions.

**convector**

surface designed to transfer its heat to a surrounding fluid largely or wholly by convection.

**conversion**

1. process of changing information from one form of representation to another, such as, from the language of one type of machine to that of another or from magnetic tape or disc to the printed page.
2. process of changing from one data-processing method to another, or from one type of equipment to another.

3. *verb.* to change from use of one fuel to another.

**cool**

*verb.* to remove heat, generally not below 30°F (−1°C). Compare refrigerate.

**coolant**

fluid used to transfer heat from one place to another. Compare refrigerant.

**brine**

secondary coolant consisting of a solution of a salt in water.

**primary coolant**

refrigerant used to lower the temperature of a secondary coolant.

**secondary coolant (secondary fluid)**

liquid used for the transmission of heat without a change of state, having no flash point, or a flash point above 150°F (65.6°C).

**cooled space**

space within a building provided with a positive cooling supply.

**cooler**

thermally insulated enclosure kept at a reduced temperature by a refrigeration. See also air cooler; cooling system.

**Baudelot cooler (falling film surface cooler)**

liquid cooler in which the liquid to be cooled passes by gravity over a refrigerated surface.

**brine cooler**

heat exchanger for cooling brine or other secondary coolant.

**chill-room cooler**

room refrigerated to chill the product without freezing it.

**cold-storage cooler**

insulated room maintained usually at below 40°F (5°C) but not below 30°F (−1°C).

**cooler-stabilized operation**

operating condition at which all test values would be repetitive (or cyclic) if the machine were operated for an extended period.

**drinking water cooler**

unit in which drinking water is cooled by refrigeration and usually dispensed by a manual valve.

**drum cooler**

rotating refrigerated cylinder whose surface is in contact with the liquid to be cooled.

**enclosed liquid cooler**

1. within a pressure-tight vessel, a heat exchanger consisting of an assembly of tubes containing the liquid to be cooled.
2. apparatus for cooling fluid out of contact with the atmosphere.

**evaporative cooler**

one that cools indoor air by moisture evaporation, thereby lowering its dry-bulb temperature and raising its wet-bulb temperature, all at a constant energy level. See also evaporative cooling.

**ice-bank cooler**

water cooler in which ice is allowed to collect on the evaporator tubes.

**milk cooler**

apparatus capable of cooling milk to the required temperature prior to collecting, processing, or delivery.

**nonpriming cooler** one in which tubes are omitted from the top segment of the shell, leaving a gas space above the tubes approximately equal to one-fourth of the inside shell diameter.

**oil cooler**

heat exchanger which can be cooled by air, water, or refrigerant vaporization, to cool oil in a lubrication system.

**panel cooler**

refrigerated flat surface, mainly by radiation.

**plate liquid cooler**

heat exchanger made of thin plates so formed that liquid to be cooled flows through the passage between the plates and the cooling fluid flows through the alternate passages.

**precooler**

1. cooler for removing sensible heat before shipping, storing, or processing.
2. device for cooling a fluid before it enters a system.

**scuttlebutt cooler**

evaporator cooler used for cooling drinking water at a central plant.

**sensible-heat cooler**

cooling surface located on the leaving side of a dehydrator, frequently treating room air which is not circulated through the dehydrator.

**swamp cooler**

slang for evaporative cooler.

**tunnel cooler**

chilled, elongated space for cooling foodstuffs on a movable transport system by rapid circulation of cold air.

**unit cooler**

direct-cooling, factory-made encased assembly including an air-cooling coil, refrigerating compressor and condenser, fan and motor (usually) and directional outlet, including the necessary automatic controls. See air cooler.

**walk-in cooler**

cooling chamber large enough to walk in.

**cooling**

process for reducing the temperature of a space or system below a specified level. Compare chilling; refrigeration.

**air-blast cooling**

cooling by forced circulation of air at high velocity. Compare jet cooling.

**comfort cooling**

refrigeration for comfort as opposed to refrigeration for storage or manufacture.

**contact cooling**

cooling by direct contact with a cold surface.

**district cooling**

concept of providing and distributing, from a central plant, cooling to a surrounding area (district) of tenants or clients (residences, commercial businesses, or institutional sites). Compare district heating.

**evaporative cooling**

sensible cooling obtained by latent heat exchange from water sprays or jets of water. See cooling system.

**flood-type hydrocooling**

obsolete term. Use immersion hydrocooling.

**forced-draft cooling**

1. cooling air or gas by forced circulation over the cooling surface.
2. cooling a space by means of air cooled by forced convection.
3. cooling condenser water by moving air across its spray.

**hydrocooling**

cooling of produce (generally vegetables or fruit) by direct contact with chilled water.

**immersion hydrocooling**

process of cooling fruits and vegetables by submerging them in a chilled water bath.

**jacket cooling**

cooling process in which produce is placed either in a room surrounded by a jacket of cold air, or in a tank surrounded by a jacket of cold liquid.

**jet cooling**

quick-chilling process using air at very high speed forced around the products, usually while those products are continuously moving on a conveyor belt. Compare air-blast cooling.

**magnetic cooling**

cryocooling by adiabatic demagnetization of certain paramagnetic substances.

**natural convection cooling**

1. cooling a fluid by natural convection over the cooling surface.
2. cooling a space by means of air cooled by natural convection.

**oil cooling**

transfer of heat from oil in pipe or tubing to a refrigerant or brine.

**precooling**

cooling fruits and vegetables prior to freezing or prior to shipment, before or after they enter a shipping carrier.

**pressure cooling**

process that forces cold air under pressure, but at low speed, into packages containing produce to be cooled.

**radiant cooling system (panel air system)**

system using panel coolers to absorb radiant heat.

**recooling**

cooling of air that has been previously heated.

**regenerative cooling**

process of using heat that must be rejected or absorbed in one part of the cycle to perform a useful function in another part of the cycle.

**roof spray cooling**

system that reduces heat gain through a roof by cooling the outside surface with a water spray; suited for only temporary treatment, because high humidity may be introduced by air intakes on the roof.

**spot cooling**

cooling the air of a limited portion of an enclosed space without the use of walls or partitions.

**spray cooling**

cooling by spraying a low-temperature liquid on the object to be cooled.

**subcooling**

cooling a substance below its saturated condition or its freezing temperature.

**surface cooling**

method of cooling air or other gas by passing it over cold surfaces.

**transpiration cooling**

cooling produced by evaporation of water lost by a body.

**vacuum cooling (vacuum chilling)**

cooling by vaporization under vacuum of part of the water contained in the material to be cooled.

**waterside economizer cooling**

economizer process that uses cooling-tower water directly or indirectly in the cooling coils, permitting the chiller to be shut down when the outside wet-bulb temperature is sufficiently low.

**cooling bath**

cold liquid in a tank for immersion cooling.

**cooling capacity (total cooling capacity)**

design maximum rate, expressed in watts, at which equipment removes heat from the air passing through it under specified conditions of operation.

**latent cooling capacity**

design maximum rate at which equipment removes latent heat, or reduces the moisture content of air passing through it, under specified conditions of operation.

**sensible cooling capacity**

design maximum rate at which the equipment removes sensible heat.

**cooling element**

heat transfer unit containing refrigerating fluid in the location where refrigerating effect is desired.

**cooling medium**

substance used, with or without a change of state, to lower the temperature of other bodies or substances. See coolant.

**cooling range**

(in a cooling process) difference between the average temperatures of a fluid entering and leaving a cooler.

**cooling rate**

decrease in temperature in unit time.

**cooling surface**

surface that is lower in temperature than the fluid being cooled by contact with it.

**cooling system**

apparatus for lowering the temperature of a space or product to a specified temperature.

**direct cooling system**

system in which the evaporator is in direct contact with the material or space refrigerated, or is located in air-circulating passages communicating with such spaces.

**indirect cooling system**

system in which a liquid such as brine or water, cooled by the refrigerant, is circulated to the material or space to be refrigerated, or is used to cool air so circulated.

**radiant cooling system (panel air system)**

system using panel coolers to absorb radiant heat.

**rock-bed regenerative cooling system**

system of air conditioning in which packed beds of crushed stone or gravel are used for both evaporative cooling and heat energy storage.

**cooling tower**

heat-transfer device, often tower-like, in which atmospheric air cools warm water, generally by direct contact (evaporation).

**atmospheric tower (natural-draft cooling tower)**

one in which air movement through the tower occurs by aspiration or natural convection, as opposed to mechanical means.

**counterflow tower**

one in which air, drawn in through air inlets at the tower perimeter (induced draft), or forced in (forced draft) at the base by the fan, flows up through the fill material in a direction opposite to the falling hot water.

**crossflow tower**

one in which air, drawn or forced in through the air intakes by a fan, flows horizontally across the fill section perpendicular to the falling hot water.

**film cooling tower**

cooling tower with a type of packing over which the water spreads in a thin film.

**forced-draft water cooling tower**

type of mechanical draft tower in which one or more fans are located at the air inlet to force air into the tower.

**hyperbolic tower**

cooling tower of hyperbolic shape which depends on natural draft for air movement through the tower. It can be either crossflow or counterflow. See natural-draft tower.

**induced draft water cooling tower**

type of mechanical draft tower in which one or more fans are located in the air outlet to induce airflow through the air inlets.

**mechanical draft water cooling tower**

tower through which air movement is effected by one or more fans. There are two main types: forced draft with fans located at the air inlet; induced draft with fans located at the air exhaust.

**natural draft water cooling tower**

one in which air movement is dependent upon the difference in density between the entering air and internal air. As the heat of the water is transferred to the air passing through the tower, the warmed air tends to rise and draw in fresh air at the base of the tower. See hyperbolic tower.

**splash filled tower**

cooling tower with a type of packing which repeatedly interrupts the flow of falling water, breaking the water into fine droplets as it falls.

**spray filled water cooling tower**

tower which has no fill; water-to-air contact depends entirely on the breakup of the water by means of pressure-spray nozzles.

**water cooling tower**

enclosed device for evaporatively cooling water by contact with air.

**wet-dry cooling tower**

wet (evaporative) cooling tower in combination with a dry (nonevaporative) heat exchanger system, used to reduce or abate cooling tower fogging during cold weather by modifying the tower exhaust air condition.

**cooling tower fogging**

fog condition created when the exhaust air or plume from a cooling tower, which is essentially a saturated air-water vapor mixture warmer than ambient air, becomes supersaturated so that part of the water vapor condenses into visible liquid droplets.

**cooling tower packing (tower filling)**

that part of a crossflow, counterflow, or natural-draft tower consisting of splash bars, vertical sheets of various configurations, or honeycomb assemblies, tile, or other materials, which are placed within the tower to effect heat and mass transfer between the circulating water and the air flowing through the tower.

**plate (film fill) cooling tower packing**

closely spaced embossed or corrugated sheets.

**splash cooling tower packing**

thin wooden bars of various materials and configurations causing water to break up into drops.

**cooling tower plume**

visible exhaust from a cooling tower. Compare cooling tower fogging.

**copper plating**

film of copper deposited by electrical immersion, or other means, on the surface of another material such as iron or steel; in refrigerating equipment, usually on compressor walls, pistons, discharge valves, shafts, or seals.

**corded packing**

beverage containers nested together for best utilization of storage space.

**corrosion**

rusting or deterioration of a substance (usually a metal) or its properties because of a reaction with its environment.

**corrosion inhibitor**

1. chemical agent that slows corrosion of metal parts of a system.
2. substance added to a brine or other cooling medium to minimize corrosion.

**crankcase**

part of a reciprocating machine in which the crankshaft is housed.

**crankpin**

pin fitted into the arm of a crank to which a reciprocating member is attached.  
crankshaft shaft of a piston machine which either gives reciprocating motion to the piston or transforms reciprocating motion into rotary motion of the shaft.

**critical nucleate boiling heat flux (peak nucleate boiling heat flux)**

heat flux for which the surface coefficient of heat transfer between a heating wall and a liquid under nucleate boiling is a maximum. Also called maximum nucleate-boiling heat flux. Compare gas binding.

**critical process**

processes with environmental control needs that are more constrained than occupancy comfort parameters. Examples of typical processes or areas that have unique needs and are thus critical are: printing, papermaking, textiles, computer rooms, broadcasting studios, food processing, medical and hospital areas, clean rooms, controlled laboratories, unusual safety and health needs, explosive areas, cold storage, milling and machining, casting, and glassmaking.

**critical speed**

operating speed at which the vibration of a unit reaches an unacceptable limit.

**critical velocity**

1. velocity at which given phenomena occur.
2. in fluid mechanics, the velocity above which flow in a pipe is no longer laminar.
3. for helium (He II), the maximum velocity at which superfluid flow can be maintained.

**critical volume**

specific volume at the critical point of a gas.

**crosstalk**

undesirable transfer of energy from active signal line(s) to one or more independent signal lines, creating signals that may reach proportions to cause system errors.

**cryocooling (cryogenic cooling)**

cooling below 120 K (−243°F).

**cryogenic equipment**

everything used to produce or maintain cryotemperatures.

**cryogenic liquid**

liquefied gas below 120 K (−243°F).

**cryogenics**

science that deals with the production of very low temperatures and their effect on the properties of matter.

**cryogrinding (freeze-grinding) process**

grinding at low temperature of a substance that otherwise could not be ground or would be spoiled by the temperature rise resulting from the operation.

**cryohydrate**

eutectic mixture of which one component is water. See also eutectic solution.

**cryopump**

device designed for producing ultrahigh vacuum by condensation or adsorption of a gas at a very low temperature, usually below 77 K (−320°F).

**cryostat**

batch operating apparatus in which a cryogenic liquid or solid evaporates to maintain a cryotemperature, which need not be constant but may vary in a predetermined fashion.

**cryotrap**

surface cooled below 120 K (−243°F) in order to condense vapors. Can be used to reduce pressure.

**CTI**

Cooling Tower Institute.

**Curie point**

see temperature.

**cusec [cubic feet/second (cf/s)]**

unit of volume flow rate in pumping. An improper term. 1 cf/s = 448.83 gpm, the preferred term.

**cut-in**

initiation of an event for which control is applied.

**constant cut-in**

used in refrigerating devices constructed to permit the cut-in point to remain constant while providing a variable cut-out (variable differential) range when the dial shaft is turned.

**cut-in point**

predetermined value (pressure, temperature, etc.) at which operation commences.

**cut-out**

1. cessation of an event for which control is applied.
2. device that causes the cessation, either manual or automatic.
3. time when a water heater thermostat has acted to reduce the energy or fuel input to the heating elements or burners under its control to a minimum.

**high-discharge temperature cut-out**

safety device which acts when an abnormal rise in the discharge temperature starts an alarm or stops the compressor.

**high-pressure safety cut-out**

switch designed to stop the compressor when the discharge pressure reaches a predetermined high value.

**low-pressure safety cut-out (suction pressure safety cut-out)**

switch designed to stop the compressor motor when the suction pressure reaches a predetermined low value.

**pressure differential cut-out**

cut-out control reactive to the difference between two pressures.

**cut-out point**

predetermined value (pressure, temperature, etc.) at which operation ceases.

**C-value**

improper term. Use C-factor for thermal conductance.

**cycle**

1. interval of space, or time, or a sound wave in which one set of repetitive events or phenomena is completed.
2. set of operations that is repeated regularly in the same sequence. The operations may be subject to variations on each repetition.
3. complete series of values of a periodic quantity that occur during a period.
4. in alternating current, the time for a change of state from a zero through a positive and a negative maximum, and back to zero.
5. complete course of operation of working fluid back to a starting point, measured in thermodynamic terms (functions).
6. in the operation of a thermostat, the period of operation from cut-in to cut-in.
7. process or series of processes wherein the initial and final states of the system are identical. Therefore, at the conclusion of a cycle, all the properties have the same value as at the beginning. See also storage cycle.

**binary vapor cycle**

thermodynamic cycle relative to the varying condensing and evaporating temperatures of a nonazeotropic mixture of two fluids.

**Carnot cycle**

ideal reversible thermodynamic cycle comprising two isothermal processes and two adiabatic processes. The cycle represents the maximum theoretical conversion of heat energy into mechanical energy. Compare reverse Carnot cycle; thermodynamics laws, second law, Carnot cycle efficiency.

**closed cycle**

one in which the fluid is used over and over without introduction of new fluid, typical of a sealed system.

**compressing cycle (refrigeration)**

refrigerating cycle comprising four principal stages: vaporization of the refrigerant; compression of the vapor; liquefaction of the vapor; expansion of the liquid.

**cycle of concentration**

1. in boilers, the ratio of chlorides in the boiler water to the chlorides in the feedwater.
2. in cooling tower operation, the ratio of chlorides in the recirculating cooling tower water to the chlorides in the makeup water.

**defrosting cycle**

duration of the "off-cycle" of a refrigerating system sufficient to permit defrosting of a cooling coil.

**diesel cycle**

in a two- or four-stroke reciprocating engine, air without fuel is compressed, usually to more than 500 psig (3500 kPa), to raise its temperature above the ignition temperature of the fuel that is injected into the hot compressed air at or near the start of the power stroke. In modified diesel engines, a glow plug is used to aid ignition when the engine is started.

**expander cycle (work extraction cycle; work cycle)**

thermodynamic cycle in which the working fluid transfers mechanical energy to some outside system (e.g., in a mechanical expander).

**Otto cycle**

in a two- or four-stroke reciprocating engine, the compressed fuel-air mixture is ignited by a spark at or near the start of the power stroke as in conventional automobile engines.

**Rankine cycle**

theoretical thermodynamic cycle used in steam engines comprising four principal stages: vaporization of water under high pressure; expansion of steam; condensation of steam; pumping of the water back to initial pressure.

**refrigerating cycle**

thermodynamic cycle of a system which transfers heat from a low-temperature reservoir to a high-temperature reservoir.

**reverse cycle**

cycle obtained when a fluid is made to follow the different thermodynamic stages of a cycle in the reverse order.

**reversible cycle**

theoretical thermodynamic cycle composed of a series of reversible processes.

**standard rating cycle**

refrigerating cycle as defined by standard conditions. See also standard rating.

**Stirling cycle**

theoretical thermodynamic cycle comprising two isothermal processes and two isochoric processes.

**vapor jet (steam jet) (refrigerating) cycle**

refrigerating cycle using an ejector to compress the refrigerant vapor from the evaporator to the condenser. The term "steam jet" is used when water is the refrigerant.

**cycling**

1. continuous oscillation occurring without periodic stimuli. A situation in a closed-loop system where the controller output to an input change causes instability.
2. periodic change in the controlled variable from one value to another. Also called hunting.

**duty cycling (electric)**

process of turning off electrical equipment for predetermined periods of time during operating hours to reduce consumption and demand.

**cycling life**

expected total duration of lifetime cycling expressed in time or number of events.

**cylinder head**

in a reciprocating engine, pump, or compressor, the end of a cylinder opposite to that from which the piston rod or connecting rod projects.

**safety cylinder head**

movable cylinder head retained in position by springs powerful enough to oppose normal compression pressures, but capable of lifting in case of slugging.

**daily range**

difference between high and low temperatures for a typical day. Used in HVAC load calculations.

**damper**

device used to vary the volume of air passing through an outlet, inlet, or duct; or generally through a confined cross section by varying the cross-sectional area.

**backdraft damper (shutter)**

device which, when mounted in a duct or opening, permits the flow of air in one direction only.

**barometric damper**

mechanically balanced damper that rotates from changes in pressure within breeching to bleed air into the breeching to maintain a steady draft.

**blast gate damper**

in an air-handling system, a sliding damper.

**butterfly damper**

1. damper consisting of a plate turning on a diametral axis inside a duct.
2. pair of flaps hinged to a common diametrical spindle and permitting flow in one direction only.

**ceiling damper**

device to protect air openings in fire rated ceiling assemblies that operates to interrupt airflow automatically in the event of fire to restrict passage of heat and flame.

**equalizing damper**

device to maintain constant static pressure or volume flow.

**fire damper**

device that interrupts airflow automatically through part of an air system to restrict passage of flame. Installed in a fire rated wall or floor and closes automatically in the event of fire to maintain the integrity of the fire rated separation.

**guillotine damper**

isolation damper having a blade which is withdrawn from the duct area when the damper is fully open.

**muffler-noise damper**

device intended to dampen noise; more particularly an expansion chamber in the exhaust line of an internal combustion engine.

**multileaf (multiblade) damper (multiple-louver)**

damper having two or more blades.

**single-leaf (single-blade) damper**

damper with a single blade.

**slide damper**

damper consisting of a plate that can be slid between two guides that are generally perpendicular to the axis of the duct.

**volume control damper**

device mounted in a duct or opening used to vary the volume of air flowing through.

**damper actuator (motor)**

device that provides the necessary force to position a damper.

**damping**

1. reducing the amplitude of vibrations by dissipating the corresponding mechanical energy to some suitable absorbing sink.
2. progressive diminution with time of certain quantities characterizing a phenomenon.

**darcy unit**

measure of permeability. At one darcy, a material will pass a fluid of one centipoise viscosity through a section of one square centimetre at a rate of one cubic centimetre per second, with a drop in pressure of one standard atmosphere.

**data**

1. general term used to denote any or all facts, numbers, letters, and symbols that refer to or describe an object, idea, condition, situation, or other factors.
2. representations such as characters or analog quantities to which meaning might be assigned.

**analog data**

data represented in a continuous form, as contrasted with digital data represented in a discrete (discontinuous) form; an analog of the variable represented.

**data bank**

any electronic depository of data.

**data base**

ordered and named collection of data particularly for use in computerized information systems.

**data display module**

device that stores computer output and translates this output into signals which are distributed to a program-determined group of lights, annunciators, and numerical indicators in operator consoles and remote stations.

**data logging**

1. device used for collection of characters or analog signals.
2. recording of data about events that occur in time sequence.
3. (real-time processing) processing of data in synchronism with a physical process so that the results of the data processing are useful to the physical operation.

**data processing device (machine)**

general name for a machine which can store and process numeric and alphabetic information.

**peripheral data processing device**

1. unit or equipment distinct from the central processor.
2. console device that is not a part of the central processor, but is connected to the central electronics processor function cards via the console cabling system or other input-output means, *i.e.*, the keyboard, visual display, teletypewriter, projector, pilot lights, CRT display, and tape reader.

**data reduction**

process of transforming masses of raw test or experimentally obtained data, usually gathered by automatic recording equipment, into useful, condensed, or simplified intelligence.

**data table**

collection of data with each item uniquely identified either by some label or by its relative position.

**dead air pocket (dead zone)**

stagnant area in a space unaffected by air circulation.

**dead band (dead zone)**

range of values within which an input variable can be varied without initiating any noticeable change in the output variable.

**dead time (lag time)**

time interval between a change in the input variable and the initiation of the corresponding change in the output variable.

**debug**

1. to operate equipment prior to use to detect and replace parts that are defective or expected to fail, and to correct error in fabrication or assembly.
2. to isolate and remove a mistake or malfunction.

**decay**

rate any physical attribute that decreases with time in a regular fashion. An example is the rate of decay of the concentration of a tracer gas, as used to measure the air infiltration rate of a building. See also sound decay rate.

**decibel**

unit used in acoustics for expressing the relation between two amounts of airborne power. By definition, the difference in decibels between two powers  $P_1$  and  $P_2$ ,  $P_2$  being the larger is: db difference =  $10 \log$  (to the base 10)  $P_2/P_1$ .

**declination of sun**

angle of the sun above or below the equatorial plane. It is plus if north of the plane and minus if south.

**decomposition**

process of chemical change; breaking up of structures; spoilage. Compare deterioration.

**decrement**

1. quantity by which a variable is decreased.
2. specific part of an instruction word in some binary computers; thus, a set of digits.

**deflector (turning vane)**

fixed or adjustable device, usually in a duct, to change direction of airflow.

**defrosting**

planned process to remove or prevent accumulation of frost (ice) on coils of refrigerating units.

**automatic defrosting**

defrosting automatically at set intervals, based on time or temperature conditions, or both.

**electrical defrosting**

defrosting by means of electrical heating.

**external defrosting**

defrosting using heat from external sources.

**hot-gas defrosting (internal defrosting)**

method which utilizes heat from inside the pipes of the evaporator, usually the highly superheated vaporized refrigerant from the compressor.

**manual defrosting**

defrosting by natural or manual means with manual initiation and termination of overall defrost operation.

**off-cycle defrosting**

1. method of defrosting in which the temperature of the evaporator coils is allowed to rise naturally during an "off cycle," no refrigerant being supplied.
2. rapid heating of the evaporator coil during the off part of each cycle.

**reverse-cycle defrosting**

defrosting an evaporator by reversing its function with that of the condenser.

**semiautomatic defrosting**

defrost system in which the defrost cycle is started manually and ends automatically with automatic resumption of normal refrigeration at the end of defrost operation.

**thermobank defrosting**

use of a storage tank heated by compressor discharge gas during normal refrigeration, to evaporate liquid produced during hot gas defrosting, thus preventing liquid from returning to the compressor.

**time defrosting**

defrosting process automatically and intermittently operated for a predetermined period.

**time-initiate, temperature-terminate defrosting**

process which starts the defrost cycle at a predetermined time or intervals and by a thermostat, and stops when the heated coils reach a set temperature.

**time-initiate, time-terminate defrosting**

process which starts and stops the defrost cycle at a predetermined time or intervals, but has no thermostatic control for the heating coil.

**water defrosting**

defrosting in which water is sprayed or poured over the frosted surface.

**defrosting system**

equipment and controls designed to remove frost (ice) from cooling coils of a refrigerating system.

**demand defrost**

automatic defrosting system in which the defrost cycle is initiated by a drop in performance of the refrigerating system.

**degradation**

failure of a superconductor to carry the current which would be expected from a knowledge of the critical current field relationship of that material.

**degree-day (DD)**

difference in temperature between the outdoor mean temperature over a 24-hour period, and the given base temperature of a building space. Compare kelvin day.

**cooling degree-days (CDD)**

sum of the degree-days for cooling, using a common base of 75°F (25°C in Canada), is used with other factors to evaluate the energy requirements of a cooling season.

**heating degree-days (HDD)**

sum of the degree days for heating, using a common base of 65°F (18°C in Canada), used with other factors to evaluate the energy requirements of a heating season.

**degreening**

imposed transformation from a green color to a yellow or orange color (especially with citrus fruits), due to destruction of chlorophyll.

**degrees of freedom**

number of variables necessary to determine the state of individual phases less the number of phases more than one. Equals two plus independent components minus number of phases.

**dehumidification**

removal of water vapor from air.

**dehumidifier**

air cooler, or an absorption or adsorption device used for lowering moisture content.

**surface dehumidifier**

1. dehumidifier with a surface at a temperature below the dew point.
2. air-conditioning unit, designed primarily for cooling and dehumidifying air by passing the air over cooling coils that are below the dew point of the air.

**dehumidifying effect**

mass of water condensed during cooling or the equivalent refrigerating capacity expressed in terms of the latent heat of the water condensed per unit of time.

**dehydration (drying)**

removal of water from any substance.

**dehydrator (drier)**

device for removing moisture from refrigerant or other substance.

**deicing**

intentional melting of an ice layer.

**delivery valve**

discharge valve. See valve.

**demand (demand load)**

electric power delivered to or by a system, part of a system, or a piece of equipment; expressed in kilowatts, kilovolt-amperes, or other suitable unit at a given instant or averaged over any designated period.

**demand-limit tripping (electric)**

1. process of, or equipment for, automatically opening an electric-service disconnect device
2. removing interruptible or deferrable load(s) at the user level when electric power or current flow to that user, or to a portion of the load, exceeds a specified level for more than a specified time, as determined by agreement. The automatic function can be enabled or disabled remotely by the serving utility via centralized communication.

**demand limiter**

electrical/electronic, mechanical, or electromechanical device that monitors user electric power demand and causes that demand to be limited in a manner not to exceed a selected or programmed maximum value.

**demodulation**

modulation process wherein a wave resulting from previous modulation is employed to derive a wave having substantially the characteristics of the original modulating wave; sometimes used to describe the action of a frequency converter or mixer, but this use is deprecated.

**density**

1. mass per unit of volume.
2. measure of the light transmitting or reflecting properties of an area. Compare specific gravity.

**desiccant**

absorbent or adsorbent, liquid or solid, that removes water or water vapor from a material.

**activated alumina desiccant**

form of aluminum oxide, readily used as a drying agent, which absorbs moisture. phosphorous pentoxide desiccant ( $P_2O_5$ ) although an effective drying agent, it becomes gummy on reacting with moisture so is not used as a drying agent in refrigerating systems.

**silica gel desiccant (aerogel)**

form of silicon dioxide which absorbs moisture and may be used as a drying agent.

**desiccation**

1. process for evaporating water or removing water vapor from a material.
2. complete removal of water from a material.

**design conditions**

specified environmental conditions, such as temperature and humidity, required to be produced and maintained by a system.

**design airflow**

required airflow when the system is operating under assumed maximum conditions of design, including diversity.

**design professional**

individual responsible for the design and preparation of architectural or engineering contract documents.

**design professions (environmental)**

professions collectively responsible for the design of human physical environment, including architecture, engineering, landscape architecture, urban planning, and similar environment-related professions.

**architect (licensed architect)**

designation reserved, usually by law, for a person or organization professionally qualified and duly licensed to perform architectural services, including but not necessarily limited to analysis of project requirements, creation and development of project design, preparation of drawings, specifications and bidding requirements, and general administration of the construction contract.

**architect-engineer**

individual or firm offering professional services as both architect and engineer.  
field engineer term used by certain governmental agencies to designate their representative at the project site.

**prime professional**

person or entity having a contract directly with the owner for professional services.

**professional engineer (licensed engineer)**

designation reserved, usually by law, for a person professionally qualified and duly licensed to perform engineering services such as civil, electrical, mechanical, sanitary, and structural.

**project architect**

architect designated by the principal-in-charge to manage the firm's services related to a given project.

**project engineer**

engineer designated to be responsible for the design and management of specific engineering portions of a project.

**resident engineer**

engineer employed by the owner to represent the owner's interests at the project site during the construction phase.

**registered engineer**

appropriately qualified and licensed professional engineer.

**desorption**

liberation of a gas held in a substance by sorption.

**deterioration (spoilage)**

in food, any damage due to diverse causes resulting in quality decrease.

**deviation**

difference between the set point and the value of the controlled variable at any instant.

**standard deviation**

square root of the average of the squares of the deviations from the mean (root-mean-square deviation); a measure of the dispersion of a population.

**device**

piece of equipment or a mechanism designed to serve a special purpose or to perform a special function; refer to specific device of interest.

**dew**

1. deposit of water droplets on cold surfaces formed by the condensation of water vapor.
2. hydrometeor produced on objects at or near the ground.

**Dewar (vacuum) flask**

silvered glass flask with double walls with the space between them highly evacuated.

**dew-point depression**

difference between dry-bulb temperature and dew-point temperature. See wet-bulb temperature.

**dew-point rise**

increase in moisture content (specific humidity) of air expressed in terms of a rise in dew-point temperature.

**dial**

1. (industrial control) a plate or disc, suitably marked, that serves to indicate angular positions, as for example the position of a handwheel.
2. (automatic switching) type of calling device used in automatic switching that, when wound up and released, generates pulses required for establishing connections.

**diaphragm**

1. bellows whose elastic deflection can be increased by the use of corrugations.
2. flexible membrane separating two cavities.
3. in pneumatics or hydraulics, the membrane separating the fluid pressure system from the mechanical side.

**diathermanous**

pertaining to the nature of a substance or a space which allows the passage of heat (more particularly radiant heat).

**dielectric strength**

maximum electric field that an insulator can withstand without breakdown.

**differential**

1. of a control, the difference between cut-in and cut-out temperatures or pressures.
2. range which the controlled variable must pass in order to actuate the control element.

**operating differential**

difference between the cut-out and cut-in at the sensing element.

**diffuse (flux)**

indicates that radiant flux propagates in many directions as opposed to a single direction; as in a direct beam, which refers to collimated flux.

**diffuser**

1. circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
2. duct of increasing area following the outlet of a rotary blower so that the reduced velocity of the fluid will convert some of the kinetic energy into pressure energy.  
See also air outlet.

**ceiling diffuser**

supply-air diffuser designed for ceiling mounting.

**slot diffuser**

elongated type of air diffuser consisting of a single or a number of slots.

**diffuser radius of diffusion**

horizontal distance (air throw) from a ceiling air diffuser to the point of preset terminal velocity of the air.

**diffusion**

1. displacement of the molecules of a fluid within another fluid.
2. distribution of air within a space by an outlet discharging supply air in various directions and planes.

**diffusion area**

effective area covered by a jet of air on leaving a distribution outlet.

**digital display**

data displayed by alphanumeric display instead of a dial indicator or meter.

**digital indication**

1. digital display.

2. direct numeric readout of a measurable property or condition.
3. displaying of data in an electrical readout based on the use of discrete integral numbers.

**digital transmission**

transmission of data in a serial format of two discrete signal levels on a discrete time interval.

**diluent**

neutral fluid added to another fluid to reduce the concentration of the second fluid in a mixture.

**dimensionless number**

ratio of various physical properties (such as density or heat capacity) and conditions (such as flow rate or mass), of such nature that the resulting number has no defining units of mass, rate, etc. Also called a nondimensional parameter.

**direct drive**

in a machine, the drive and the driven units are directly coupled, either by a common shaft or by a mechanical coupling.

**direct exhaust system**

mechanical appliance venting system supplied or recommended by the manufacturer through which the products of combustion pass directly from the appliance to the outside, and which does not employ a means of draft relief.

**direct vent system (appliance)**

system supplied by a manufacturer which provides outdoor air directly to a unit for combustion and for draft relief, if the unit is equipped with a draft control device, and which provides for discharge of all flue gases to the outside atmosphere.

**discharge line (hot-gas line)**

line through which refrigerant vapor flows from a compressor to a condenser.

**discharging (thermal storage)**

withdrawing cooling or heating capacity from storage.

**compressor-aided discharging**

operating the compressor of an ice storage system during the discharging period.

**distribution system**

1. conveying means, as ducts, pipes, wires, to bring substances or energy from a source to the points of use.
2. parts of a cooling tower, beginning with the inlet connection, that distribute the hot circulating water within the tower to the points where it contacts the air. See also air-conditioning distribution system.

**distributor**

device for dividing flow of fluids into parallel paths.

**district cooling**

concept of providing and distributing, from a central plant, cooling to a surrounding area (district) of tenants or clients (residences, commercial businesses, or institutional sites).

**district cooling system cooling density**

measure of cooling demand per unit area. Customary units are kW/hectare, or tons/acre.

**district heating**

concept of providing and distributing, from a central plant, heating to a surrounding area (district) of tenants or clients (residences, commercial businesses, or institutional sites). Compare district cooling.

**geothermal district heating**

use of geothermal energy passing through a heat exchanger to a secondary loop, from which the secondary fluid is circulated through the distribution system.

**low-temperature district heating**

use of fluids less than 50°C (200°F) (in round numbers) for district heating supply; permitting use of energy sources formerly discarded.

**waste-heat reclamation district heating**

use of collected heat from an available process as a source for a district heating system.

**district-heating system heating density**

measure of heating demand per unit area. Customary units are kW/hectare or Btu × 10<sup>6</sup>/acre.

**domestic**

*adj.* refers to use in residential and small commercial buildings.

**double break**

1. condition that results when a switching device opens an electrical circuit by providing two gaps in a single supply line.
2. breaker arrangement whereby dual circuit breakers are used to reduce likelihood of extended power outages of any circuit due to circuit breaker trouble; permits breaker maintenance without a feeder outage.

**double line break**

loss of continuity in a double-line system. See double break.

**double suction riser**

in a compressor, a riser arrangement designed to assure adequate oil return at all conditions of refrigerant flow.

**draft**

current of air, when referring to:

1. pressure difference that causes a current of air or gases to flow through a flue, chimney, heater, or space.
2. localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
3. change in cross section that occurs during rolling or cold drawing of metals.

**balanced draft**

two fans connected to a combustion unit, one to supply the combustion air and the other to induce draft.

**forced draft**

combustion air supplied under pressure to the fuel burning equipment.

**induced draft**

fan exhaust of hot gases from the heat absorbing equipment.

**natural draft**

airflow resulting from the difference between atmospheric density and some lower density existing in the furnace or gas passages of heat generating unit, chimney effect.

**draft hood**

device not an integral part of a furnace or boiler, connected to the furnace or boiler by a short length of flue pipe. It is designed to (1) provide for the exhaust of products of combustion in the event of no draft, back draft, or stoppage beyond the draft hood; (2) prevent a back draft from entering the furnace; (3) neutralize the effect of stack action of the chimney or gas vent upon the operation of the furnace.

**draft hood relief opening**

opening provided in draft hood to permit the ready escape to the atmosphere of the fuel gases in the event of no draft or stoppage beyond the draft hood, and to permit inspiration of air into the draft hood to neutralize strong chimney or vent updraft. draft regulator see regulator.

**draft relief**

1. provision for drafts to escape the venting system of a boiler or furnace.
2. relief or taper given to a pattern, die, or mold to enable the work to be easily withdrawn.

**drain pan**

vessel or tray placed under an evaporator coil to receive condensed moisture, melted frost, or ice. Also called drip tray, defrost pan.

**drawing**

graphic and pictorial document showing the design, location, and dimensions of the elements of a project.

**axonometric drawing**

perspective drawing showing plan and partial elevations on the same drawing.

**clarification drawing**

1. graphic interpretation of the drawings or other contract documents issued by the architect.
2. drawing to correct an ambiguity in a previous drawing.

**detail drawing**

drawing, at a larger scale, of a part of another drawing, indicating in detail the design, location, composition, and correlation of the elements and materials not shown on the smaller scale.

**elevation drawing**

two-dimensional graphic representation of the design, location, and dimensions of a project, or parts thereof, seen in a vertical plane viewed from a given direction.

**isometric drawing**

form of three-dimensional projection in which all of the principal planes are drawn parallel to corresponding established axes and at true dimensions. orthographic drawing plan and elevation detail drawing.

**perspective drawing**

graphic representation of a project or part thereof as it would appear three-dimensionally.

**plan (drawing)**

two-dimensional graphic representation of the design, location, and dimensions of a project, or parts thereof, seen in a horizontal plane viewed from above.

**preliminary drawing**

drawing intended for use during the early stages of the design of a project, and not to be used for construction.

**record drawing**

construction drawing revised to show significant changes made during the construction process, usually based on marked-up prints, drawings, and other data furnished by the contractor or anyone who prepared the original drawings.

rendering drawing of a project or portion thereof, with an artistic delineation of materials, shades, and shadows.

**schematic design drawing**

drawing illustrating the relationship of project components.

**section drawing**

drawing of a surface revealed by an imaginary plane cut through a project, or portion thereof, in such a manner as to show the composition of the surface as it would appear if the part intervening between the cut plane and the eye of the observer were removed.

**shop drawing**

drawing, diagram, schedule, and other data specially prepared for the work by the contractor or any subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the work.

**study (drawing)**

preliminary sketch or drawing to facilitate the development of a design.

**topographic survey (drawing)**

configuration of a surface, including its relief and the locations of its natural and man-made features, usually recorded on a drawing showing surface variations by means of contour lines indicating height above or below a fixed datum.

**working drawing**

drawing suitable for actual construction.

**drier (dehydrator)**

1. device in a refrigerating system that contains a desiccant.
2. desiccant or refrigeration device placed in the main air line of a pneumatic control system to reduce moisture. Compare desiccant. See also dryer.

**drift**

1. change in mechanical or electrical characteristics with the passage of time, change in temperature, or both.
2. movement of current carriers in a semiconductor under the influence of an applied voltage.
3. change in output-input relationship over a period of time with the change unrelated to input, environment, or load.
4. in a cooling tower, water lost as liquid droplets entrained in the exhaust air. It is independent of water lost by evaporation.

**drift eliminator (carryover eliminator)**

assembly constructed of any suitable material which serves to remove entrained moisture from the discharged air.

**drip**

1. pipe, or a steam trap and a pipe considered as a unit which conducts condensation from the steam side of a piping system to the water or return side of the system.
2. liquid which appears on thawing frozen food, water melting from evaporator, or water droppings from a cooling surface.
3. leak in a liquid system.

**drip tray (defrost pan)**

vessel or tray placed under the cooling coil to receive the melt from frost or ice. Also called drain tray.

**drive**

means for giving motion to a machine or machine part.

**droop**

1. linear term referring to the percentage decrease in output voltage for a square wave or rectangular wave as a function of time. Also can apply to voltage error caused by leakage in a sample and hold circuit.
2. deviation from the no-load control point that results from a change in the heating or cooling load.

**dry**

*verb.* to separate or remove a liquid or vapor from another substance.

**dryer**

appliance that removes moisture. Compare drier.

**dry ice**

solid carbon dioxide, CO<sub>2</sub>. A proprietary term.

**duct**

1. tube or conduit for conveying or encasing purposes.
2. passageway made of suitable material, not necessarily leak-tight, used for conveying air or other gas at low pressures.

**air duct**

tube or conduit for conveying air. *Note:* Air passages of self-contained systems are not recognized as air ducts. See also warm air duct.

**flexible duct**

flexible passageway used to connect an air distribution duct to an outlet or diffuser.

**outside air intake duct**

duct which delivers outside air to a central installation or air-conditioning apparatus.  
**pipe duct** tube or conduit for encasing pipe.

**warm air duct**

1. in commercial refrigerators, the passage through which warm air ascends from storage space to the bunker.
2. in heating, ventilating, and air conditioning, pipes or ducts for conveying warm air into or out of a space or room.

**wire duct**

tube or conduit for encasing wire.

**duct breakout noise**

transmission or radiation of noise from some part of a duct system to an occupied space in the building. Also called flanking, and duct radiation.

**duct distribution**

distribution of air into a room or a building by means of ductwork.

**duct sizing**

calculation of dimensions of ducting for a given air distribution system.

**equal-friction method duct sizing**

method in which ducts are sized so that their frictional resistance per unit length is constant.

**static regain method duct sizing**

method in which ducts are sized so that the regain in static pressure due to decreased velocity between two points totally or partially compensates for the frictional resistance between the points.

**velocity-reduction method duct sizing**

method in which ducts are sized so that selected velocities occur in specific duct lengths.

**duct transition section**

section of duct, breeching, or stack used to connect those elements with structures of different cross-sectional dimensions.

**ductwork (trunking)**

system of ducts for distribution and extraction of air. See system.

**dummy product**

in testing, material used for filling refrigerator spaces not occupied by test packages.

**dunnage**

strips of wood or other material placed between stored materials to permit air circulation between them. See also cargo dunnage.

**durability**

capability of a building, assembly, component, product, or construction to maintain serviceability for which it was designed over at least a specified time; based on assumed levels of use and maintenance. Compare serviceability.

**dust**

air suspension (aerosol) of solid particles, usually with particle size less than 100 micrometres. See air contaminant.

**dust eliminator**

device, usually applied at a dust-generating source, that traps dust particles suspended in the air or gases passing through it. Compare filter.

**dust extracting plant**

system that traps dust particles in the gas or airstream passing through it.

**dust spot opacity**

percentage decrease in light transmission of a dust-spot sampling target relative to the light transmission of the clean target at any chosen amount of dust accumulation on the target.

**dust spot opacity index**

number which expresses the relative dust accumulation on a dust-spot sampling target, corrected for the nonlinearity of opacity increase, at constant dust accumulation rate.

**dx coil**

direct-expansion evaporator coil or plate coil.

**dynamometer**

device for measuring power in a running engine or motor.

**ebullator (turbulator, turbulence promoter)**

device inserted in flooded evaporator tubes to prevent the evaporator from becoming oil-bound or the refrigerant liquid from becoming quiescent at a pressure lower than its boiling point.

**economizer**

1. device that, on proper variable sensing, initiates control signals or actions to conserve energy. *Note:* The economizer decision should be made at a fixed outside air temperature, or by comparing return and outside air temperatures, or by comparing the return and outside air total heat (enthalpy).
2. control system that reduces the mechanical heating and cooling requirement. Usually refers to use of outside air, but with logic to maintain a fixed minimum of outside air and to take only the minimum amount of outside air when the total heat of the return air exceeds the total heat of the outside air.

**compression economizer**

device that reduces compressor energy use by introducing intermediate pressure gas into the compressor during the compression stroke.

**fan economizer (defrost)**

device that prevents operation of the fan motor on a cold defrost during the shutdown period after the coil has been defrosted.

**feedwater economizer**

feedwater heater installed in the hot-gas duct between the boiler and the stack to transfer a portion of the heat (that would be lost up the stack) to the feedwater.

**economizer cycle****integrated economizer cycle**

cycle logic that uses the economizer mode in conjunction with mechanical cooling, typically based on return and outside air total heat.

**waterside economizer cycle**

economizer cycle that uses the condenser water side of the system. See also cooling; economizer cooling.

**eddy current**

electric current induced in the body of a conductor when that conductor either moves through a non-uniform magnetic field or is in a region where there is a change in magnetic flux.

**eddy current test**

nondestructive test in which the change of impedance of a test coil brought close to a conducting specimen indicates the eddy currents induced by the coil, thereby indicating certain properties or defects of the specimen; for example, thickness.  
eddy flow see turbulent flow.

**EDR**

equivalent direct radiation. See thermal radiation.

**effective temperature**

use operative temperature.

**ejector**

in a fluid-carrying pipe, a device with a reduced diameter to increase the fluid velocity sufficiently to induce a lower static pressure at that point to draw another fluid into the line. See also injector; venturi.

**steam jet air ejector**

device for air removal from closed vessels in which the operating pressure is less than atmospheric.

**elastomer**

material that can be stretched markedly and repeatedly and, immediately on release of the stress, returns to its approximate original length.

**electrical conductance**

reciprocal (opposite) of resistance. The current carrying capacity of any wire or electrical component.

**electrical conductor**

common neutral electrical conductor that is common to, or serves more than one, circuit.

**electrical degree**

360th part of the angle subtended at the axis of the machine by two consecutive field poles of like polarity. One mechanical degree thus equals as many electrical degrees as there are pairs of poles in the machine.

**electrical demand**

1. kilowatt load averaged over a specified time (usually 15 or 30 minutes). The demand for any given interval is that value of power in kilowatts that, if held constant over the interval, accounts for the same consumption of electrical energy as the real power. The average of the real power over the demand interval. This is commonly identified as the block interval method.
2. (electric power utilization) load integrated over a specified time interval.
3. (installation or system) load at the receiving terminals averaged over a specified interval expressed in kilowatts, kilovolt-amperes, kilovars, amperes, or other suitable units.

**electrical diagram**

1. diagram that shows the connections of an installation or its component devices or parts.
2. diagram that shows, by graphic symbols, the electrical connections and functions of a specific circuit arrangement.

3. diagram in the form of a vertical ladder with the outer vertical lines representing the electrical supply conductors and the horizontal steps representing each individual circuit with all component devices.
4. diagram showing where wires go. It may show physical location, terminal symbols, and color codes.

**electrical enclosure**

case enclosing electrical equipment and wiring which is designed expressly to prevent (1) a person from accidentally contacting uninsulated energized parts; (2) burning or molten materials from contacting adjacent combustible materials or falling onto combustible materials; (3) conductive or combustible materials from dropping on uninsulated energized parts; and (4) mechanical abuse of electrical equipment not designed or approved to withstand the intended normal use without such additional enclosure.

**electrical fault**

short circuit, either line-to-line or line-to-ground.

**electrical induction**

process of producing electron flow by the relative motion of a magnetic field across a conductor.

**electrical insulation**

material having high electrical resistivity and therefore suitable for separating adjacent conductors in an electric circuit, or preventing possible future contact between conductors.

**electrical resistance (ohm)**

opposition that limits the amount of current that can be produced by an applied voltage in an electrical circuit, measured in ohms.

**electrical resistor**

1. electrical component which adds resistance to an electrical network.
2. material used to produce heat or reduce voltage by passing a current through it.

**electrical volume resistivity**

electrical resistance of a substance contained between flat, parallel electrodes, multiplied by the area of the electrodes and divided by the thickness of the substance.

**electric current**

movement or flow of charge in an electrical circuit, measured in amperes.

**alternating current**

electric current that reverses its flow periodically. See frequency.

**direct current**

current in an electrical circuit that does not reverse polarity. *Note:* Direct current is said to flow from positive to negative, but electrons travel from negative to positive.

**electric current single phasing**

interruption of any one conductor in a three-phase system.

**electric power**

time rate of generating, transferring, or using electric energy, expressed in watts (W) or kilowatts (kW).

**apparent power**

product of the volts and amperes of a circuit. This product generally is divided by 1000 and designated in kilovolt-amperes (kVA). It comprises both real and reactive power.

**reactive power**

portion of apparent power that does no work. It is measured commercially in kilovars. Reactive power must be supplied to most types of magnetic equipment, such as motors. It is supplied by generators or by electrostatic equipment, such as capacitors.

**real power**

energy or work producing part of apparent power. The rate of supply of energy, measured commercially in kilowatts. The product of real power and length of time is energy, measured by watt-hour meters, and expressed in kilowatt-hours (kWh).

**electric power demand charge**

part of an electric bill based on kilowatt demand and the demand interval, expressed in dollars per kilowatt. *Note:* Demand charges offset construction and maintenance of a utility's need for large generating capacity.

**electric power demand interval**

period during which kilowatt demand is monitored by a utility service, usually 15 or 30 minutes.

**electric power demand load**

actual load on a circuit at any time. Sum of all loads which are ON. Equal to the connected load minus the loads that are OFF.

**electric power demand period**

electric power demand interval

**on-peak period**

1. time of day during which creating electrical demand incurs more cost.
2. time of day when use of power within a building is at a maximum; which may be the peak period of either the consumer or of the utility.

**off-peak period**

time of day other than the on-peak period of electrical demand.

**electric power generation****baseload generation**

large, steady electric load of an electric system produced by the largest, most efficient, generating facilities within the system. *Note:* These facilities are operated to the greatest extent possible to maximize system mechanical and thermal efficiency, and to minimize system operating costs.

**cogeneration**

any of several processes that either use waste heat from generation of electricity to satisfy thermal needs, or process waste heat in the steam generation of electricity. See also cogeneration

**on-site generation**

generation of any electrical energy on customer's property, with or without use of recoverable heat.

**electric power load factor (ELF)(diversity factor)**

comparison of electricity use to electric demand. Calculated by dividing electricity usage in kilowatt-hours (kWh) by the product of electric demand in kilowatts (kW) times the hours in the period under consideration.

**electric power load shedding**

control method of stopping selected power uses to avoid overloading power supply, or to avoid demand charges.

**electromotive force (emf)**

electric potential difference, measured in volts, between the terminals of any device used as a source of electrical energy, i.e., to supply an electric current.

**electronics**

study, control, and application of the conduction of electricity through gases or vacuum, or through semiconducting or conducting materials.

**electropneumatic device**

one that converts an electric signal to a pneumatic signal.

**ELF**

electric load factor

**EMCS**

energy monitoring and control system.

**EMCS architecture**

structure that links hardware units, software packages, sensors, control devices, and other EMCS components into a system dedicated to perform the required control, energy management, and management information functions on HVAC processes in buildings.

**EMCS end-to-end accuracy**

accuracy with which the measured condition is displayed or recorded.

**emf**

electromotive force.

**EMI (electromagnetic interference)**

electrical interference generated at radio frequencies inside systems. Compare RFI.

**emissive power (emittance)**

ratio of the radiant flux emitted by a body to that emitted by a blackbody at the same temperature and under the same conditions.

**emissivity**

radiation property of a material, evaluated with its surface optically smooth and clean, and of sufficient thickness to be opaque.

**emulsion**

relatively stable suspension of small but not colloidal particles of a substance in a liquid with the suspended particles undissolved.

**endothermic reaction**

one in which heat must be supplied to further the reaction. Compare exothermic reaction.

**energy**

1. capability for doing work.
2. capacity for producing an effect. Having several forms, which may be either stored or transient, and can be transformed from one into another. Forms include thermal (heat), mechanical (work), electrical, radiant, and chemical.

**available energy**

energy in the form of shaft work or in a form completely convertible to shaft work by ideal processes.

**chemical energy**

1. energy possessed by a system caused by the arrangement of atoms composing the molecules.
2. energy related to chemical phenomena in the formation and decomposition of compounds, in the reactions that occur in electrochemistry.

**electrical energy (electricity)**

energy derived from either moving or stationary electric charge, usually electrons; measured in joules. In the electric utility industry, measured in kilowatt-hours (kWh).

**internal energy**

sum of all kinetic and potential energies contained in a substance due to the states of motion and separation of its several molecules, atoms, and electrons. It includes sensible heat (vibration energy) and that part of latent heat represented by the increase in energy during evaporation.

**kinetic energy**

energy caused by the velocity of the molecules.

**mechanical energy**

capacity for doing work, usually expressed in work units (foot-pounds or newton-metres); sometimes in heat units (Btu or joule). Energy may be inherent in the speed of a body (kinetic energy) or in its position relative to another body (potential energy). new energy energy, other than recovered, used for heating, cooling, or lighting.

**nuclear (atomic) energy**

energy possessed by the system from the cohesive forces holding protons and neutrons together as the nucleus of the atom.

**potential energy**

energy possessed by a system caused by the attractive forces existing between molecules, or the elevation of the system.

**radiant energy**

energy passing through space in the form of electromagnetic radiation, such as light, or ultraviolet or infrared radiation; or as a stream of particles, e.g., electrons or protons.

**thermal energy**

energy possessed by a system caused by the motion of the molecules and/or intermolecular forces; i.e., heat.

**zero point energy**

residual energy of a system at absolute zero.

**energy audit**

identification and documentation of gross energy usage during a calendar period using any of several means, such as source, department, product, equipment, and cost.

**energy availability**

maximum fraction of energy in a system that, in the presence of a medium at a given temperature  $T_0$ , can be converted into useful work during a process at the end of which the system temperature is  $T_0$ .

**energy cascading**

multiple use of an energy stream for successive needs. See energy system. energy concept (total energy system) utilization of energy derived from a single fuel source for providing all energy services such as generation of electricity, heating, and cooling.

**energy conservation**

more effective use of energy resources. Energy conservation seeks to reduce energy invested per unit of product output, service performed, or benefit received through waste reduction. Energy conservation and energy use reduction are not synonymous.

**energy factor**

measure of overall efficiency in terms of energy output compared to energy consumption over a 24-hour cycle.

**energy level (energy state)**

state of a physical system with a certain defined energy.

**energy management**

electric utility operation that plans, coordinates, and controls power supply, transmission, distribution, and utilization.

**energy management function**

effective management to achieve efficient use of energy in buildings.

**energy management system (EMS)**

formal system of building energy conservation through all available means.

**energy quality**

temperature of an energy stream as a measure of potential energy.

district heating energy quality temperature of the district heating energy stream as a measure of potential energy. *Note:* Quality is a measure of both absolute and relative energy source potential: while an energy stream at 5°C is of lesser absolute quality than one at 15°C, the 5°C stream provides higher quality cooling potential relative to a 20°C ambient.

**energy recovered**

energy used, which would otherwise be wasted.

**energy sources**

conventionally, fossil fuels, hydro, nuclear, solar, geothermal, and wind.

**alternative energy sources**

nondepletable sources alternative to energy derived from combustible waste or heat recovery processes.

**nondepletable energy sources**

sources of energy (excluding minerals) derived from incoming solar radiation, including photosynthetic processes, from phenomena including wind, waves and tides, lake or pond thermal differences, and energy derived from the internal heat of the earth, including nocturnal thermal exchanges.

**waste energy sources**

collectively, energy available and thermally satisfactory for a heating, cooling, or process requirement within an industrial site, partially degraded to ambient conditions, and normally to be exhausted, drained, or removed from the site or thermally converted and removed by the HVAC system.

**energy value target**

energy use value to which a building is designed.

**engine**

prime mover; device for transforming fuel or heat energy into mechanical energy.

**diesel engine**

reciprocating engine that changes thermal energy to mechanical energy using the heat of compression to ignite the injected fuel.

**engineering**

design, technology, and practice by which the properties of matter and the sources of power in nature are made useful to humans in structures, machines, and products.

**environmental engineering**

branch of engineering relating to providing or maintaining an indoor environment.

**refrigerating engineering**

technique of design, manufacture, application, and operation of refrigerating machinery and its primary equipment.

**enthalpy (heat content)**

thermodynamic quantity equal to the sum of the internal energy of a system plus the product of the pressure-volume work done on the system.  $h = E + pv$ , where  $h$  = enthalpy or total heat content,  $E$  = internal energy of the system,  $p$  = pressure, and  $v$  = volume.

**specific enthalpy**

enthalpy per unit mass of a substance.

**enthalpy chart (enthalpy diagram)**

graphical representation of thermal properties of a substance with enthalpy as one of the coordinates.

**entropy chart (entropy diagram)**

graphical representation of thermal properties of a substance with entropy as one of the coordinates.

**entry loss**

loss in pressure caused by a fluid stream flowing into a pipe, duct hood, or vessel.

**environment**

water, land, and air and the interrelationship that exists among and between them and all living things.

**environmental chamber (climatic chamber)**

enclosed space in which it is possible to simulate particular environments.

**environmental conditions**

natural or controlled conditions of air and radiation prevailing around a person, an object, a substance, etc.

**enzyme**

complex organic substance (such as diastase, pepsin, etc.) capable of transforming other compounds by catalytic action; a soluble ferment.

**equalizer**

1. piping arrangement on an enclosed compressor to equalize refrigerant gas pressures in crankcase and suction; also a device for dividing the liquid refrigerant between parallel low-side coils; also a piping arrangement to divide the lubricating oil between the crankcases of compressor operating in parallel or in tandem.
2. piping arrangement to maintain a common liquid level or pressure between two or more chambers.
3. piping arrangement to equalize steam header pressure and condensate return pressure in a steam boiler.

**external equalizer**

in a thermostatic expansion valve, a tube connection from a selected control point in the low-side circuit to the pressure-sensing side of the control element.

**internal equalizer**

in a thermostatic expansion valve, an integral internal part or passage whereby the actuating element (diaphragm or bellows) is exposed to pressure leaving the valve.

**equation of time**

difference between true solar time and local mean time as the result of earth's orbit about the sun. The difference varies throughout the year, reaching a maximum of 16 minutes during the first week of November. See true solar time.

**equilibrium**

steady-state condition, during which the fluctuations of variables remain within prescribed operating tolerances.

**evaporative equilibrium**

condition attained when the wetted wick of a wet-bulb instrument has reached a stable and constant temperature. This temperature approaches the true wet-bulb temperature when the instrument is exposed to air at velocities over 900 ft/min (4.6 m/s).

**mechanical equilibrium**

equilibrium obtained in a system when the performance of the various components of the system remains unchanged.

**thermal equilibrium**

equilibrium obtained in a system when the temperatures are nonvarying.

**equilibrium point dryness (EPD)**

water contact of a liquid refrigerant after being in contact long enough to reach an equilibrium state. EPD is expressed as parts of water per million parts of refrigerant (ppm) on a mass basis.

**equivalent diameter**

diameter of a circle having the same area as another geometric shape.

**equivalent length**

resistance of fittings or appurtenances in a conduit through which the fluid flows, expressed in length of straight conduit of the same diameter or shape that would have the same resistance; also expressed in length/diameter units.

**errata**

list of errors in a standard or guidelines, discovered after publication.

**error (bias)**

1. incorrect step, process, or result.
2. difference between the true or actual value to be measured (input signal) and the indicated value (output) from the measuring system. Errors can be systematic or random.
3. part of an erratum due to a particular identifiable cause; e.g., a truncation error contrasted with mistake. In a restricted sense, that deviation due to unavoidable random disturbances, or to the use of finite approximations to what is defined by an infinite series.

**random error**

statistical error caused by chance and not recurring. A general category for errors that can take values on either side of an average value. To describe a random error, its distribution must be known.

**systematic error**

persistent error not caused by chance; likely to have the same magnitude and sign for every instrument constructed with the same components and procedures.  
error band limit or span over which error can occur.

**ethanol (ethyl alcohol)**

liquid monohydric primary alcohol ( $C_2H_5OH$ ), flammable organic solvent, used also as a motor fuel additive (gasohol).

**ethylene glycol**

clear, colorless liquid used to depress the freezing point of water for use as a secondary coolant in HVAC&R systems. Inhibitors are required to control corrosion caused by ethylene glycol solutions.

**eudiometer**

instrument for volumetric measurement and analysis of gases.

**eupatheoscope**

instrument for assessing comfort environment in terms of operative temperature.

**eutectic**

mixture of substances whose solid and liquid phases in equilibrium have identical composition. Such a mixture has a minimum freezing point.

**eutectic plate**

thin, rectangular container containing eutectic mixture, generally with a coil to be connected to a refrigerating system in order to freeze the mixture.

**eutectic point**

freezing temperature of a liquid mixture which produces a solid phase of the same composition.

**eutectic solution**

mixture that melts or freezes, normally at a specific temperature, with constant composition. Its melting point is usually the lowest possible for mixtures of given substances. See also cryohydrate.

**evaporation**

change of state from liquid to vapor.

**equivalent evaporation**

amount of water a boiler would evaporate, in pounds per hour (kilograms per second), if it received and vaporized feedwater at 212°F (100°C) and standard atmospheric pressure. (Used for comparison of different boilers.)

**evaporation loss (cooling tower)**

water evaporated from the circulating water into the atmosphere by the cooling process.

**evaporation rate**

mass of substance evaporated per unit time.

**evaporator**

part of a refrigerating system in which the refrigerant is evaporated to absorb heat from the contacting heat source.

**circulation-type evaporator**

flooded evaporator comprising a low-pressure receiver, in which the unvaporized refrigerant returns to the evaporator inlet by gravity or by means of a pump or an ejector.

**dry-expansion [direct-expansion (DX)] evaporator**

refrigerant evaporator with organized distribution, from which the refrigerant exits at a vapor quality of one, usually with superheat. Compare flooded evaporator.

**dry-type evaporator**

continuous tube evaporator, in which refrigerant from a pressure-reducing device is fed into one end, and the suction line connects to the outlet end.

**embossed plate evaporator**

evaporator in which the refrigerant passages are formed by sheets having pressed corrugations and welded together.

**flooded evaporator**

refrigerant evaporator characterized by no organized flow, in which most of the evaporator surface is in contact with the liquid refrigerant, and from which the refrigerant exits at a vapor quality of one, without significant superheat. Compare dry-expansion evaporator.

**gravity circulating evaporator**

organized evaporator with circulation induced by a static head of liquid refrigerant driving an opposing column of boiling refrigerant in the evaporator; sometimes referred to as a thermosyphon.

**herringbone (V-coil) evaporator**

evaporator in which the tubes, arranged in the vertical plane, are bent in the form of a vee.

**ice bank evaporator**

evaporator immersed in water, on which an ice bank is formed.

**liquid overfeed (liquid circulation) system evaporator**

evaporator feed system whereby refrigerant liquid is flashed to saturated suction pressure and temperature in an accumulator and is then fed by a mechanical pump or by refrigerant vapor pressure to the evaporators. This liquid is normally fed at a rate greater than the evaporation rate for the refrigerant to ensure wetting of the entire evaporator surface for better heat transfer.

**plate evaporator**

evaporator consisting of two plates between which are arranged channels for the circulation of refrigerant or of a tube grid welded onto a plate or sandwiched between two plates.

**pump fed evaporator**

evaporator in which the refrigerant liquid is circulated by a mechanical pump.

**recirculation-type evaporator**

variant of the preferred terms, circulation-type evaporator, or liquid-overfeed evaporator.

**roll bond evaporator**

evaporator consisting of two metal plates which are weld-bonded together with the exception of the printed circuit forming the refrigerant passage which is obtained by inflation under pressure.

**shell-and-coil evaporator**

closed cylindrical shell containing an evaporator coil which is in contact with the liquid to be cooled.

**shell-and-tube evaporator**

evaporator in which the fluid to be cooled is passed through the tubes which are immersed in the refrigerant.

**spray-type evaporator**

shell-and-tube evaporator in which the tubes are sprayed by liquid refrigerant. starved evaporator condition when an evaporator does not receive sufficient refrigerant.

**tube-in-sheet evaporator (plate evaporator)**

evaporator constructed from a pair of plates assembled to form a shallow compartment containing a coil through which refrigerant flows, the fluid to be cooled circulating in the compartment.

**tube-on-sheet evaporator (plate coil)**

type of extended surface evaporator consisting of one or several metal sheets with a coil through which refrigerant flows, brazed to one face.

**vertical-type evaporator**

evaporator consisting of a series of parallel tubes arranged vertically.

**wrap-around evaporator**

evaporator shaped to form an envelope around the space being cooled.

**evaporator holdover**

ability of an evaporator to stay cold after evaporation stops.

**evaporator unit**

assembly of refrigerating compressor, evaporator, and necessary accessories attached to one base.

**exchanger-diffuser**

in controlled atmosphere storage, an apparatus with a membrane that enables interchange of CO<sub>2</sub> and O<sub>2</sub> between controlled atmosphere rooms and the exterior, but inhibits exchange of other gases.

**excitation**

1. armature current that induces the magnetic field in a rotating electric machine.
2. (fans) external force applied to a system that causes the system to vibrate. See also fan torsional excitation.

**exergy**

expression for the loss of available energy due to the creation of entropy in irreversible systems or processes. The energy loss in a system or component is determined by multiplying the absolute temperature of the surroundings by the entropy increase.

**exfiltration**

converse of air infiltration.

**exhaust opening**

opening through which air is removed from a conditioned space.

**exitance**

total radiant flux that leaves unit area of a surface. The sum of the radiant flux emitted and reflected by the surface plus any radiant flux transmitted through that surface. Compare radiosity.

**spectral exitance**

use radiance.

**exothermic reaction**

chemical reaction that releases more energy (heat) than is required to start it. The combustion reaction (burning) is an example, as are fission and fusion reactions. Compare endothermic reaction.

**expansion**

increase in volume of a substance.

**adiabatic expansion**

expansion of a fluid during which no heat is exchanged with the surroundings.

**dry expansion (direct)**

process of heat removal by a refrigerant in an evaporator fed by a flow control device, responsive to temperature or pressure, or both, at some point in the evaporator, or to the difference between high- and low-side pressures and not to the liquid level in the evaporator. All entering refrigerant is evaporated before being recirculated. See refrigerating system, direct expansion.

**isenthalpic expansion**

expansion of a fluid during which no heat or mechanical energy is exchanged with the surroundings; the enthalpy remains constant.

**multistage expansion**

allowing refrigerant to pass through two or more expansion valves in series with each other.

**polytropic expansion**

expansion of a fluid involving heat exchange.

**thermal expansion**

increase in one or more of the dimensions of a solid body or a liquid volume, caused by a temperature rise.

**expansion bend**

bend, usually a loop, put into a pipe run to relieve stresses induced by expansion and contraction from temperature changes.

**expansion stroke**

part of the piston stroke between the top dead center and the opening of the suction valve.

**expansion valve capacity**

refrigerating effect in watts, Btu/h or tons (12,000 Btu/h), produced by the evaporation of refrigerant passed by the valve under specified conditions.

**expert system**

computer programs that solve problems difficult enough to require human expertise, by using a previously assembled knowledge base and internal procedures. A form of artificial intelligence. See also knowledge-based system.

**face area**

total plane area of the portion of a grille, coil, or other item bounded by a line tangent to the outer edges of the openings through which air can pass.

**facility cost****life cycle cost**

cost of equipment over its entire life, including operating and maintenance cost.

**replacement cost**

estimate of the current or future cost to replace existing facilities either as currently structured or as redesigned to embrace new technology with facilities that will perform the same functions.

**reproduction cost**

estimated cost to reproduce existing facilities in their current form and capability at current cost levels.

**failsafe**

1. position or mode of operation a controlled device takes on removal of the control signal and/or power.
2. *verb.* to return to a position that, on loss of control system power, allows the controlled system to exist in a safe manner.

**failure response**

maintenance department resources expended or reserved for dealing with interruptions in the operation or function of a system or equipment under the maintenance program. This response has two types of classification: repair and service.

**false ceiling (intermediate ceiling)**

ceiling panel supported below the structural ceiling, so the space between may be used for the circulation or distribution of air. Compare suspended ceiling.

**false floor**

secondary floor installed above the original floor, so the space between may be used in air conditioning for the circulation, distribution, or reentry of circulating air. Compare false ceiling.

**fan**

device for moving air by two or more blades or vanes attached to a rotating shaft. See also impeller.

**airfoil**

fan shaped blade (backwardly inclined or forward curved) in a fan assembly to optimize flow, with less turbulence.

**attic fan**

exhaust fan to exhaust air near the top of a building while air, generally cooler, is forced (drawn) in at lower levels.

**axial fan**

fan that moves air in the general direction of the axis about which it rotates.

**bifurcated fan**

tubeaxial fan (ducted) whose motor is mounted outside a bifurcated (divided) duct with only the blades of the fan located in the airstream.

**blower fan**

multibladed, driven rotor enclosed so that air from an inlet is compressed to a higher discharge pressure, which depends on conformation of the blades and the shroud at a given rotational speed. See also impeller.

**centaxial fan**

in-line duct fan with centrifugal blades, which can develop static pressures higher than normal duct fans.

**centrifugal exhauster**

factory-assembled fan consisting of one or several centrifugal wheels directly connected to a motor and enclosed in a housing. An inlet grille and back-draft damper usually are included. Installation can be in a ceiling or wall.

**centrifugal fan**

1. fan in which the air enters the impeller axially and leaves it substantially in a radial direction.
2. fan rotor or wheel within a scroll-type casing (shroud) that includes supports for either belt drive or direct connection.

**circulating fan**

free-flow propeller fan designed to circulate the air in a room without any air duct.

**crossflow fan (tangential fan)**

fan in which air flows through the impeller at a right angle to its axis both on entering and on leaving the impeller at its periphery.

**exhaust fan**

fan used to draw air from a space by suction.

**induced draft fan (ID fan)**

fan exhausting hot gases by suction, normally associated with combustion equipment.

**mixed flow fan**

fan whose characteristics combine both centrifugal and axial airflow.

**plenum fan (plug fan)**

fan assembly consisting of a single inlet impeller, mounted perpendicular to airflow, that pressurizes a plenum chamber in an air distribution system. The impeller is typically an airfoil or backward inclined design.

**propeller fan**

1. fan in which the air enters and leaves the impeller in a direction substantially parallel to its axis.
2. propeller or disc-type wheel within a mounting ring or plate and including driving mechanism supports for either belt drive or direct connection.

**tubeaxial fan**

1. propeller or disc-type wheel within a cylinder and including driving mechanism supports for either belt drive or direct connection.
2. axial fan whose blades revolve in a cylindrical casing. The term "ducted fan" is used when the casing is of substantial length.

**tubular centrifugal fan**

fan with a centrifugal impeller within a cylindrical housing discharging the gas in an axial direction.

**vaneaxial fan**

fan with a disc-type wheel in a cylinder, a set of air guide vanes located either before or after the wheel, and drive mechanism supports for either belt drive or direct connection.

**wind turbine fan (aeolian fan)**

rotating wind-driven device.

**fan air density**

density of air corresponding to the total pressure and total temperature at the fan inlet, when the fan is operating.

**fan appurtenances**

accessories added to a fan for purposes of control, isolation, safety, static pressure regain, wear, etc. Such appurtenances include inlet boxes, inlet box dampers, variable inlet vanes, outlet dampers, vibration isolation bases, inlet screens, belt guards, diffusers, sound attenuators, wear protection, turning gears, etc.

**fan boundary (inlet and outlet)**

interface between the fan and the remainder of the system, at a plane perpendicular to the airstream where it enters or leaves the fan. Appurtenances such as inlet boxes, inlet vanes, inlet cones, silencers, screens, rain hoods, dampers, and discharge cones may be included as part of the fan between the inlet and outlet boundaries.

**fan blast area**

fan scroll outlet area less the area of the cutoff.

**fan casing (volute, scroll)**

part of the casing of a centrifugal fan or compressor that receives fluid forced outward from the impeller or diffuser and leads it to the discharge. Compare fan shroud.

**fan coil unit (fan convector unit)**

fan and a heat exchanger for heating and/or cooling assembled within a common casing.

**fan curve**

diagram showing the pressure/volume characteristics of a fan, and often the power required by the fan.

**fan free-discharge area**

area where the fan chamber meets the discharge scroll. Used in fan system effect calculations.

**fan inlet (outlet) area**

area of the fan or fan equipment fitting provided for connection to attached ductwork.

**fan nodal line**

line of zero vibration response on the fan such that the blades on opposite sides of the line vibrate in opposite phase.

**fan performance curve (constant speed performance curve)**

graphical representation of static or total pressure and power input over a range of air volume flow rate at a stated inlet density and fan speed. It may include static and mechanical efficiency curves.

**fan power**

power input at the fan shaft, or the total of the power input to the fan shaft and the power loss attributable to the power transmission device.

**fan pressurization test**

test for determining the air leakage of a building using a fan-induced pressure difference.

**fan propeller**

propeller or disc-type wheel within a mounting ring or plate, and including driving mechanism supports for either belt drive or direct connection. Compare impeller.  
fan shroud protective housing which surrounds the fan and which may also direct the flow of air. Compare fan casing.

**fan sound power**

sound power radiated into a duct.

**fan static pressure**

difference between fan total pressure and fan discharge velocity pressure.

**fan torsional excitation**

type of excitation in which external force is applied to the fan through the hub in the form of torque pulsations.

**fan total pressure**

arithmetic difference between fan outlet total pressure and fan inlet total pressure.

**fan wheel**

revolving part of a fan or blower. See also impeller.

**fan wheel cone**

inlet ring, impeller shroud, impeller rim annular plate, or conical ring on the air inlet side of a centrifugal fan to which the impeller blades are fixed.

**feedback**

1. returning of a fraction of the output to the input.

2. measurement of an output signal and feeding it back as an input to modify the output.

**feeder (electric)**

main distribution line, usually three-phase, supplying electric energy within an electric service area or subarea.

**fenestration**

1. in an external wall of a building, any area which allows light to pass.
2. commonly used to refer to any opening, usually glazed, in a building envelope; windows.

**fenestration elements**

1. framing, mullions, muntins, and dividers.
2. glazing material, either glass or plastic.
3. external shading devices.
4. internal shading devices.
5. integral (between-glass) shading systems.

**FID**

1. field-installed device.
2. field interface device.

**field (in engineering)**

1. sphere of engineering operation, observation, or intellectual activities.
2. physical area of engineering activity. Compare shop.

**field-installed device (FID)**

microprocessor (DDC) control panel, field mounted and connected. Compare product integrated control.

**field of view (FOV)**

total angular dimensions within which objects can be imaged, recorded, and displayed by an imaging device when pointed in a fixed direction.

**instantaneous field of view (IFOV)**

angle determined by dividing the size of the sensor's detector by the effective focal length of the sensor's objective lens system and multiplying by 1000. Also called resolution element.

**figure-of-merit (FOM)**

performance rating that governs the choice of a device for a particular application, e.g., the efficiency of a material used in a thermoelectric device. See also part-load value.

**film boiling**

boiling phenomenon corresponding to the development of a continuous vapor layer on the heating surface that separates this surface from the boiling liquid.

**filter**

1. device to remove solid material from a fluid.
2. capacitor and/or inductor placed in a series/parallel combination across a DC line to remove the effects of the AC signal or to decrease the ripple voltage in a DC power supply.
3. device to remove gases from a mixture of gases.

**absolute filter**

filter having an efficiency of 99.90% or higher, capable of dealing with particle sizes down to 0.01 micrometre; a HEPA filter.

**brush filter**

air filter in which the filter medium consists of a screen of brushes.

carbon filter filter that utilizes a mass of granulated activated carbon to adsorb certain gases.

**cellular filter (cartridge filter)**

air filter of juxtaposed square or rectangular elements which can be easily dismantled for cleaning or replacement.

**cyclone filter**

funnel-shaped device for removing particles from air or other fluids by centrifugal means.

**disposable filter**

filter whose elements are discarded after use.

**dry layer filter**

filter having dry filtering medium (as opposed to a viscous filter).

**electrostatic filter**

filter in which the airstream is passed through a high-voltage ionizing field to impart an electrical positive charge to particles, then collecting them on electrically negative plates. See also precipitator.

**fabric filter**

filter having a textile-based filter medium.

**fibrous filter (fiber-pad filter)**

filter having a fibrous medium of glass, cellulose, plastics, metal, etc.

**HEPA filter (absolute filter)**

high efficiency particulate air filter.

**impact filter**

filter in which air is submitted to sudden changes of direction and speed, to induce deposit of heavier particles on an adhering surface.

**roll filter (moving curtain filter)**

filter in which the filter medium is a continuous belt on movable rolls to bring clean filter area into the airstream, either automatically or manually.

**suction-line filter**

device installed in the suction line of a refrigerating system for the purpose of removing solid contaminants. The device generally consists of a shell with fittings and an internal filtering element.

**viscous filter**

filter in which the medium is made from materials which have been impregnated with a viscous oil.

**filter cell (filter cartridge; filter unit; filter element)**

interchangeable frame or cylinder containing a filter medium.

**filter drier (filter dehydrator)**

encased desiccant, generally inserted in the liquid line of a refrigerating system, and sometimes in the suction line, to remove entrained moisture, acids, and other contaminants.

**filter medium**

portion of a filtrating system that provides the liquid-solid separation, such as close-woven textiles, metal screens, papers, non-woven fabrics, granular beds, or porous media.

**filter mixing box**

in air-handling units, a combination filter section outside air/return air mixing plenum, including control dampers. Compare VAV box.

**filter press**

device for removing liquid from a slurry or suspension of solids under pressure with the liquid expressed through screens or other filter media until the desired density of the slurry is attained.

**fin**

thin piece of metal attached to a pipe, tubing, or other surface in order to increase the heat transfer area. See also heat transfer surface.

**inner fin**

fin that is formed or fitted inside a tube.

**integral fin**

surface extension formed from the parent material at time of manufacture.

**longitudinal fin**

strip of material parallel to the axis of the tube to which it is fixed.

**plate fin**

plate drilled or punched to receive a number of parallel tubes with the purpose of increasing the heat transfer area.

**spiral fin (helical fin; strip fin)**

continuous strip of metal helically wound and attached to a tube.

**finned length**

on a finned tube, the distance between the two end fins (excluding lengths for return bends and other overall lengths).

**finned surface area**

total area of fins and prime surface of tube or plate to which fins are attached.

**fin pitch**

number of transverse fins per unit length of tube.

**fin spacing**

distance between two successive transverse fins on a tube.

**fire point**

lowest temperature at which a product ignites and continues to burn for a specified time after a small flame has been applied to its surface under standardized conditions. Compare flash point.

**first-hour rating**

amount of hot water that a water heater can supply in an hour of operation.

**fitting system**

part used to join, adjust, or adapt other parts as in a pipe or duct system.

**flame impingement**

condition existing when the flame resulting from the combustion of the fuel comes into contact with any interior surface of the furnace.

**flange**

1. disc rim on the end of a pipe for coupling pipes together, usually by bolts.
2. projection of metal on formed objects.
3. parts of a channel at right angle to the central section or web. See also pipe fitting.

**blank flange**

solid flange that has not been machined.

**blind flange**

flange used to seal the end of a pipe.

**companion flange**

pipe flange to connect with another flange or with a flanged valve or fitting. It is attached to the pipe by threads, welding, or other method and differs from a flange, which is an integral part of a pipe or fitting.

**flat-face flange**

smooth-faced flange used with gaskets that cover the full face of the flange.

**male-female flange (raised face flange; R-F flange)**

male flange carries a boss which fits into a corresponding recess in the female flange.

**raised face flange**

flange that provides a raised, usually serrated, gasket surface.

**tongue-and-groove flange**

male flange carries a projection that fits into a corresponding groove in the female flange.

**weld-neck flange**

flange with a small collar to provide for a butt-weld connection.

**flanking transmission (sound)**

reduction in apparent sound transmission loss of a wall caused by being carried around the wall by other paths (structure-borne, leaks, etc.). See also duct breakout noise.

**flare nut**

nut used to hold flared tubing on a flare fitting.

**flaring tool (flaring block)**

device for shaping the end of a ductile pipe or tube to increase its diameter to a shape suited for a flare fitting.

**flash chamber**

in a refrigerating system, a separating tank placed between the expansion device and evaporator to separate and bypass any flash gas formed due to pressure reduction.

**flashing**

flash vaporization.

**flash intercooler**

vessel located between compression stages where injected liquid refrigerant vaporizes immediately.

**flash point**

1. lowest temperature to which a product must be heated for its vapors to ignite in the presence of a flame when operating under standardized conditions. Compare fire point.
2. in a vacuum cooling chamber, that pressure corresponding to the vapor pressure at the product temperature and below which water vaporizing commences.
3. in a piping suction, the pressure below which the liquid will flash into vapor.

**flash vaporization (instantaneous vaporization)**

partial or total vaporization obtained by sudden reduction of pressure.

**flavor**

mingled sensation of aroma and taste.

**floating action**

continuous action in which the input variable determines the rate of change of the output variable; e.g., in the case of a controller, of the system deviation change.

**floating floor**

composite flooring system which exhibits a high sound transmission loss value, consisting of a "floating" flooring surface supported from a structural floor through the use of a series of vibration isolation pads.

**flock point**

temperature observed at the start of the formation of wax or other solid; determined by a standardized test to assess the low-temperature compatibility of certain petroleum products with refrigerants.

**floor area (gross, of a building)**

area within the perimeter of the outside walls as measured from the inside surface of the exterior walls, with no deduction for hallways, stairs, closets, thickness of walls, columns, or other interior features; used in determining the required number of exits, or in determining occupancy classification. Compare architectural area.

**floor area (net, of a building)**

actual occupied area, not including accessory unoccupied areas or thickness of walls; used in determining the required number of exits.

**floor rack (airflow floor)**

type of floor used in vehicles or cold rooms; allows air circulation beneath the load of ware.

**flotation**

method of treating material by floating in a liquid; an ice-making method in which ice floats away from the surface on which it has been frozen.

**flow**

continuous motion of a fluid in pipes, ducts, channels, or through openings. See also airflow; backflow; slip.

**annular flow**

form of two-phase flow in a pipe where the gas forms the core and the liquid flows annularly against the internal walls of the pipe.

**balanced flow**

airflow where the supply volume equals the exhaust volume.

**boundary-layer flow**

flow of that portion of a viscous fluid in the area of a body in contact with the fluid, and in motion relative to the fluid.

counterflow in heat exchange between two fluids, the opposite direction of flow; i.e., the coldest portion of one fluid meeting the coldest portion of the other.

dispersed flow form of two-phase flow, where the overriding gaseous phase entrains dispersed large liquid drops.

emulsion flow (bubble flow) form of two-phase flow where the liquid carries finely dispersed bubbles of gas.

laminar flow (streamline) fluid flow in which all the particles move in substantially parallel paths.

**molecular flow**

gaseous flow where the average free path of the gas molecules is greater than the largest dimension of the cross section of the duct.

parallel flow see parallel flow heat exchanger.

**plug flow (piston flow)**

1. form of two-phase flow in which plugs of gas and liquid flow alternately in the pipe.

2. flow regime where the flow is predominantly in one direction and any contaminants are swept along with the flow.

3. flow of solids suspended in liquid, characterized by slippage of the cylindrical mass and equal velocity in cross section.

**pulsating flow**

fluid flow phenomenon characterized by periodic (or pseudoperiodic) variation in velocity.

**separated flow**

phenomenon that occurs when a fluid flowing along a wall separates itself from the wall, caused by a change in wall orientation such as a relatively short radius of curvature. *Note:* Separated flow occurs particularly at the edges of the blades of a turbomachine.

**stonewall flow (choking flow)**

state at which gas flow through a pipe or a centrifugal compressor reaches conditions that significantly impede flow.

**slug flow**

plug flow.

**stratified flow**

form of low velocity two-phase flow in horizontal pipes, so that the free surface of the liquid remains level between a gaseous and liquid phase above and below it, respectively. See also airflow.

**superfluid flow**

frictionless passage of helium (He II) through narrow channels or capillaries.

**turbulent flow (eddy flow)**

fluid flow in which the velocity varies in magnitude and direction in an irregular manner throughout the mass.

**two-phase flow**

simultaneous flow of two phases of a fluid, usually gas-liquid flows. See also slip.

**variable flow**

throttling control of water during a cooling or heating process.

**viscous flow**

1. laminar flow or streamline flow.
2. type of gas flow in which the average free path of gas molecules is much smaller than the smallest cross-sectional dimension of the pipe conveying the substance.

**wavy flow**

1. in horizontal pipes carrying two-phase liquid-vapor systems, the alternation of full liquid and partially full liquid levels that progress as waves along the pipe.
2. separated flow of vapor and liquid in a conduit.

**flow area**

in a heat exchanger with a bundle of tubes, the section that is effectively traversed by the external fluid. (This section often varies from one point to another of an exchanger.)

**flow capacity (of a filter)**

refrigerant gas flow that a filter passes while maintaining a specified pressure drop across the clean filter. The flow capacity is expressed in lb/min (g/s) flow at a specified evaporator temperature and return gas temperature for the given refrigerant.

**flow nozzle**

tube specially shaped to increase the discharge velocity of the fluid.

**flow pattern**

configuration of the direction and velocity of a flowing fluid.

**flow velocity**

velocity (local or average) of a fluid in a pipe, duct, or canal, or from an orifice.

**flue**

1. passage through which flue gases pass from a combustion chamber to the outside atmosphere.
2. conduit between the flue outlet of the furnace and the integral draft diverter, draft hood, barometric draft regulator, vent terminal, or any other point of draft relief.

**appliance flue**

flue within an appliance.

**chimney flue**

chimney for conveying the flue gases to the outside atmosphere.

**dilution flue**

flue designed to effect the dilution of flue gases with air before discharge from an appliance.

**flue collar**

that portion of an appliance designed for attachment of a chimney, vent connector, or a draft hood.

**flue gas collector**

chamber designed to capture the products of combustion and accompanying excess air.

**flue gas receptor location**

any point (e.g., an openable window, an occupied terrace) at which a person in a nearby building can become exposed to flue gases emanating from a chimney. Receptor locations include intakes of air-conditioning and ventilating systems.

**flue gas vent**

conduit or passageway for conveying flue gases to the outer air.

**flue outlet**

opening provided in an appliance for the release of flue gases.

**fluid**

substance, as a liquid or gas, that is capable of flowing, and which changes shape when acted on by a force.

**working fluid**

medium evolving within a thermodynamic cycle.

**fluidics**

science and technology of using the properties of flow of fluids, to perform functions of sensing, amplifying, and control in nonelectric circuits, and without the use of any mechanical moving parts.

**fluid mechanics**

mechanics of flowing (deforming) fluids, involving changes in momentum, direction of flow, turbulence, pressure, and volume.

**fluorocarbon**

any of a broad group of organic compounds analogous to hydrocarbons, in which all or most of the hydrogen atoms of the hydrocarbon have been replaced by fluorine; some types also contain chlorine, and these are called chlorofluorocarbons. The saturated aliphatic-type fluorocarbons comprise the series of refrigerants developed by Midgeley in the 1930s. Compare halocarbon.

**flux**

amount of some quantity flowing across a given area (often a unit area perpendicular to the flow) per unit time. *Note:* The quantity may be, for example, mass or volume of a fluid, electromagnetic energy, or number of particles. See also magnetic flux; heat flux.

**brazing flux**

substance or mixture that promotes fusion and prevents formation of or eliminates oxides, nitrides, or other undesirable inclusions in the brazing area.

**soldering flux**

chemical substance that aids the flow of solder and serves to remove and prevent formation of oxides on the pieces to be joined.

**flywheel**

heavy wheel attached to a shaft to reduce rotation fluctuations.

**FMS**

facility management system.

**foaming**

formation of a foam or froth of oil refrigerant due to rapid boiling out of the refrigerant dissolved in the oil when the pressure is suddenly reduced. See also boiler foaming.

**FOM**

figure of merit.

**force**

1. action on a body which induces changes of rest or motion.
2. physical cause capable of modifying the motion of a body. The vector sum of the forces acting on a body at rest or in uniform rectilinear motion is zero.

**forced lubrication**

mechanical lubrication. See also pump lubrication.

**forecooler**

in an ice plant, a device for cooling water before pouring into ice-making cans; precooler.

**FOV**

field of view.

**fractionation**

separation of a liquid mixture into parts by the preferential evaporation of the more volatile component.

**free convection number****free water**

in organic tissues, that part of water which can be easily removed, because it is not held by adsorptive forces.

**freezant**

medium, usually a liquid cooled by the evaporator of a refrigerating system, used to freeze products.

**freeze concentration (cryoconcentration)**

concentrating a solution by partial freezing of water and removing ice crystals.

**freeze desalination**

freezing saline or brackish water, so that salt-free ice crystals are formed, then removed and melted.

**freeze dryer**

apparatus or system for drying substances by dehydration in a frozen state. drum freeze dryer apparatus having a rotating cylinder in which a product is freeze dried.

**freeze drying (lyophilization)**

dehydration of a substance by freezing, and subsequent sublimation of ice.

**atmospheric freeze drying**

process in which the solid phase of the solvent is sublimed at atmospheric pressure.

**centrifugal freeze drying**

process in which a liquid product is vacuum frozen while being centrifuged in order to avoid foaming.

**continuous freeze drying**

process in which the product is continuously moved through the drying chamber. secondary drying in freeze drying, the removal of most of the solvent retained in the product after primary drying.

**spray freeze drying**

freeze drying process during which a liquid product is spray frozen prior to sublimation of the ice.

**freeze drying additive**

substance added to a product to be freeze dried in order to facilitate recovery of the frozen mass.

**freeze out**

to separate the constituents of a mixture by freezing one of them.

**freezer**

1. in cold storage, an insulated room kept below 30°F (−1°C).
2. device for freezing perishables. See freezing room.

**blast freezer**

chamber in which cold air is circulated rapidly around products to be frozen so that freezing occurs rapidly enough to avoid formation of large ice crystals that may damage the product.

**carrying freezer**

cold storage freeze room, generally kept between −20 and 20°F (−29 and −7°C) to receive and hold frozen goods.

**chest freezer**

freezer in which access is gained by raising a lid.

**contact freezer**

freezer in which the product is frozen by contact with a refrigerated surface.

**double-contact freezer**

contact freezer in which the product to be frozen is placed between two refrigerated surfaces and makes contact with both.

**fluidized bed freezer**

trough having a perforated bottom through which an upward flow of cold air suspends the produce, usually of small unit size, and causes it to flow like a fluid.

**household freezer**

cabinet designed for extended storage of frozen food at a recommended temperature of 0°F (−18°C), with inherent capability for freezing of food and a source of refrigeration; intended for household use.

**multiplate freezer**

double contact freezer consisting of a series of parallel refrigerated metal plates.

**plate freezer**

contact freezer in which the refrigerated surface is a flat metal plate. Compare double contact freezer.

**scraped surface freezer**

apparatus in which a liquid freezes on the surface of a cooled drum to form a thin layer which is removed by a scraper.

**sharp freezer**

cold storage freezer room, generally kept at −30 to −10°F (−34 to −23°C), to receive unfrozen goods and freeze them.

**spray freezer**

insulated enclosure in which refrigerated liquid is sprayed over the product to be frozen.

**tunnel freezer (freezing tunnel; blast-freeze tunnel)**

elongated enclosure provided with rapid cold air circulation for the freezing of foodstuffs.

**upright freezer**

freezer in which access is gained through a side-opening door.

**walk-in freezer**

freezer chamber large enough to walk in.

**freezer burn**

damage to frozen produce caused essentially by excessive desiccation. Compare cold injury.

**freezer capacity**

amount of produce that can be installed at one operation.

**freeze-thaw resistance**

property of a material which permits it to be alternately frozen and thawed through many cycles without damage.

**freeze-up**

1. failure of a refrigerating unit to operate normal-ly due to formation of ice at the expansion device.
2. frost formation that impedes airflow through a coil.

**freeze-up control**

1. control device that prevents failure of a refrigeration system due to formation of ice at the expansion device or in a coil such that it impedes airflow.
2. thermostatic device that senses the approach of an icing condition and makes compensating adjustments.

**freezing**

process of changing a liquid substance or the liquid content of a food or other commodity to a solid state by removing heat.

**bulk freezing**

freezing of unpackaged products.

**contact freezing**

freezing of produce by direct contact with a refrigerated surface.

crust freezing (shell freezing) very quick freezing of the outer part of a product (mainly poultry), final freezing being completed by conventional methods.

**food glazing**

freezing a coat of ice on frozen foods by dipping the product in water, with the latent heat absorbed inward.

**individual quick-freezing (IQF)**

freezing of food units of small size (e.g., peas, shrimp) individually separated.

**jet freezing**

quick freezing process using cold air at very high speed forced onto the produce. Also called blast freezing.

**quick-freezing (deep-freezing)**

freezing of a food or other commodity at a rapid rate of temperature reduction to produce a desired crystalline structure in the frozen product.

**refrigerated plate freezing**

heat removal by direct contact of the packaged product with refrigerated plates.

**shell freezing**

freezing of a liquid in thin layers on the walls of rotating bottles.

**slow freezing**

freezing of produce without attempting to reduce the temperature rapidly below that of the zone of maximum crystallization.

**soil freezing**

1. in public works, freezing the moisture in unstable water-bearing soils, in order to facilitate digging mine shafts, tunnels, or foundations.
2. accidentally occurring under the floors of cold rooms (frost heave).

**spray freezing**

freezing of produce by spraying with a refrigerated liquid.

**still air freezing**

freezing of produce in a room without mechanical movement of air.

**tray freezing**

freezing food arranged on shallow trays which are placed on portable racks and put in an insulated chamber through which cold air is blown.

**vacuum freezing**

freezing of a substance by lowering pressure to induce vaporization of a part of the solvent (usually water).

**freezing capacity**

mass of produce that can be frozen per unit time by a particular freezer in specified conditions of entry and final temperature.

**freezing mixture**

mixture of salts with crushed ice to lower its melting point.

**freezing plant**

installation, factory, etc. designed to freeze products, usually to prepare frozen foods.

**freezing plateau (thermal arrest)**

during the freezing of produce, that part of the graph of temperature against time, in which the temperature remains virtually constant. It is induced by the time required to remove latent heat.

**freezing point depression**

difference between the freezing temperature of a pure solvent and that of a solution.

**freezing rate (speed of freezing)**

ratio between the distance from the mean surface of a food mass to its thermal center and the time elapsed between the surface reaching 32°F (0°C) and the thermal center reaching 14°F (−10°C).

**freezing room**

cold chamber usually kept at temperature of −22 to −31°F (−30 to −35°C), with high volume air circulation. See freezer.

**freezing section**

in a food processing plant, that section where foods are frozen.

**freezing time**

time for any complete freezing process to take place.

**effective freezing**

time time required from a given initial temperature, to freeze a product and to lower its temperature at the thermal center to a given value.

**nominal freezing**

time for a given product of specified dimensions and at an initial uniform temperature of 32°F (0°C), the time it takes for the thermal center to reach 14°F (−10°C).

**frequency**

number of cycles per second through which an alternating electric current passes; in North America, generally standardized at 60 cycles per second (60 Hz).

**frequency response (of a fan)**

normalized motion response of a fan to a known excitation, expressed as a function of the frequency of the excitation. The frequency response usually is given graphically by curves showing the relationship of the response to the excitation (and, where applicable, phase shift or phase angle) as a function of frequency.

**fresh air makeup**

volume of outside air introduced into a space.

**freshness index**

sensory index (usually a 9 point scale) of subjective assessment of the purity of air by occupants.

**frictional resistance**

resistance of fluid flow due to friction between the fluid and the contact surface over which it flows.

**friction loss**

pressure loss due to friction between a flowing fluid and its contact surface.

**friction ring (rubbing ring)**

component, rotary or fixed, of a shaft seal with a precision-machined contact face of the ring that provides the gas-tight seal.

**frost**

water from airborne droplets or vapor frozen on a surface.

**frostback**

coating of frost on suction line and crankcase due to liquid refrigerant leaving an evaporator and carried along the suction line into the compressor crankcase.

**frostbite (frost damage; freezing injury)**

injury to living beings or produce caused by formation of ice in tissues.

**frost deposit**

frost formed on the cold surface (tubes, plates) of a cooling coil.

**frosted**

coated with frost.

**frost formation**

frost formed on any cold part of a refrigerating circuit.

**frost heave**

rising of the cold store floor due to the expansion of freezing water in the supporting soil.

**frost level indicator**

pipe loop projecting from a vessel showing approximately the liquid level by the frost formation.

**frozen earth storage (frozen ground storage; frozen soil storage)**

underground storage of liquefied gas within a space with walls, floor, and roof consisting of frozen soil or rock.

**frozen food**

food in which the contained water is in solid form.

**frozen food cabinet**

refrigerated cabinet for the short-term storage of frozen foods.

**frozen food display case**

refrigerated counter designed for displaying frozen foods.

**frozen food locker**

individual lockable compartment in a collective multicompartment establishment for the freezing and storage of food.

**frozen food store**

store that contains exclusively frozen food storage rooms.

**frozen food storage room (freezer room)**

cold room designated to receive and store frozen foods.

**frozen food weight factor**

conversion factor of 35 lb/ft<sup>3</sup> (560 kg/m<sup>3</sup>) for a net freezer space weight rating. Many commercially available packaged frozen foods weigh less than 35 lb/ft<sup>3</sup> (560 kg/m<sup>3</sup>).

**fuel**

1. substance which is burnable to provide heat.
2. nuclear substance usable in system energy generation, usually electricity.

**fossil fuel**

organic material occurring in nature excluding wood, including but not limited to coal, oil, and natural gas.

**refuse-derived fuel (RDF)**

refuse used as a combustion fuel source to provide heat in a district heating plant.

**fuel input rate**

rate at which fuel is supplied to an appliance. The rate may be expressed in Btu per hour, watts, or thousands of Btu per hour; in cubic feet per hour, litres per second, or thousands of cubic feet per hour; in therms (th) or dekatherms (dth) per hour, or in gallons per hour.

**fume hood**

fume collection device mounted over a closed table or shelf serving to conduct unwanted gases away from the area enclosed.

**compensating hood**

hood capable of compensating for local high velocities and turbulence caused by sash equipment placed within, or operator interference at the hood face, or traffic past the hood face.

**fume hood face**

plane of minimum area at the front portion of a laboratory fume hood through which air enters when the sash(es) is fully opened, usually in the same plane as the sash(es) when present.

**fume hood performance rating**

series of numbers and letters indicating the specific performance characteristics. fume hood specified rating hood performance rating as specified, proposed, or guaranteed in either the purchase of the hood, in the design and construction of the laboratory, or both.

**fume hood system**

arrangement consisting of a fume hood, its adjacent room environment, and the equipment, such as blowers and ductwork, required to make the hood operable. fumes very small airborne particles, usually less than one micrometre in size, from burning or melting materials.

**fumigation**

in the food industry, exposure of a product to gaseous substances, generally to kill insects, their eggs, and larvae.

**functional performance**

rating full range of checks and tests carried out to determine if all components, subsystems, systems, and interfaces between systems function in accordance with the contract documents. In this context, "function" includes all modes and sequences of control operation, all interlocks and conditional control responses, and all specified responses to abnormal and emergency conditions.

**fungicide**

substance capable of killing parasitic fungi.

**furnace**

1. part of a boiler or warm air heating system in which energy is converted to heat.
2. enclosed chamber or structure in which heat is produced, as by burning fuel, or by converting electrical energy.

**attic-type central furnace**

one designed specifically for installation in an attic or in a space with low headroom, normally unoccupied.

**condensing furnace**

one that circulates the products of combustion and extracts available heat to a point that causes condensation to occur. Some of this latent heat of condensation is recovered as usable energy, resulting in higher operating efficiency.

**downflow-type central furnace**

one designed with airflow essentially in a vertical path, discharging air at or near the bottom of the furnace.

**Dutch oven furnace**

extended furnace with a refractory cover, generally shaped to reradiate heat back onto the burning fuel.

**forced warm air furnace**

central furnace equipped with a blower which provides the primary means for circulation of air.

**horizontal-type central furnace**

one designed with airflow through the furnace essentially in a horizontal path.

**upflow-type central furnace**

one designed with airflow essentially in a vertical path, discharging air at or near the top of furnace.

**warm air furnace**

self-contained, direct-fired, or electrically heated furnace designed to supply heated air through ducts to spaces that require it.

**furnace firebox**

combustion chamber in a furnace.

**furnace stoker**

device that automatically feeds solid fuel to a furnace (used mainly with coal).

**furnace volume**

space enclosed by the chamber floor, the refractory walls, the heat-absorbing water walls of a boiler firebox, and the crown sheet, shell, or water tubes of a boiler. If a target wall (bridgewall) is installed in the furnace, the furnace volume is reduced by the volume behind the bridgewall.

**fusible plug**

safety device for release of pressure by melting a contained substance with a predetermined melting temperature.

**fusion**

change of phase from solid to liquid.

**gage (gauge)**

1. instrument for measuring pressure, flow, level, or other factor.
2. arbitrary scale of measurement for sheet metal thickness and wire and drill diameters.

**bourdon gage**

mechanical pressure measuring instrument that senses pressure with a curved oval tube that tends to straighten when the pressure increase and recurves when the pressure decreases.

**compound gage**

pressure gage that indicates pressures above and below atmospheric pressure.

**discharge gage (high-pressure gage; head pressure gage)**

gage fitted to the high-pressure side of a refrigerating system.

**ionization vacuum gage**

gage operated via the ionization of a gas, measuring the ionic current.

**oil pressure gage**

gage fitted to the delivery side of an oil pump.

**pressure gage**

instrument for measuring pressure above or below atmospheric pressure.

**service pressure gage**

pressure gage temporarily used during the installation and servicing of a refrigerating system.

**suction gage (low-pressure gage; back-pressure gage)**

gage fitted to the low-pressure side of a refrigerating system.

**thermal conductivity vacuum gage**

vacuum gage consisting of two surfaces at different temperatures between which heat is transported by gas molecules (in vacuum techniques).

**vacuum gage**

gage for measuring pressures below atmospheric pressure.

**gage glass**

device for showing liquid level.

**gas**

state of matter in which substances exist in the form of nonaggregated molecules, and which, within acceptable limits of accuracy, satisfy the ideal gas laws; usually a highly superheated vapor. See state.

**flash gas**

portion of the liquid refrigerant which is vaporized by sudden reduction of pressure.

**flue gas (vent gas)**

all gases in a flue during combustion in the combustion chamber, including reaction products such as excess air, carbon dioxide, carbon monoxide, oxygen, water vapor, nitrogen, and other inerts.

**hot gas**

refrigerant gas in the high-pressure side of the system.

**ideal gas (perfect gas)**

gas whose internal energy and enthalpy depend solely on temperature and which is defined by  $pV = RT$ .

**incondensable gases**

gases, other than water vapor, found in steam and produced at the boiler; containing oxygen and carbon dioxide as causes of corrosion in steam and condensate systems.

**inert gas**

gas that neither experiences nor causes chemical reaction nor undergoes a change of state in a system or process, e.g., nitrogen or helium mixed with a volatile refrigerant.

**liquefied petroleum gas (LPG)**

mixed hydrocarbon gases stored under pressure in liquid form.

**natural gas**

naturally occurring mixture of hydrocarbon and non-hydrocarbon gases found in porous geologic formations beneath the earth's surface, often in association with petroleum. The principal constituent is methane.

**noncondensable gas (foul gas)**

gas in a refrigerating system that does not condense at the temperature and partial pressure at which it exists in the condenser, therefore imposing a higher head pressure on the system.

**storage gas**

in controlled atmosphere storage, a gas or atmosphere with carbon dioxide added.

**gas-air mixture****lean mixture**

gas-air mixture of which the air content is more than adequate for complete combustion, and the resultant combustion gases will contain an excess of oxygen.

**rich mixture**

gas-air mixture of which the air content is not sufficient for complete combustion, and the resultant combustion gases will contain burnable but unburned hydrocarbons.

**gas binding rate**

gas ebullition rate that flushes liquid out of the evaporator, creating a pressure that prevents infeed, resulting in drying of the evaporator surface.

**gas capacity (I-P)**

concept of power throughput, in Btu/h, at 1-inch water column pressure drop for the gas being used.

**gas demand rate**

rate at which gas is delivered to or by a system, part of a system, or a piece of equipment, expressed in cubic feet (cubic metres or litres) or therms (MJ) or multiples thereof, for a designated period called the demand interval. Compare gas load.

**gas enrichment**

increasing the heat content of a gas by mixing with it a gas of higher heat content.  
gaseous state see state; gas; phase.

**gas load**

amount of gas delivered or required at any specified point or points on a system; load originates primarily at the gas-consuming equipment of customers.

**generating capability (electric)**

maximum load that a generating unit, generating station, or other electrical apparatus can carry under specified conditions for a given period, without exceeding approved limits of temperature and stress ratings.

**gland**

device for preventing leakage at a machine joint, such as where a shaft emerges from a vessel containing a fluid under pressure.

**gravity current**

stream of incoming fluid that moves horizontally immediately adjacent to the upper or lower boundaries of a stagnant body of fluid. The stream moves due to density differences between the fluid in the stream and that in the stagnant body of fluid. See also Froude number.

**grille**

louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

**ground coupling**

in a thermal storage system or a heat pump, a closed loop of piping, plastic tubing, or ducting used as a heat exchanger between the ground, acting as a low-grade heat source, and a circulating fluid.

**ground fault**

unintentional electrical connection to ground. electrical ground zero voltage, or any point electrically connected to the earth, or ground.

**guide vane assembly**

assembly of adjustable guide vanes fitted to the inlet of a fan or turbocompressor. Its function is to modify the flow and the pressure/flow rate.

**pre-rotary vane assembly**

in a turbocompressor, an assembly of adjustable guide vanes fitted to the inlet; its function is to orient the fluid so that the pressure/flow rate characteristics can be modified.

**pre-rotation vane (pre-rotary vane)**

guide vane in the pre-rotary vane assembly of a turbo-compressor.

**halide torch**

device to detect gas leaks using the color changes of a flame in the presence of a halogenated hydrocarbon.

**halocarbon**

compound containing carbon, one or more halogens, and sometimes hydrogen. Compare fluorocarbon.

**halogen**

one of the electronegative elements of Group VII A of the periodic table of the elements (fluorine, chlorine, bromine, iodine, and astatine); listed in the order of their chemical activity, fluorine being the most active of all chemical elements.

**hard copy**

printed copy of machine output, e.g., printed reports, listings, documents, and summaries.

**hardening (quenching)**

1. rapid cooling from specific temperatures of metallic products, particularly steel, in order to increase hardness.
2. cooling the product from the ice cream freezer in order to freeze most of the water not solidified in the freezer.

**hardware**

parts such as fasteners, hinges, shovels, and rakes. See also computer hardware.

**hard-wired**

1. in electronic circuits connected with wires.
2. method of programming a system to perform specified functions through the use of wires (often patchboard styles, or, more recently, readonly memory techniques) as opposed to a stored program or software method.

**Hartford loop**

condensate return arrangement for low-pressure steam-heating systems, featuring a constant waterline in the boiler.

**HCFC**

halocarbon that contains fluorine, chlorine, carbon, and hydrogen.

**HDD**

heating degree-day. Degree-day for departure below the base. See degree-day.

**head**

1. energy per unit mass of fluid divided by gravitational acceleration.
2. in fluid statics and dynamics, a vertical linear measure. *Note:* The terms head and pressure are often mistakenly used interchangeably. See also suction head.

**friction head**

height of liquid that represents system resistance caused by the flow. (Not an SI term.)

**pressure head**

hydrostatic height of fluid, equal to the fluid pressure divided by the density times the gravitational acceleration.

**static head**

hydrostatic height of a fluid.

**total head**

sum of static head, pressure head, and velocity head.

**velocity head**

height of fluid corresponding to the kinetic energy per unit mass of fluid divided by gravitational acceleration.

**header**

1. pipe or tube (extruded, cast, or fabricated) to which a number of other pipes or tubes are connected.
2. removable end cover.

**steam header**

1. horizontal piping connected to a boiler steam outlet or outlets.
2. in a location out of a boiler room, where a steam main extends into several branches located close together.

**head loss (dynamic head loss)**

during flow, the reduction in the velocity head.

**heat**

1. energy that is transferred in the direction of lower temperature.
2. form of energy which is exchanged between a system and its environment or between parts of the system induced by temperature difference existing between them.

**fermentation heat**

heat evolved during a fermentation process.

**heat of fusion (fusion heat)**

1. latent heat involved in changing between the solid and the liquid states.
2. heat energy required to cause a change of state from solid to liquid at constant temperature. For ice-to-water: 143.5 Btu/lb (333.8 kJ/kg).

**humid heat**

ratio of increase of enthalpy per unit mass of air, with its associated moisture, to the rise of temperature under conditions of constant pressure and specific humidity.

**latent heat**

change of enthalpy during a change of state.

**latent heat of condensation**

quantity of heat released on change of unit mass of vapor to liquid with no change in temperature.

**latent heat of vaporization**

heat energy required to cause a change of state from a saturated liquid to a saturated vapor, measured in Btu/lb mass (J/kg).

**mechanical equivalent of heat**

in SI, one joule of heat equals one joule of mechanical work.

**metabolic heat**

heat produced by oxidation of food elements (i.e., metabolism) in humans or animals. The met represents the average heat produced by a sedentary man: approximately 90 kcal/h or 100 W (340 Btu/h).

**radiant heat**

heat transferred by radiation.

**recoverable heat**

portion of thermal input to a prime mover that is not converted to mechanical power and can be reclaimed.

**respiratory heat**

in plants, heat evolved during the respiratory process (absorption of oxygen and evolution of CO<sub>2</sub>).

**sensible heat**

heat which causes a change in temperature.

**specific heat**

ratio of the quantity of heat required to raise the temperature of a given mass of any substance one degree to the quantity required to raise the temperature of an equal mass of a standard substance one degree [usually water at 59°F (15°C)].

**total heat**

enthalpy.

**waste heat**

unused heat rejected from a system, usually a heat engine or combustion furnace, to its surroundings.

**heat anticipation**

ability of a thermostat to terminate heat input at a temperature lower than its setting, and in advance of the time that the rising air temperature at the thermostat normally would cause the thermostat to terminate heating.

**heat balance**

statement that shows the changes in a system from heat and work input to output losses.

**heat bridge (heat channel; heat leak)**

part of the boundary construction of an insulated enclosure through which heat can flow readily by conduction.

**heat capacity**

amount of heat necessary to raise the temperature of a given mass one degree; numerically, the mass multiplied by the specific heat.

**heated slab**

concrete slab-on-ground floor, heated by integral wires, cables, pipes, or ducts, that radiates heat to a conditioned space.

**heated space**

space within a building which is provided with a positive heat supply. Finished living space within a basement, or registers or heating devices to supply heat to a basement space automatically define that space as heated space.

**heat equivalent of work**

heat energy corresponding to a unit of mechanical energy. See heat, mechanical equivalent of.

**heater**

apparatus or appliance to supply heat to a space or a fluid. See also water heater.

**blast heater**

set of heat transfer coils or sections used to heat air which is drawn or forced through them by a fan. A unit heater.

**direct-fired heater**

fuel burning device in which the heat from combustion and the products of combustion are transferred directly to the space to be heated.

**electric heating element**

unit assembly of a resistor, insulated supports, and terminals for connecting the resistor to electric power.

**indirect-fired heater**

one in which combustion products do not come into contact with the material to be heated; heating of the material is accomplished by radiation or conduction from the heated surface.

**integrated heater**

boiler operated in conjunction with an indirect-fired storage water heater or an external storage tank in which domestic water, heated by the boiler, is stored.

**noncontaminating heater**

one used with a heavy oil burner that avoids contamination of the water supply to the heater.

**unit heater**

heater consisting of a fan for circulating air over a heat-exchange surface, all enclosed in a common casing.

water heater low-pressure, hot water boiler having a volume not exceeding 120 gallons (450 L), or a heat input not exceeding 200,000 Btu/h (60 kW), or an operating temperature not exceeding 250°F (120°C), to provide hot water to a system.

**heater cable (heater tape; heater strip)**

electrical heating element usually fitted to cold room doors to prevent icing.

**heater mat**

electrically heated wire mesh or heated liquid network embedded in a cold store floor to prevent freezing of water, which may be in the soil below.

**heat exchange**

process of heat transfer in which heat flows from one substance to another.

heat exchange surface surface area of any heat exchanger available for transmitting heat.

**extended heat exchange surface (augmented surface)**

increased area for heat flow by means of fins, discs, etc.

**heat exchanger (heat interchanger)**

device to transfer heat between two physically separated fluids. See also heat exchanger system; superheater.

**air-to-air heat exchanger**

exchanger that transfers heat from an exhaust airstream to a separated supply airstream. *Note:* Fixed plate, rotary wheels, heat pipes, runaround coil loops, and shell-and-tube are the most common types.

**counterflow heat exchanger**

heat exchanger in which fluids flow in opposite directions approximately parallel to each other; inlets for the two fluids are at opposite ends of the exchanger.

**crossflow heat exchanger**

heat exchanger in which fluids flow perpendicular to each other.

**direct contact heat exchanger**

apparatus in which the fluids exchanging heat are brought into contact with each other.

**double pipe heat exchanger**

two pipes arranged concentrically, one within the other, and in which one fluid flows through the inner pipe and the other through the annulus between them.

**double wall heat exchanger**

two fluids separated by two walls with the space between open to the atmosphere so that a fracture on one wall will not transfer one fluid into the other. Used in water systems with a potable fluid and a potentially hazardous fluid.

**heat pipe heat exchanger**

tubular closed chamber containing a volatile fluid in which heating one end of the pipe causes the liquid to vaporize and transfer to the other end where it condenses and dissipates its heat. The liquid that forms flows back toward the hot end by gravity or by means of a capillary wick.

**indirect heat exchanger (water heater)**

heat exchanger taking heat from steam or water rather than heat directly.

**liquid or suction heat exchanger**

superheater.

**multichannel heat exchanger**

apparatus in which fluids exchange heat by flowing in an assembly of separated channels.

**multitubular heat exchanger (multipipe heat exchanger)**

heat exchanger consisting of an assembly of tubes which convey one of the heat exchange fluids.

**parallel flow heat exchanger**

heat exchanger in which fluids flow approximately parallel to each other and in the same direction.

**plate heat exchanger**

fixed plates that separate and keep the hot and cold fluids separate. (See also plate liquid cooler).

**rotary heat exchanger**

apparatus in which the heat exchange surface rotates.

**runaround heat exchanger**

finned tube coils (closed system) or spray chambers (open systems) in which a liquid is circulated by gravity or pump action through a heat source exchanger and then through a heat sink exchanger. Antifreeze may be used in the coil loop, and a desiccant in the spray system.

**scraped heat exchanger**

exchanger having a surface on which a fluid can be solidified and the solid layer scraped off.

**shell-and-tube heat exchanger**

nest of tubes or pipes, or a coil of tube or pipe, contained in a shell or container. The pipe(s) carries a fluid through it, while the shell is also provided with an inlet and outlet for flow of another fluid.

**heat exchanger casing**

structure which encloses the heat exchanger and forms a passage around it for the fluid being heated.

**heat exchanger face area**

in a heat exchanger, with a bundle of tubes, the section that is effectively traversed by the external fluid just before it passes through the tube bundle. The area measured is the lesser area of the two heat exchanger surfaces.

**heat exchanger heating surface**

area intended for transferring heat.

**extended surface**

assembly consisting of fins, pins, or ribs that receives heat by conduction from the prime surface; an extension normally of the side of the fluid with the lower coefficient of heat transfer. See also heat transfer surface.

**primary surface (direct surface)**

1. surface that is in direct contact with both the heat-absorbing and heat-emitting media.

2. portion that is exposed to radiation from the fire and transfers heat directly to the air being heated.

**prime surface**

surface having the heating medium on one side and fluid (or extended surface) on the other.

**secondary heating surface**

portion of the heat exchanger not exposed to direct radiation from the fire that transfers heat by direct convection from the combustion products to the air to be heated. The area of the outer casing, inner lining, or any radiation shields are not considered heating surfaces.

**secondary surface (indirect surface)**

in extended surface exchangers, the additional surface that is not in direct contact with both the heat absorbing and heat-emitting media.

**heat exchanger removable head (removable end cover)**

in shell-and-tube heat exchangers, a head which can be unbolted for cleaning or maintenance.

**heat exchanger system**

assembly (factory- or field-assembled) of components necessary to comprise a complete heat exchanger system.

**energy recovery system**

heat exchanger assembly for transferring heat between two isolated airstreams; incorporating an exhaust air blower, auxiliary heaters or coolers, auxiliary dampers (intake, exhaust, face and bypass, and recirculating), controls (operating and safety), and other custom-designed features.

**heat recovery ventilator (HRV)**

factory-assembled unit for transferring heat between two isolated airstreams; incorporating exhaust and fresh air fans, auxiliary components necessary for operation (dampers and heaters), and controls (safety and operating).

**heat exchanger tube plate (tube sheet)**

plate located at the end(s) of a multitubular shell-and-tube heat exchanger, into which the tubes are fixed.

**heat flow**

passage of heat from one point to another or one space to another by one or more of the three modes, conduction, convection, and radiation. See also thermal transmittance.

**transient heat flow**

heat flow induced by a temporary temperature difference.

**heat flow meter**

apparatus designed to measure the heat flow from or into a surface.

**heat flow path**

in a variable temperature field, the lines of heat flow.

**heat flow rate**

quantity of thermal energy flowing in unit time.

**heat flux (density of heat flow rate)**

heat flow rate from a surface per unit area.

**heat gain (heat uptake)**

quantity of heat absorbed by an enclosed space or system.  
solar heat gain (sun effect) solar energy flowing into a building, through both windows and structural materials.

**heating**

process of adding heat energy causing a rise in temperature, or a transfer of sensible heat into latent heat. See also district heating; heating system.

**electric space heating**

permanently installed electric heating as the principal source of space heating throughout an entire dwelling or business establishment.

**regenerative heating**

heat rejected in one part of a system used to perform a useful function in another part.

**thermodynamic (reverse cycle) heating**

heating by use of a heat pump.

**heating coil**

coil supplied with either heated liquid or vapor, designed to heat fluids (air, gas, or liquids).

**heating stack loss**

sensible heat carried away by the flue gas, and the sensible and latent heat carried away by the water vapor in the flue gas.

**heating system**

one in which heat is transferred from a source of energy through a distribution network to spaces to be heated. See also hot water heating system.

**central heating plant**

1. one serving all or most of the rooms in a building, as distinguished from individual room heaters.
2. one serving two or more buildings, also termed district heating.

**direct heating system**

heating, air-conditioning, or refrigerating system in which electric heating elements or products of combustion, or the refrigerant, exchange heat directly with the material or space to be heated, or with the air in a passageway communicating with such space.

**direct return heating system**

two-pipe system in which the heating medium is returned from the terminal exchange unit to the boiler.

**down-feed heating system**

pipng arrangement for heating, air-conditioning, or refrigerating systems, in which heating and cooling fluid is circulated through supply mains which are above the levels of the heating or cooling units they serve.

**dry return heating system**

steam heating in which a return pipe carries both condensate and air. The return pipe is always above the waterline in the boiler in a gravity system.

**dual heating system**

heating system utilizing two fuel or energy sources, such as gas, oil, coal, or electric power, either as alternate sources or with one as a booster to the other.

**dump trap liquid return heating system**

method of separation and automatic return of liquid refrigerant from an accumulator in the low side to the high side of the plant.

**heat-of-light system**

system in which heat due to lighting intensity is utilized for heating spaces in a building.

**hot water heating system (hydronic heating system; wet heating system)**

heating system for a building use in which the heat-conveying medium is hot water and the heat emitters are radiators, convectors, or panel coils.

**indirect heating system**

one in which a fluid, such as air, is circulated to the material or space to be heated, or is used to heat air so circulated.

**one-pipe steam system**

system in which the condensable vapor from the supply main passes into a heating unit and returns as condensate through the same supply main.

**radiant comfort heating**

system in which temperatures of room surfaces are adjusted in order to control the rate of heat loss by radiation from subjects within that room.

**reverse return heating system**

heating system in which the hot water return piping from terminal units is sized to provide equal lengths for balanced flow rates.

**series perimeter loop heating system**

hot water heating system in which each radiator is connected in series with the next, and all flow returns to the boiler in the loop.

wet heating system see hot water heating system

**wet return heating system**

steam heating system in which a return pipe carries condensate. The pipe usually is located below the level of the waterline in the boiler, although not necessarily so.

**heating system performance factor (HSPF)**

total heating output of a heat pump during its normal period for heating, in Btu, divided by the total electric energy input during the same period, in watt-hours. For SI use, compare coefficient of performance.

**heating value**

amount of heat produced by the complete combustion of a unit quantity of fuel. The gross or higher heating value is that obtained when all the products of combustion are cooled to the temperature existing before combustion, the water vapor formed during combustion is condensed, and all the necessary corrections have been made. The net or lower heating value is obtained by subtracting the latent heat of vaporization of the water vapor formed by the combustion of the hydrogen in the fuel, from the gross or higher heating value.

**heat lag (thermal lag)**

time elapsing between the initiation of a thermal phenomenon and the appearance of its effect.

**heat losses**

1. (infiltration losses) energy required to warm outdoor air leaking in through cracks and crevices around doors and windows, or through open doors and windows, and through porous building materials.
2. (transmission losses) heat transferred through confining walls, glass, ceiling, floor, or other surfaces.

**heat loss rate (thermal storage)**

rate at which heat is lost from a storage device per degree temperature difference between the average storage medium temperature and the ambient temperature (or ground temperature, if the storage device is buried).

**heat of reaction**

heat per unit mass (or per mole) of reagents and substances in a chemical reaction; exothermal if heat is given off, endothermal if absorbed.

**heat of subcooling**

quantity of heat removed from a liquid to reduce it from its saturation temperature at saturation pressure, to some lower temperature at the same pressure.

**heat of the liquid**

enthalpy of a mass of liquid above an arbitrary zero.

**heat output**

heat input less heat loss; when electricity is the energy source, output is the same as input.

**heat pump**

thermodynamic heating/refrigerating system to transfer heat. The condenser and evaporator may change roles to transfer heat in either direction. By receiving the flow of air or other fluid, a heat pump is used to cool or heat.

**cooling and heating heat pump**

system designed to alternately or simultaneously use heat extracted at a low temperature and heat rejected at a higher temperature for cooling and heating functions, respectively.

**heating heat pump**

refrigerating system designed primarily to use rejected heat for desired heating.

**thermoelectric heat pump**

one based on the Peltier effect.

**heat pump balance point**

temperature at which the heat pump capacity and the building heat requirement are equal.

heat pump heating effect see compressor heating effect.

**heat rate**

measure of generating station thermal efficiency, generally expressed in Btu per net kilowatt-hour. Computed by dividing total energy content of fuel burned for electric generation by the resulting net kilowatt-hour generation.

**heat recovery**

use of heat that would otherwise be wasted from a heating system.

**heat recovery ventilator (HRV)**

factory-assembled unit that incorporates a means to circulate air for ventilation and provision to transfer heat between two isolated airstreams.

**heat reservoir**

system that can absorb or reject heat from storage.

**heat sink (cold source)**

substance or environment into which unwanted heat is directed.

**heat source**

substance or environment from which heat is taken.

**low-grade heat source**

heat source at a temperature too low to be efficiently used by an exchanger for the heating intended, but which may be used through the intermediary of a heat pump.

**heat transfer (heat transmission; heat transport; thermal transmission)**

flow of heat energy induced by a temperature difference.

**heat transfer fluid**

fluid used in a heat transfer process.

**heat transfer medium**

material used within rotary heat exchangers, also referred to as matrix or heating medium; a fluid, such as water, steam, air, or flue gas to convey heat from a boiler, furnace, or other heat source, and deliver it, directly or through a suitable heating device, to a substance or space to be heated.

**heat transfer surface**

outside area of a heat exchanger through which heat flows. See fin.

**extended surface (augmented surface)**

increase in area of a heat transfer surface by addition of fins, discs, or other means; used on the side of the heat-transfer surface which has the lowest coefficient of surface film transmission.

**heat transmission**

1. time rate of heat flow; usually refers to conduction, convection, and radiation combined.
2. in thermodynamics, a general term sometimes used for heat travel; but, since most applications have continuity of time, heat flow is the more appropriate term.
3. general term for the process by which incident flux leaves a surface or medium on a side other than the incident side.

**heat trap**

energy conserving arrangement of the hot water piping leaving the water heater constructed to counteract the convective forces of the heated water (thermosyphoning) during standby periods.

**heat treatment**

heating and cooling a metal or alloy to obtain desired properties or conditions.  
heat value (heating value; heat of combustion) amount of heat released in the oxidation of one mole of a substance at constant pressure, or constant volume.

**helium**

inert, noncombustible gaseous element of atomic number 2, that liquefies at 4.2 K to form helium I. Helium II is formed on cooling helium I below its transition point. It has the property of "superfluidity," i.e., exhibiting extremely high thermal conductivity, and viscosity approaching zero.

**hertz**

unit of frequency equal to one cycle per second.

**HFC**

halocarbon that contains only fluorine, carbon, and hydrogen.

**higher heating value (HHV)**

amount of heat produced per unit of fuel when complete combustion takes place at constant pressure, and the products of combustion are cooled to the initial temperature of the fuel and air, and when the vapor formed during combustion is condensed. The higher heating value is expressed in Btu/lb or Btu/ft<sup>3</sup> (W/m<sup>3</sup>) for gaseous fuel, or Btu/lb (MJ/kg) or Btu/gal for liquid fuel.

**Hilsch-Ranque effect**

spot cooling effect produced in a tube into which gas is introduced tangentially producing vortex flow.

**Hilsch-Ranque tube (pulse tube)**

device in which the Hilsch-Ranque effect is produced.

**hipot test**

electrical insulation test, which consists of the application of a high voltage between a circuit and its frame.

**HLF**

heating load factor.

**hoarfrost**

deposit of ice crystals, produced in a manner similar to dew but at a temperature below 32°F (0°C).

**home run wiring**

wiring from the device all the way to the distribution panel. This wiring is usually run in the most direct paths but with standard wiring practices and does not contain any splices, branches, or devices.

**horsepower**

unit of power in the I-P system; work done at the rate of 550 ft-lb/s (745.7 W). See also brake horsepower.

**hot deck**

hot air chamber forming part of an air handler.

**hot gas bypass regulator**

automatic valve operated by the suction pressure which it maintains above a given value by diverting a certain quantity of high side vapor to the low side of the system.

**hot-gas line**

1. line used to convey discharge gas from the compressor to the condenser.
2. line used to convey discharge gas from the compressor to the evaporator for the purpose of defrosting.

**humidifier**

device to add moisture to air or gases.

**central humidifier**

device that humidifies air to be circulated through ducts in an air-conditioning system.

**direct injection humidifier**

device that injects boiler steam into airflow through ducting.

**room spray humidifier**

air humidifier which sprays atomized water directly into the room.

**self generating humidifier**

unit producing steam at or about atmospheric pressure for injection, either directly into the air through a room fan unit, or directly into ducting through an injection manifold.

**spinning disc humidifier**

apparatus using centrifugal action to atomize and distribute moisture into an airstream.

**humidify**

to add water vapor or moisture to any moisture-absorbing material, including the atmosphere.

**humidifying effect**

product of the mass of water evaporated times the latent heat at the evaporating temperature.

**humidity****absolute humidity (vapor concentration; water-vapor density number)**

in a mixture of water vapor and dry air, the mass of water vapor in a specific volume of the mixture. Compare relative humidity.

**relative humidity**

1. ratio of the partial pressure or density of water vapor to the saturation pressure or density, respectively, at the same dry-bulb temperature, and barometric pressure of the ambient air.
2. ratio of the mole fraction of water vapor to the mole fraction of water vapor saturated at the same temperature and barometric pressure.

**specific humidity**

ratio of the mass of water to the total mass of a moist air sample.

**humidity controller**

device sensitive to relative humidity variations used for system regulation.

**humidity percentage**

ratio in percent of the mass of moisture at a given temperature to the maximum possible at the same temperature. See relative humidity.

**humidity ratio (mixing ratio)**

ratio of the mass of water vapor to the mass of dry air.

**humidity saturation ratio**

ratio of the specific humidity to that at saturation at the same temperature and pressure, usually expressed as a percentage.

**hunting (in a control system)**

condition that occurs when a controller, controlled device and system, individually or collectively, continuously overrides and undershoots or overshoots the control point, with resulting fluctuation and loss of control of the condition to be maintained. See cycling.

**HVAC system**

system that provides either collectively or individually the processes of comfort heating, ventilating, and/or air conditioning within, or associated with, a building.

**HVAC system end-to-end accuracy**

combined end-to-end accuracy of the EMCS (energy monitoring and control system) and the accuracy with which the EMCS sensors represent the HVAC process.

**HVAC&R**

heating, ventilating, air conditioning, and refrigeration.

**hydraulic diameter**

four times the flow area divided by the perimeter of the solid boundary in contact with the fluid.

**hydraulic lift**

in a pumping system, the static height (head) to be overcome by the pump.

**hydraulic shock**

internal pressure stress imposed in piping systems by a sudden change in liquid velocity, as by the sudden stopping of flow.

**hydrocooling**

cooling of produce (generally vegetables or fruit) by direct contact with chilled water.

**hydrolysis**

alteration of a chemical substance by water.

**hydrometer**

instrument that indicates the density of a liquid by the depth of its submergence while it is floating.

**hydrometeor**

any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface. Examples are rain, snow, sleet, and hail.

**hydronics**

science of heating and cooling water.

**hydrostat**

device for controlling the level of a liquid in a reservoir.  
hydrostatic lockup potential internal pressure stress in piping or vessels due to temperature rise in liquids such as refrigerants, water, or secondary coolants, when the containment volume is completely filled with liquid.

**hygrometer**

instrument responsive to relative humidity, usually relative humidity in the atmosphere. Compare psychrometer.

**absorption hygrometer (chemical hygrometer)**

1. instrument in which the relative humidity is determined from the absorption of water vapor by a hygroscopic material.

2. chemicals impregnated into small paper cards that change color with specific relative humidities.

**dew-point hygrometer**

device that measures the temperature at which water droplets just appear on a cooled polished surface.

**electrical hygrometer**

one whose sensitive element has electrical properties that vary with humidity.

**electrolytic hygrometer**

one that indicates relative humidity from the electrical resistance of a hygroscopic salt.

**organic hygrometer**

instrument that indicates relative humidity by variations in shape or length of units of organic matter.

**hygroscopic**

capable of absorbing and retaining/losing moisture.

**hypothermia**

severe chilling of the human body; may be used for limited periods in certain surgical cases.

**hysteresis**

in control systems, the difference between the response of a system to increasing and decreasing signals.

**IAQ**

indoor air quality.

**ice**

frozen water; the solid phase of H<sub>2</sub>O.

**briquette ice**

ice produced as small regularly shaped and sized pieces.

**chip ice (chipped ice)**

ice in thin flakes.

**clear ice (crystal ice)**

block ice obtained by agitating the water during freezing, and subsequently removing by suction the core of unfrozen water where impurities are concentrated.

**crushed ice**

small, irregularly shaped pieces of ice produced by crushing block ice or plate ice.

**cube ice**

ice manufactured in small cubes or regular pieces.

**dynamic ice**

ice formed on a cooling surface, then removed to be stored in an insulated container (tank). Compare ice harvester.

**eutectic ice**

frozen eutectic mixture used as cold accumulation.

**fragmented ice**

ice manufactured on refrigerated surfaces and harvested by hot gas and mechanical choppers.

**plate ice**

ice manufactured in thick sheets or harvested in winter from lakes or rivers.

**ribbon ice**

ice produced in the form of long, thin ribbons (obsolete).

**rime ice**

granular deposit of opaque ice on a surface, formed by quick-freezing of supercooled water droplets.

**seawater ice**

ice made by freezing seawater.

**shell ice**

ice manufactured on external surfaces of vertical refrigerated tubes and harvested by hot gas.

**slice ice (scale ice; flake ice)**

ice produced by freezing a thin layer of water on a refrigerated cylinder and removing by a scraper.

**slush ice**

small pieces of wet ice, usually wet snow ice or wet flake ice.

**static ice**

ice formed in containers or on pipe coils.

**white ice**

opaque ice in which air or salts present in the raw water are trapped.

**ice builder**

refrigerated coils immersed in a tank of water used for forming ice, and to provide ice water. Compare thermal storage device.

**ice core sucking-and-filling system**

combination of a pump, distributing piping, hose, and device by which impure water may be withdrawn from the unfrozen core of an ice block, and, connecting the source of water supply, the core may be refilled with pure water.

**ice cream**

sweet frozen food containing cream, or one of various substitutes, and flavoring.

**ice cream freezer**

apparatus for partially freezing an ice-cream mixture.

**ice cream hardening process**

refrigerating process in which ice-cream mixture is hardened immediately after partial freezing.

**ice harvester**

machine that manufactures ice on a cooling surface, then delivers it to storage.

**ice maker**

automatic ice-making machine in which ice is formed, harvested, and stored.

**cyclic ice maker**

automatic ice maker with separate and sequential water fill, freezing, and harvesting phases of the ice-making operation.

**noncyclic ice maker**

continuous ice maker with simultaneous water supply, freezing, and harvesting phases in the ice-making operation.

**ice making capacity**

actual productive mass output of an ice-making plant in a given time.

**ice making temperature**

temperature range in which most freezing takes place, i.e., about 25 to 30°F (−4 to −1°C) for water. Also called zone of maximum crystal formation.

**ice making water forecooler**

device for cooling water before it is fed into the ice cans.

ice-melting equivalent heat absorbed by ice at 32°F (0°C) in liquefying to water at 32°F (0°C). For precise data, 143.5 Btu/lb. (334.4 kJ/kg); for definition of ton, 144 Btu/lb.

**ice point (melting point)**

1. equilibrium temperature of ice and water (usually at standard atmospheric pressure).
2. temperature at which water freezes under normal atmospheric pressure 14.696 psig, 32°F (101.325 kPa, 0°C).

**ice regelation**

1. refreezing phenomenon; for ice, after removal of pressure induced by contacting materials, such as ice skates, wheels, wires, and bars.
2. refreezing of the water film that forms on or within ice when the pressure from applied material is sufficient to reduce the freezing point to below the ice temperature at that location.

**ice slurry (liquid ice)**

suspension of ice crystals in a secondary coolant.

**ice storage system**

thermal storage system, used for chilling processes or for comfort cooling, that uses the phase change of ice to water. Ice is formed during periods of low refrigerating demand, for delivery of cooling during periods of high refrigerating demand.

**ice surfacing**

treatment to smooth the ice surface.

**ice tray**

container for freezing water into ice.

**ice water**

1. melted ice.
2. water chilled, as with ice.

**icing**

chilling.

**ID**

1. induced draft.
2. inside diameter.
3. internal dimension. (Also: i.d.)

**ignition**

initiation of combustion. *Note:* Combustion may be evidenced by glow, flame, detonation, or explosion. The combustion may be sustained or transient.

**illuminance**

luminous (photometric) irradiance.

**impact pressure**

velocity pressure plus static pressure.

**impedance**

total restriction (resistance and reactance) that an electrical circuit presents to the flow of an alternating current; specifically the ratio of voltage to current and the phase angle between them.

**input impedance**

impedance inside an electrical circuit or network as seen from the outside at the input terminals.

**load impedance**

1. impedance that an electrical load imposes on a circuit.
2. impedance that an electrical load should by design impose on a circuit.

**nonlinear impedance**

1. impedance that varies with applied voltage.
2. impedance that cannot be represented by a first-order mathematical equation.

**impeller (rotor; wheel)**

rotating part of a device (fan, blower, compressor, or pump) that moves fluid. See also fan.

**backward-curved impeller**

centrifugal rotor in which the convex sides of blades face in the direction of rotation.

**forward-curved impeller**

centrifugal rotor in which the concave sides of blades face in the direction of rotation.

**radial-bladed impeller (paddle-bladed impeller)**

one in which the blades are flat and disposed radially from the fan hub to the outer edge.

**unshrouded impeller (open impeller)**

impeller with the blades left uncovered.

**impeller backplate (impeller hub disc; impeller hub plate)**

disc rotating with the axle, to which the impeller blades of a centrifugal fan are fixed.

**impeller reaction**

ratio of the variation of the fluid pressure in the impeller to the total variation of pressure in the device.

**impeller running noise frequency**

in a turbomachine, the noise frequency resulting from the rotational speed of the impeller.

**inch of water (inch water gage; inch water column)**

in the I-P system, a unit of head equal to a column of liquid water 1 inch high at 39.2°F.

inch-pound units

**indicated horsepower**

horsepower absorbed as measured by means of an indicator diagram.

**indicated work**

work absorbed as measured by an indicator diagram, independent of time.

**indicator diagram (indicator card)**

pressure-volume diagram tracing a gas in a compressor or engine cycle in terms of pressure and volume displaced. See also volumetric efficiency.

**indicator diagram reexpansion line**

curve on an indicator card representing the pressure; the total volume relationship of clearance fluid during the initial portion of the return stroke of the piston prior to the opening of the suction valve.

**indoor air quality (IAQ)**

attributes of the respirable atmosphere (climate) inside a building including gaseous composition, humidity, temperature, and contaminants. See also freshness index. acceptable indoor air quality air in which there are no known contaminants at harmful concentrations, as determined by cognizant authorities, and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction. See also sick-building syndrome.

**induction (entrainment)**

entrainment of room air by the jet action of a primary airstream.

**induction unit**

air terminal device that delivers a small quantity of conditioned (primary) air through high-velocity jets, to induce a large quantity of room (secondary) air into the supply airstream. A heating coil may be located in the primary or secondary airstream. Primary air often is predominately outside air. Units generally discharge directly through a grille into the space due to limited downstream static pressure capability.

**high-pressure induction unit**

one that uses nozzles which produce high-velocity jets; the high-velocity jet of primary air induces a flow of secondary air through coils located in the secondary airstream.

**low-pressure induction unit**

one using a jet of conditioned air (or primary air) to induce into the unit a flow of room or secondary air which mixes with the primary air. The mixture is discharged into the room through a grill at the top of the unit. Heating coils are located in the secondary airstream for use in heating.

**room air induction unit**

one consisting of a cooling coil (or cooling and heating coil) and means for delivery of preconditioned air received under pressure from an external source mixed with recirculated air by air induction process to the space being conditioned. This device is normally designed for free delivery of air into rooms.

**inductive load**

alternating current load in which current lags voltage.

**infiltration degree-day (°F-day; °C-day)**

measure of the severity of the climate as it relates to building air infiltration.

**infrared CO<sub>2</sub> meter**

instrument for estimation of carbon dioxide content, based on absorption of infrared radiation.

**infrared detector**

device that transduces the infrared irradiance incident on it into some other form of energy, in most cases electrical.

**infrared imaging system**

apparatus which converts the two-dimensional spatial variations in infrared radiance from any object surface into a two-dimensional thermal map of the same scene in which variations in radiance are displayed in gradations of gray tone.

**infrared noise**

equivalent temperature difference measure of the (electric) noise of an infrared imaging system or line scanner; the target-to-background temperature difference between a low spatial frequency blackbody target and its black-body background at which a ratio of one is obtained between the peak-to-peak signal and RMS noise at the output of the detector processing electronics of the sensor in question.

**infrared panning**

infrared surveying procedure in which an infrared device is moved back and forth across a subject surface thereby permitting thermal anomalies to be identified.

**infrared (IR) radiation**

range of electromagnetic radiation wavelengths greater than those of visible light and shorter than those of microwaves; generally between 0.8 micrometre and 1 millimetre. IR originates from either incandescent or nonincandescent hot bodies or from flames. The energy is used as a means of direct heat transfer from the source to the object(s), to be heated without materially heating the intervening air.

**infrared (thermal) resolution**

measure of the capability of an infrared sensing device to distinguish the apparent radiance temperature difference between two blackbodies near the same temperature.

**limiting resolution**

highest spatial frequency of an object space target which an imaging sensor is able to resolve. The spatial frequency of the target is determined by taking the inverse of the ratio of two bar widths divided by the distance from sensor to target. This number generally is multiplied by 1000 and expressed in cycles per milliradian.

**object plane resolution**

size in the object plane which corresponds to the products of the system's instantaneous field of view in radians and the distance from the system to the object.

**spatial resolution**

planar angle defined by the instrument instantaneous field of view, i.e., the resolution element.

**infrared scanner**

infrared detector mounted on a motor-driven platform which causes it to scan a field of view line-by-line, much as in television.

**imaging line scanner**

apparatus which scans in a single dimension and is moved perpendicular to the scan direction to produce a two-dimensional thermal map of the scene. See also infrared survey.

**line scanner**

apparatus which scans along a single line of a scene to provide a thermal mapping of a discrete width or slice of the scene.

**infrared sensing device**

wide class of instruments used to display and/or record information which is proportional to or equivalent to the thermal radiation from any object surfaces viewed by the instrument. The instrumentation varies from simple spot radiometers, which measure only one spot or area, to two-dimensional thermal imagers, which provide photographic quality pictures and which map the scene radiosity.

**infrared survey (airborne)**

generation of thermograms of building structures as viewed from overhead using an imaging line scanner.

**imaging exterior survey**

generation of thermograms of outside surfaces of a building.

**imaging interior survey**

generation of thermograms of portions of a building as viewed from the building interior.

**nonimaging survey**

generation of a set of apparent temperature measurements of building surfaces (usually the interior) obtained with a nonimaging thermal sensing device.

**inherent regulation**

property of a system to reach a steady state after a disturbance without the intervention of a control equipment.

**injector**

1. device for forcing water into a boiler against the pressure of the boiler by means of a steam jet.
2. device for lifting or pumping one fluid by using another, higher pressure fluid to create a partial vacuum. See also ejector.

**input-output device**

equipment that introduces data into or receives data from a data communications system.

**input rating**

fuel-burning capacity of an appliance in Btu/h (W), as specified by the manufacturer. Appliance input ratings are based on sea level operation, and need not be changed for operation up to 2000 feet (600 metres) altitude.

**inspection authorities**

person(s) designated by governing codes to inspect installed systems for code compliance.

**instruction**

statement that specifies an operation and the values or locations of all operands. In this context, the term "instruction" is preferable to the terms "command" or "order," which are sometimes used as synonyms. Command should be reserved for electronic signals. Order should be reserved for sequence, interpolation, and related use. Both command and order have important military applications.

**logical instruction**

instruction that carries out a logical operation, such as AND, OR, NOR. microinstruction small single, short, add, shift, or delete type of command.

**instruction repertoire**

1. part of an instruction cycle during which the control or data-processing system is capable of performing.
2. set of instructions which an automatic coding system assembles.

**instruction time**

1. portion of an instruction cycle during which the control unit is analyzing the instruction and setting up to perform the indicated operation.
2. same as execution time.

**instrument sensitivity**

measure of the smallest incremental change to which an instrument can respond.

**insulated door**

door built with materials that resist heat flow, often designed for service in cold or freezer rooms, or for service in high-temperature rooms, or for specified fire resistance.

**insulating cement**

mixture of dry granular, flaky, fibrous, or powdery materials that when mixed with water and applied to a surface forms a coherent thermal insulating covering after drying.

**insulating mastic**

premixed soft material that possesses some thermal resistance, applied by spray, trowel, brush, or by hand.

**insulation**

see electrical insulation, sound insulation, thermal insulation.

**integral draft diverter (heating appliances)**

device that is an integral part of an appliance designed (1) to provide exhaust of the products of combustion in the event of no draft, back draft, or stoppage beyond the draft diverter; (2) to prevent a back draft from entering the unit; and (3) to counteract the effect of stack action of the chimney or gas vent on the operation of the unit.

**integrating sphere**

optical device used either to collect flux reflected or transmitted from a sample into a hemisphere, or to provide isotropic irradiation of a sample from a complete hemisphere. It consists of a cavity that is spherical in shape, with apertures for admitting and detecting flux, and usually having additional apertures over which sample and reference specimens are placed.

**intelligent building**

building in which direct digital control systems are employed to control mechanical, electrical, and elevator systems; fire and smoke systems; and security systems for a complete, integrated building automation and display, for operation and maintenance. Compare smart house.

**intercooler (interstage cooler)**

apparatus for cooling compressed gas or vapor between two compression stages.

**intercooling**

removal of heat from compressed gas between compression stages.

**interface**

connection between a computer and some other device that either transmits information to or receives information from the computer.

**internal gross volume**

volume as determined from internal dimensions of a container with no allowance for the volume of internal parts.

**interpretation (of a standard)**

written explanation of the meaning of specific provisions, as determined by the issuing body in response to an inquiry.

**interrupt device**

device to disconnect a load from a power source, or distribution center under an overload or short circuit condition; e.g., a fuse, disconnect switch, etc. This interrupt is not an integral part of the operating equipment.

**external interrupt device**

1. one not an integral part of the operating equipment, such as a fuse or disconnect switch.
2. one generated by an alarm point that causes an alarm. See also switch; motor protection.

**interruptible load (electric)**

1. (commercial and industrial) those loads that by contract can be interrupted by the supply system in the event of a capacity deficiency in the supplying system.
2. (load management) those loads that by user agreement can be interrupted in the event of a capacity deficiency in the supply, transmission, or distribution systems, or for load deferral.

**interruptible rate (electric)**

price rate normally covering reduced pricing for a supply of electricity that can be interrupted at the utility's option, either instantaneously as required or with advance notice.

**interstitial space**

space between two zones, rooms, or floors of a building.

**intrinsic barrier (electric)**

component or circuit that limits the energy available in a hazardous location to a level that is incapable of igniting the hazardous atmosphere.

**ion**

atom or molecularly bound group of atoms that has gained or lost one or more electrons and acquires a negative or positive electric charge; sometimes a free electron or other charged subatomic particle.

**ionizing radiation treatment**

atomic particles and rays applied to foods to destroy microorganisms. Compare irradiation.

**I-P units (inch-pound units)**

units using inches, pounds, and other designations; as opposed to SI units in the metric system. Examples are: foot, Btu, horsepower, gallon.

**irradiance**

radiant flux density. See also solar irradiance.

**irradiance (at a point of a surface)**

quotient of the flux incident on an element of a surface containing the point, by the area of that element, measured in watts per square metre.

**background irradiance**

irradiance at the entrance aperture of the infrared sensing system that is not radiated directly from the object being investigated.

**direct normal (beam) irradiance**

irradiance received from the sun without significant change of direction from the apparent position of the sun. See also pyrheliometer.

**diffuse (sky) irradiance**

solar radiation that has been scattered in passing through the earth's atmosphere. It is equal to the global irradiance less the direct normal and ground-reflected components.

**global (hemispherical) irradiance**

quantity of solar energy incident on a unit surface area in unit time through a unit hemisphere above the surface, expressed in Btu/h·ft<sup>2</sup> (W/m<sup>2</sup>).

**instantaneous irradiance**

quantity of solar radiation incident on a unit surface area in unit time, measured in Btu/h·ft<sup>2</sup> (W/m<sup>2</sup>).

**integrated average irradiance**

quantity of solar radiation incident on a unit surface area during a specified time divided by the duration of that time period.

**spectral irradiance**

density of the radiant flux incident on a surface per unit of wavelength (W/(m<sup>2</sup>·nm)).

**total irradiance**

quantity of radiant energy incident upon a surface over all wavelengths.

**irradiation**

1. subjecting foods, etc., to radiations of special wavelengths, such as the 0.2537 micrometre wavelength, which kills certain bacteria.
2. quantity of radiant energy incident on a surface of unit area in unit time.

**irrigation cooler**

see Baudelot cooler.

**isenthalp**

thermodynamic change at constant enthalpy. See isenthalpic expansion.

**isentrop**

line of equal or constant entropy.

**isentropic process (reversible adiabatic)**

thermodynamic change at constant entropy. See also efficiency.

**isochor**

graph that shows the variation of one quantity with another; for example, the variation of pressure with temperature, when the volume of the substance is held constant.

**isobar**

1. line graph of state representing an isobaric process.
2. line at one barometric pressure.

**isobaric (isopiestic)**

thermodynamic change at constant pressure.

**isochome**

thermodynamic change at constant volume.

**isolated combustion system**

installation in which a unit is installed indoors but all combustion and ventilating air is admitted through grilles or ducts from outdoors and all such air does not communicate with air in the conditioned space.

**isomer**

one of a group of substances with the same ultimate chemical composition but different molecular structure.

**isopsychric**

state of constant relative humidity.

**isotherm**

graph of a state line that represents one temperature.

**isothermal**

process at constant temperature.

**isotope**

one of two or more atoms with the same number of protons, but different numbers of neutrons in their nuclei. Isotopes have very nearly the same chemical properties, but often different physical properties.

**iterative procedure**

process which repeatedly executes a series of operations until some prescribed condition is satisfied.

**jacket**

1. sealed space around a piece of equipment or a storage unit, through which a thermal medium can be circulated.
2. integral covering, sometimes fabric reinforced, which is applied over insulation, or the core, shield, or armor of a cable to provide mechanical or environmental protection.

**water cooled jacket**

hollow casing around the cylinder head and/or walls of a compressor, through which cooling water is passed.

**joint**

area at which two ends, surfaces, or edges are attached.

**brazed joint (high-temperature)**

gas-tight joint obtained by joining metal parts with alloys that melt at temperatures higher than 1500°F (800°C), but at less than the melting temperatures of the joined parts.

**brazed joint (low-temperature)**

gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys that melt at temperatures below 1500°F (800°C), but above 1000°F (540°C).

**butt joint**

joint between two members lying approximately in the same plane.

**compression joint**

multi-piece joint with cup-shaped threaded nuts which, when tightened compress tapered sleeves so that they form a tight joint on the periphery of the tubing that they connect.

**expansion joint**

device in a structure, a pipe run, etc., that can by linear compensation accept variation of length from expansion or contraction due to temperature changes.

**flanged joint**

one made by bolting together a pair of flanged ends.

**flared joint (flare fitting)**

metal-to-metal compression joint in which a conical spread is made on the end of a tube that is compressed by a flare nut against a mating flare.

**mechanical joint**

general form for gas-tight joints obtained by joining metal parts through a positive holding mechanical construction (such as flanged joint, screwed joint, flared joint).

**Pittsburgh lock joint**

longitudinal folded joint used in rectangular sheet metal duct construction.

pocket lock joint transverse joint used in rectangular sheet metal duct construction.

**slip joint**

method of constructing transverse seams in rectangular sheet metal ducts.

**snaplock joint**

longitudinal folded joint used for rectangular sheet metal duct construction in which the seam is snapped together.

**soldered joint**

gas tight joint obtained by joining metal parts with metallic mixtures or alloys that melt at approximate temperatures above 400°F (200°C), but not exceeding 800°F (430°C).

**standing seam joint**

folded joint used for transverse joints in rectangular sheet metal duct construction and for apparatus casing seams.

**sweat joint**

type of fitting formed by a melted filler metal alloy flowing by capillary action between the parts to be joined.

**swing joint**

arrangement of screwed fittings and pipe provided for expansion in pipelines.

**welded joint**

gas tight joint obtained by joining metal parts in the plastic or molten state.

**joint creep**

tendency of a soldered joint to part when subjected to tensile force.

**joint ring**

gasket in the form of a torus used for a seal between flanges or joints.

**joule (J)**

1. (electric work) work done by one ampere flowing through a resistance of one ohm for one second.  $J = W \cdot s$  (watt second).
2. (heat or mechanical work) work done by a force of one newton acting over one metre.  $J = N \cdot m$ .

**katharometer (katherometer)**

instrument for measuring the CO<sub>2</sub> concentration in a cold-storage atmosphere working on the principle that CO<sub>2</sub> has a thermal conductivity different from other gases. Concentrations of other gases can also be measured using this principle. kelvin day SI unit of accumulated temperature departure; a degree-day in kelvin temperature units. Compare degree-day.

**kilocalorie**

obsolete term (not SI), use joule. See calorie.

**kilowatt**

1000 watts.

**kilowatt-hour**

energy unit used in marketing electrical power. Preferred SI unit for energy is the joule (J),  $\text{m}^2 \cdot \text{kg} / \text{s}^2$ .

**kip**

1. load of 1000 lb. (453.59 kg).
2. (obsolete) 1000 inch-pounds.

**laboratory fume hood**

box-like structure enclosing a source of air contamination, with one open or partially open side into which air is moved for the purpose of containing and exhausting air contaminants and generally used for bench-scale laboratory operations, but not necessarily involving the use of bench or table.

**lag**

1. delay in action of the sensing element of a control device due to the time required for the sensing element to reach equilibrium with the variable being controlled, i.e., temperature lag, flow lag, etc.
2. retardation of an output with respect to the causal input.
3. delay attributable to the transport of material or the finite rate of propagation of a signal or condition. *Note:* Also termed transport lag and transportation lag.
4. in thermal insulation, preformed narrow blocks attached around large pipes or vessels by wires or bands.

**leader**

1. in gravity warm air heating, the duct running horizontally from the furnace to the riser, or stack.
2. in plumbing, a water conductor from the roof to the storm drain.

**leakage current**

1. nonreversible constant electric current component of the measured current that remains after the capacitive current and absorption current have disappeared.  
*Note:* Leakage current passes through the insulation volume, through any defects in the insulation, and across the insulation surface of solid or liquid insulation.
2. current that flows when a semiconductor device is in the off or blocked state (usually in the nanoampere range).

**leak detection**

in general, any operation designed to reveal a leak in a system.

**leased line (computer)**

transmission path rented from a common carrier for purposes of interconnecting data modems. Ordinarily, a voice-grade channel path for data transmission.

**leased line network**

total leased line conductors between all interconnected data modems in a datatransmitting system.

**interexchange leased line network**

leased line network with data modems connected at multiple locations through central offices. Usually synonymous with intercity or interstate.

**intraexchange leased line network**

leased line network with data modems connected at multiple locations through a single common carrier central office, or offices in the case of a big city or a city with suburbs. Usually limited to shorter distances because of leasing charges.  
single-premises leased line network leased line network on a single customer premises, either interbuilding or multiple building, that does not run back through the common carrier central office.

**least squares**

estimate in statistics and econometrics, the method of estimation that involves the choice of an estimate such that the sum of the squares of the deviations of the data from the estimate is a minimum.

**life cycle cost**

cost of equipment over its entire life, including operating and maintenance cost.

**light emitting diode (LED)**

low-current, low-voltage semiconductor light used as an indicator in electronic circuitry.

**lighting**

natural or artificial illumination.

**essential lighting**

lighting which is necessary for the safe and efficient use of the illuminated area. The presence of natural illumination may affect what is defined as essential.

**nonessential lighting**

lighting which would not impair the safety nor materially interfere with the occupancy of an area if it were turned off. *Examples:* decorative; advertising, except simple identification of structures or addresses; and multiple lamp groupings resulting in illumination levels greater than accepted standards for the purpose (as for aisles, corridors, streets, and highways).

**limit stat**

controller designed to provide limit control.

**limit stop**

physical stop or device that prevents an operator from adjusting the set point of a controller beyond a maximum or minimum setting, often for safety.

**linear regression**

finding of a straight line that best fits the data points, commonly by use of the least-squares technique.

**linear swell**

percentage increase in the length of a test specimen, usually an elastomer, as a result of exposure to refrigerants or oils.

**liner**

enclosure forming the interior of the general refrigerated compartment or some freezer compartment(s). The complete liner comprises the compartment liner in the cabinet, the exposed breaker strip surfaces, and the door liner(s).

**liquefaction**

change of state to liquid; generally used instead of the term, condensation, in cases of substances ordinarily gaseous.

**liquid**

state of matter intermediate between crystalline substances and gases in which the volume of a substance, but not the shape, remains relatively constant.

**compressed liquid**

one in which the existing pressure is greater than the saturation pressure for the given temperature.

**saturated liquid**

liquid existing at the saturation temperature and pressure.

**supercooled liquid**

one in which the existing temperature is lower than the saturation temperature for the given pressure.

**liquid cooler**

heat exchanger designed to cool liquids.

**liquid line**

tube or pipe carrying the refrigerant liquid from the condenser or receiver of a refrigerating system to a pressure-reducing device.

**liquid pocket (liquid slug)**

accidental trapping of liquid refrigerant at any point in the system.

**liquid-vapor mixture**

liquid and gaseous phases of a single substance or azeotrope usually at saturation.

**liquor**

solution used in absorption refrigeration.

**strong liquor (rich liquor; strong solution)**

solvent with a relatively high concentration of dissolved refrigerant.

**weak liquor (weak solution)**

solvent with a relatively low concentration of dissolved refrigerant.

**liter**

use litre.

**litre**

SI unit of volume; (cubic decimetre) limited to capacity in dry measure of granular, freely pouring solids, and to fluid measure (both liquids and gases). No prefixes except milli or micro should be used.

**LNG**

liquefied natural gas.

**LNG regassification plant**

plant for vaporizing LNG, generally located where and when it will be used.

**load**

1. amount of heat per unit time imposed on a refrigeration system by the required rate of heat removal.
2. energy absorbing device.
3. material, force, torque, energy, or power applied to or removed from a system or element.
4. to put data into a register or storage. See also Btu; capacity; kilowatt; ton; load units.

**connected load**

sum of all loads on an electrical circuit at a selected time.

**cooling load**

1. amount of cooling per unit time required by the conditioned space or product.
2. heat a cooling system must remove from a controlled system over time.

**design load (peak load)**

peak instantaneous load that a system is expected to meet.

**gross load**

sum of the space heating or air-conditioning load, domestic hot water load, process load, and the piping and pickup load.

**heating load**

heating rate required to replace heat loss from the space being controlled.

**latent heat load (moisture tons; wet tons)**

cooling load to remove latent heat.

**locked-rotor load (rotating machinery)**

electrical loads that exist when the circuits of a motor are energized, but the rotor is not able to turn.

**pickup load**

actual load for heating the system following setback.

**piping load**

unusable heat loss or gain from piping.

**refrigerating load**

amount of heat per unit time imposed on a refrigerating system for the required rate of heat removal.

**refrigerating service load**

quantity of heat to be removed from a refrigerated space to compensate for opening doors, presence of personnel, heat from electric lights, etc.

**resistive load**

1. electric load without capacitance or inductance or one in which inductive portions cancel capacitive portions at the operating frequency.
2. electric load with all energy input converted to heat and light.

**sensible heat load**

cooling load to remove the sensible heat. See also sensible heat ratio.

**thermal load**

thermal capacity of a system under specified conditions. See also capacity.

**usage load**

sum of the air change, product, and miscellaneous loads on a refrigerator; the sum of the loads exclusive of wall, floor, or ceiling heat gains.

**load management (electric)**

deliberate control or influencing of user loads to affect the time of use of electric power and energy.

**automatic-to-user load management**

as a part of indirect load management, the automatic monitoring and control by a user of loads to take advantage of electric rate economic incentives.

**direct load management**

subfunction of power system distribution automation that controls interruptible user loads or otherwise selected user appliances from one or more centralized, utility-operated locations in chosen groups, load classes, and/or timed patterns. Characterized by remote control by the serving utility of user interruptible loads. Also called active load management.

**indirect load management**

subfunction of power system distribution automation that implements economic incentives to induce user action, including automation provided by the user. Characterized by user local control of loads in response to economic incentives applied. Also called passive load management.

**system load management**

subfunction of equipment (hardware) and programming (software) that implements direct and/or indirect load management, coordinated with other functions of energy management in an electric utility system.

**loading error**

1. error due to the adverse effect of a load on the transducer or signal source driving it.
2. error in transferring data from a data source to a computer memory. See also error.

**load profile**

summary of thermal loads in a system over time. *Note:* e.g., A common load profile on a peak design day, for thermal storage designs would show hourly system load requirements for 24 hours.

**locked rotor current (LRA; locked rotor amperage)**

steady-state current taken from the line with the rotor locked and with rated voltage (and rated frequency in the case of alternating-current motors) applied to the motor. locker plant cold-storage locker.

**log**

1. record of events and data pertinent to a machine operation.
2. printout of the status of all points in a system.
3. periodic printed summary of operating data. See also data logging.

**logic**

1. science of dealing with the criteria or formal principles of reasoning and thought.
2. systematic scheme which defines the interactions of signals in the design of an automatic data-processing system.
3. basic principles and application of truth tables and interconnection between logical elements required for arithmetic computation in an automatic data-processing system.

**logical decision**

choice or ability to choose between alternatives. This amounts to an answer yes or no to a question of equality or relative magnitude.

**logical flowchart**

detailed statement of the work order in terms of logic, or built-in operations and characteristics, of a specified machine. Concise symbolic notation is used to represent the information and describe the input, output, arithmetic, and logical operations by use of a standard set of block symbols. A coding process normally follows a logical flowchart.

**loop**

1. sequence of instructions that is repeated until a terminal condition prevails.
2. communications circuit between two private subscribers or between a subscriber and a local switching center.
3. electric circuit containing a complete, continuous path as in a feedback loop.

**loss-of-charge protector**

1. device which is capable of discerning the loss of refrigerant charge in a refrigerating machine and of reacting to protect the apparatus from motor burnout.
2. splitting of a dry condensate line to permit vapors to pass above and condensate to pass below an obstruction.

**loss of head**

pressure loss expressed by the height of a column of the fluid.

**louver**

1. assembly of sloping vanes intended to permit air to pass through and to inhibit transfer of water droplets; outdoors, to shed rain.
2. device comprising multiple blades which, when mounted in an opening, permits the flow of air but inhibits entrance of other elements in a reverse direction.

**adjustable louver**

louver in which the blades may be operated manually or by mechanical means.

**fixed louver**

louver in which the blades do not move.

**low pressure side (low side)**

1. portion of a refrigerating system operating at approximately the evaporator pressure.
2. suction side.

**low pressure stage**

compression stage from a low to an intermediate pressure level.

**low temperature**

generally, a temperature below freezing. See temperature.

**low water cutoff**

in a boiler system, a device to automatically cut off the fuel supply when the surface of the water falls to the lowest safe waterline.

**LPG**

liquefied petroleum gas.

**lpm**

litres per minute. Not an SI term.

**lubrication**

reducing friction between bearing surfaces in relative motion by a low-friction fluid film, or other means.

**forced lubrication (pump lubrication; mechanical lubrication; forced-feed oiling)**

lubricating system with the oil fed under pressure by a pump.

**splash lubrication**

lubricating system for a compressor with the oil in the crankcase fed to all moving parts and to cylinder walls by the splashing action of a dip or paddle integral or attached to the crankshaft ends of the connecting rod.

**machine room**

1. engine room, a room in which mechanical equipment is permanently installed and operated.
2. main computer room.

**magnetic flux**

lines of force that exist about a magnetized body and collectively constitute a magnetic field.

**magnetic flux density**

degree of concentration of magnetic lines of force.

**main**

1. pipe or duct for distributing to or collecting flowing fluid from various branches.
2. regulated compressed air piped to pneumatic controls.

**supply mains**

1. pipes through which the heating or cooling medium of a system flows from the source of heat or refrigeration to the runouts and risers leading to the heating or cooling units.
2. (pneumatic) the air-supply piping to all controllers or other devices requiring a main air supply.
3. source of electric power to a system.

**maintainability**

specific period within which a system or facility can operate in an economical, fully restored condition.

**maintenance (maintenance program)**

maintenance concept in terms of time and resource allocation. It documents the objectives and establishes the criteria for evaluation and commits the maintenance department to basic areas of performance such as prompt response to mechanical failure, maintenance, and attention to planned functions that protect the capital investment and minimize downtime or failure response.

**corrective maintenance**

classification of expended or reserved resources used to predict and correct impending failure. Corrective action is strictly remedial and always performed before failure occurs.

**planned maintenance**

classification of maintenance department resources that are invested in prudently selected functions at specified intervals. All functions and resources attributed to this classification must be planned, budgeted, and scheduled. It embodies two concepts: preventive and corrective maintenance.

**predictive maintenance**

function of corrective maintenance. Statistically supported objective judgment is implied. Nondestructive testing, chemical analysis, vibration and noise monitoring, as well as visual inspection and logging are all classified under this function, providing that the item tested or inspected is part of the planned maintenance program.

**preventive maintenance**

classification of resources allotted to ensure proper operation of a system or equipment under the maintenance program. Durability, reliability, efficiency, and safety are the principal objectives.

**management information function**

provision of information useful for management of a building environment, and/or its energy efficiency and/or HVAC system maintenance.

**manifold**

portion of a main in which several branches are close together. Also, a single piece in which there are several fluid paths.

**water manifold**

water connection wherein one pipe communicates with several other lateral outlets through a common housing or fitting.

**manometer**

instrument for measuring head or pressure; basically a U-tube partially filled with a liquid, usually water, mercury, or light oil, so constructed that the difference in level of the liquid legs indicates the pressure exerted on the instrument.

**membrane manometer (diaphragm manometer)**

pressure gage with a flexible membrane whose deformations are used to indicate pressure.

**viscosity manometer**

pressure gage which uses the variations of viscosity of a gas with pressure (in vacuum techniques).

**manufactured home**

manufactured building intended to be used as a dwelling. *Note:* The U.S. Department of Housing and Urban Development (HUD) has adopted a legal definition, found in 42 USC 5402.

**manway (manhole)**

opening with removable cover in a vessel to permit periodic entry to the interior of the vessel.

**mass**

quantity of matter in a body; measured in terms of resistance to acceleration by a force, i.e., its inertia. In SI the standard unit of mass is the kilogram (kg); in I-P it is the slug. Compare weight.

**mass flow rate**

mass of a substance flowing per unit time.

**mass transfer (mass transport)**

transfer of one component of a mixture, relative to the motion of the mixture. It is the result of a concentration gradient. Compare heat transfer.

**materials inherently hazardous (to life and property)****at temperatures and pressures**

materials when released from piping or vessels as a sudden outburst with potential for inflicting injury or property damage by burns, impingement, or flashing to vapor state.

**chemically active or toxic**

materials corrosive or in themselves toxic or productive of poisonous gases.

flammable or explosive materials easily ignited, including materials known to be fire producers or explosives.

**radioactive**

materials that emit ionizing radiation.

**materials inherently of low hazard**

all materials not hazardous by nature, existing at near ambient pressure and temperature, and not placing at risk people working on systems carrying such materials.

**matrix**

rectangular array of quantities in a prescribed form.

**MBtuh**

deprecated I-P unit of power. One thousand Btu per hour. In SI use watts or kilowatts.

**mean tank temperature**

arithmetic mean of tank water temperatures determined, using multiple thermocouples or other measuring devices.

**measurement**

1. act or result of determining the characteristics of some thing.
2. extent, capacity, or amount ascertained by measuring.
3. system of measures.

**meat keeper**

enclosed compartment or container which is designed for the storage of fresh meat at or near 32°F (0°C).

**mechanical clearance**

free working space between two parts.

**mechanical properties**

properties of a material that reveal the elastic and inelastic reaction when force is applied, or that involve the relationship between stress and strain; for example, the modulus of elasticity, tensile strength, and fatigue limit. Compare physical properties.

**Meissner state**

thermodynamic state shown by all superconductors in a sufficiently weak magnetic field, characterized by the exclusion or expulsion of magnetic flux from everywhere within the superconductor except a thin surface layer.

**melting**

change of state from solid to liquid caused by absorption of heat.

**melting point**

for a given pressure, the temperature at which the solid and liquid phases of the substance are in equilibrium.

**memory capacity**

amount of data that can be contained in a memory storage device.

**meniscus**

1. free surface of a liquid which, near the walls of a vessel, is curved because of surface tension.
2. in a manometer, the datum point measured at the center of the free surface.

**MEP**

mechanical, electrical, and plumbing

**met**

unit of metabolic rate of people. One met is defined as 18.4 Btu/h·ft<sup>2</sup> (58.15 W/m<sup>2</sup>), which is equal to the energy produced per unit surface area of a seated person at rest. The surface area of an average man is about 19 ft<sup>2</sup> (1.8 m<sup>2</sup>).

**metabolism**

chemical changes in living cells by which energy is provided for vital processes.

**meter**

measuring device. Compare metre.

**meter constant (electric)**

multiplier applied to the register reading to obtain kilowatt-hours.

**methanol (methyl alcohol)**

CH<sub>3</sub>OH, colorless, toxic, flammable liquid boiling at 148.9°F (65.0°C), having a flash point (open cup) of 54°F (12.2°C).

**metre**

base unit of length or distance in the International System of Units (SI).

**microbiology**

branch of biology that deals with microorganisms.

**microclimate**

conditions such as temperature, humidity, and motion of air within an enclosure or limited outdoor area.

**micrometre**

unit of length, one millionth of a metre (one thousandth of a millimetre).

**micron**

obsolete unit of length, use micrometre (thousandth part of a millimetre; millionth part of a metre).

**microsecond**

one millionth of a second.

**microwave thawing (ultrahigh frequency thawing)**

dielectric thawing, usually of frozen food, heat being produced by microwave passage.

**miscibility**

ability of a liquid or gas to dissolve uniformly in another liquid or gas.

**mixed state**

thermodynamic state of certain superconductors in which an array of fluxons carries magnetic flux through the superconductor.

**mixing box (blending box; mixing unit)**

compartment into which two air supplies are mixed together before being discharged.

**mixing section**

in a duct system, a section for mixing airstreams at differing temperatures or humidities, or both.

**mnemonic**

type of instructions for a computer written in a form which is easy for the programmer to remember (a memory jogger) but which must later be converted into machine language.

**modeling**

representing of a process, device, or concept in mathematical simulation.

**modem**

acronym for modulator/demodulator. Hardware device used for changing digital information to and from an analog form to allow transmission over voice-grade circuits.

**mode of vibration**

in a system undergoing vibration, the characteristic pattern of displacement assumed by the system vibrating at one of its resonance frequencies.

**modulate**

1. to adjust by small increments and decrements.
2. to vary a voltage or other variable with a signal.

**modulation (of a control)**

adjustment of controller action by increments and decrements.

**modulus**

constant or coefficient that expresses, usually numerically, the degree in which a property is possessed by a substance or body.

**bulk modulus of elasticity**

ratio of the compressive or tensile force applied to a material per unit surface area to the change in volume of the material per unit volume. Also known as bulk modulus, compression modulus, or hydrostatic modulus.

**modulus of elasticity (Young's modulus)**

ratio of stress (nominal) to corresponding strain below the proportional (elastic) limit of a material, expressed in force per unit area based on the average initial cross-sectional area. *Note:* The proportional limit is the greatest stress that a material is capable of sustaining without any deviation from proportionality of stress to strain (Hooke's law).

**modulus of rupture in bending**

maximum stress per unit area that a specimen can withstand without breaking when it is bent, as calculated from the breaking load under the assumption that the specimen is elastic until rupture takes place.

**modulus of rupture in torsion**

maximum stress per unit area that a specimen can withstand without breaking when its ends are twisted, as calculated from the breaking load under the assumption that the specimen is elastic until rupture takes place.

**moisture**

1. water vapor.
2. water in a medium such as soil or insulation; but not bulk water or flowing water.

**grain of moisture**

convenient unit of measurement of water vapor. 1 grain = 1/7000 pound avoirdupois (historically, the average weight of a grain of wheat).

**residual moisture**

in a freeze-dried product, the ratio of the mass of residual water to the original mass of product.

**moisture carryover**

retention and transport of water droplets in a gas stream (usually air).

**moisture indicator**

device indicating the moisture content of a substance.

**moisture proofing (damp proofing)**

process for making things impervious to liquid. *Note:* If not completely impervious, use moisture retarder.

**mobile home**

manufactured home (preferred term).

**mold**

1. minute fungi growing on moist organic matter.
2. matrix or cavity in which anything is shaped or formed.

**mole (mol)**

amount of substance of a system that contains as many elementary entities as there are atoms in 0.012 kg of carbon 12 (i.e.,  $6.023 \times 10^{23}$ ). *Note:* When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.

**molecular diffusion**

diffusion in a body at rest.

**molecular sieve**

adsorbent composed of porous aluminosilicates with pores of uniform molecular dimensions that selectively adsorb molecules of the substance to be adsorbed.

**molecule**

group of atoms held together by chemical forces. The smallest unit of a compound that can exist by itself and retain all its chemical properties.

**Mollier diagram (Mollier chart)**

graph of enthalpy versus entropy of a vapor on which isobars, isothermals, and lines of equal dryness are plotted.

**monitoring**

observing, supervising, controlling, or verifying the operations of a system.

**motor**

that which imparts motion. Prime mover, as a steam engine, a windmill, an engine.

**motor overload protection**

devices that automatically disconnect a motor from its energy supply when predetermined unsafe temperatures or overcurrent conditions exist.

**inherent motor protection**

1. device buried in the motor winding to detect the winding temperature and interrupt the supply line when the allowable winding temperature is exceeded.
2. feature of electrical motor whereby protective devices are mounted integrally to the motor.

**line-break motor protection**

1. control device which automatically opens the line connections to a motor when a predetermined unsafe temperature exists in the windings of the motor.
2. electrical motor protective action which causes the power line to the motor to be interrupted on protective requirement.

**overcurrent motor protection**

1. overload devices, either eutectic alloy or bimetal, which protect a motor against an overcurrent. Fuses and circuit breakers do not protect a motor, they only protect branch wiring.
2. device used to interrupt the supply voltage to a motor when the allowable full-load current is exceeded.

**solid-state motor protection**

1. solid-state switch used with a current sensor to interrupt the supply line to a motor to provide motor protection.
2. protective device using electronic solid-state materials as opposed to conventional electromechanical devices.

**starting overload**

1. motor-starting device equipped with overload trip mechanism for protection of the motor.
2. starting a device with a load connected that will require the device to operate outside its designed operating range.

**temperature motor protection**

inherent motor protection.

**motor power (engine)**

machine in which power is applied to do work by the conversion of various forms of energy into mechanical force and motion.

**muffler**

device to deaden noise.

**multizone**

1. spatial divisions of a building having different air-conditioning loads.
2. air-conditioning unit capable of handling variable loads from different sections of a building simultaneously.

**nadir**

1. point of the celestial sphere that is directly opposite the zenith and vertically downward from the observer.
2. object point that is directly beneath an aircraft flying an airborne imaging survey.

**nameplate rating**

full-load continuous rating of a generator, prime mover, or other equipment under specified conditions, as designated by the manufacturer; and usually indicated on an attached plate. Compare capacity.

**natural air circulation**

air circulation caused by differences of density induced by differences of temperature.

**natural ventilation**

movement of air into and out of a space through intentionally provided openings, such as windows and doors; or through nonpowered ventilators; or by infiltration.

**nebulize**

to supply very fine water spray or steam into an airstream or enclosure.

**net positive suction head (NPSH) (available)**

head at the pump inlet greater than the vapor pressure (expressed as head) at the operating temperature of the liquid being pumped.

**neural network**

computer circuits patterned after the complex interconnections among nerve cells in the brain.

**NFPA**

National Fire Protection Association.

**night cover**

removable cover placed over an open-top refrigerated display case during overnight periods in order to reduce energy transfer with the environment.

**nitrogen capacity (of a refrigerating capillary tube)**

cfm (L/s) equivalent to the mass flow rate of dry nitrogen which would be passed for a specified inlet pressure if discharge had been to standard atmospheric conditions of 29.92 in. (101.325 kPa) absolute pressure.

**nitrogen purge**

procedure in which nitrogen gas is bled into piping as it is welded, brazed, or soldered; or after, to displace gases within the piping. The nitrogen displaces the air from inside the pipe, minimizing oxidation and resultant scale formation.

**noise**

sound, or a sound of any sort; especially sound without agreeable musical quality. ambient noise background noise when equipment is not in operation.

**electric noise**

random electrical signals, introduced by circuit components, natural disturbances, or other and unrelated circuits, which tend to degrade the performance of a control system.

**white noise**

1. noise, either random or impulsive, having a flat frequency spectrum at the frequency range of interest.
2. generated noise having the same noise per unit bandwidth anywhere in the spectrum.

**noise criteria curves (NC curves)**

curves that define the limits which the octave-band spectrum of a noise source must not exceed if a certain level of occupant acceptance is to be achieved.

**noise reduction (NR)**

difference between the average sound pressure levels, or sound intensity levels, of two spaces. Usually those two spaces are two adjacent rooms called, respectively, the source room and the receiving room.

**nomenclature**

system of names identifying or classifying component items or constituent parts, particularly in mathematics, science, and engineering.

**nondestructive test (NDT)**

procedure that evaluates equipment fitness and integrity without permanently altering physical state or arrangement.

**nonisothermal jet**

jet in which the primary air temperature differs from the mean space temperature.

**nonuniform flow**

fluid flow varying in velocity across the plane perpendicular to the flow.  
nonvolatile refrigerant see secondary coolant.

**normalized leakage**

dimensionless value calculated from the leakage area, building height, and floor area that describes the relative airtightness of the building envelope. See also building air infiltration.

**normally closed device**

1. controlled device that closes when the control signal is off.
2. device that returns to the closed position when power is off.

**normally open device**

device that returns to the open position when power is off.

**nozzle**

short tube with a taper or constriction used to speed up or direct a flow of fluid.

**oil burner nozzle**

nozzle for mechanically atomizing fuel oil in a burner.

**return-flow nozzle**

nozzle for a mechanical atomizing oil burner in which part of the oil supplied to the atomizer is withdrawn and returned to storage or to the oil line to the atomizer.

**spray nozzle**

orifice through which liquid is sprayed as in air washers and humidifiers.

**NR**

noise reduction.

**nuclear**

*adj.* of or pertaining to:

1. the atomic nucleus; as nuclear physics.
2. atomic energy; nuclear power.

**OD**

outside diameter; outside dimension. Also o.d.

**odor**

quality of gases, liquids, or particles that stimulates the olfactory organ.

**office building**

building or structure for office, professional, or service-type transactions, such as a medical office, bank, library, or business; including governmental offices.

**oil**

various viscous, combustible, water-immiscible liquids that are soluble in certain organic solvents, and may be animal, vegetable, mineral, or synthetic in origin.  
distillate oil light fraction of oil, separated from crude oil by fractional distillation.  
fuel oil products of petroleum graded according to energy content and viscosity (No. 1 to 6); No. 6 is residual oil, with the highest energy content and viscosity rating.

**naphthenic oil**

petroleum lubricating oil fraction in which naphthenic ring hydrocarbon structures predominate.

**paraffinic oil**

petroleum lubricating oil fraction in which straight- and/or branched-chain hydrocarbon structures predominate.

**refrigerating oil**

stable fluid which is compatible with system components, will form a friction-reducing film between rubbing surfaces, seal critical clearances, and has low-temperature properties suitable for the application.

**semisynthetic oil**

mixture of synthetic and petroleum oils that can act as a lubricant.

**synthetic oil**

synthesized material, often derived from petroleum compounds, but containing no petroleum oil fractions, that can act as a lubricant.

**white oil**

severely refined petroleum-base lubricating oil fraction essentially free of aromatic hydrocarbons.

**oil charge**

normal quantity of oil in a reciprocating compressor or engine.

**oil-distribution system (central)**

system of piping through which oil is supplied from remote central supply tank(s) to one or more buildings, mobile homes, recreational vehicles, or other structures.

**oil fired**

support of combustion in a furnace, stove, etc., by the injection of fuel oil.

**oil pressure delivery**

pressure of an oil pump in pressure-lubricated machines, or oil burners.

**oil receiver**

vessel for receiving and separating collected oil prior to returning to or discharging from the refrigerating system.

**oil rectifier (oil still)**

apparatus for purifying oil by vaporizing the refrigerant contained.

**oil removal**

removal of oil or oil vapor from a refrigerant vapor.

**oil return**

migration of oil from the evaporator to the crankcase of the compressor. See compressor oil return.

**oil separator**

device for separating oil and oil vapor from the refrigerant, usually installed in the compressor discharge line.

**oil still**

device to separate oil from refrigerant by a distillation process.

**oil trap**

device for separating and collecting oil at a given point in a refrigerating circuit.

**Olympic rink**

ice rink of standardized size (56 m by 26 m).

**open-loop control system**

control system that controls outputs by inputs only and the actual system output is not considered.

**operating life**

expected useful life of a device, usually expressed in number of operations or years, months, hours of typical operation.

**operating load**

point actual system operating capacity at the time of taking an instrument reading.

**operator**

1. person responsible for operating building automation equipment or who operates a machine.
2. in the description of a process, that which indicates the action to be performed on operands. Compare actuator.

**operator station**

point of operator interface to a building automation system using a monochromatic or a color graphic monitor with keyboard and/or mouse, and optional printers.

**optimization**

1. collection of data in a control system in order to produce the best possible output, usually in accordance with what is most economical.
2. procedure used in the design of a system to maximize or minimize some performance index. May entail the selection of a component, a principle of operation, or a technique.
3. refinement of a system to reduce its energy requirements.

**orifice meter**

instrument that measures fluid flow by recording differential pressure across a restriction placed in the flow stream and the static or actual pressure acting on the system.

**orifice plate**

relatively sharp-edged orifice in a plate used for the calculation of fluid flow rates from measurements of the pressure difference between the two sides of the orifice.

**o-ring**

ring gasket of circular cross section; a torus.

**Orsat apparatus**

gas analyzer based on absorption of CO<sub>2</sub>, O<sub>2</sub>, etc. by separate chemicals that have a selective affinity for each of those gases.

**outlet area**

gross overall discharge area of a given component in an air distribution system. outlet valve see discharge valve (under valve).

**output**

1. capacity, duty, performance, net refrigeration produced by a system.

2. (general) current, voltage, power, or driving force delivered by a circuit or device; terminals or other places where current, voltage, power, or driving force may be delivered by a circuit of device.
3. electronic digital computer. Data that have been processed; state or sequence of states occurring on a specified output channel; device or collective set of devices used for taking data out of a device; channel for expressing a state of a device or logic element.
4. process of transferring data from an internal storage.

**analog output**

1. continuous variable used to represent another; e.g., in temperature measurement, an electric voltage or current output represents temperature input.
2. varying quantity, e.g., pressure, voltage, or temperature, which can have any value between a predetermined minimum and maximum, used as the corrective action in a control system.
3. output that is continuously variable representing a physical variable such as a voltage, current, or pressure output.

**variable output**

for each element of a control system, a physical quantity whose changes are governed ultimately by the functioning of the element.

**output rating**

heating output capacity of a fuel-burning appliance.

**outside air opening**

opening used as an entry for air from outdoors.

**overall thermal transfer value (OTTV)**

quantity of heat transferred per unit of temperature difference into a building through its walls or roof, due to solar heat gain and outdoor-indoor temperature difference.

**overpressure**

pressure in excess of the designed normal operating range.

**overshoot**

1. condition in a control system where the controlled variable exceeds the desired set point as a result of approaching that set point too quickly.
2. amount of the overtravel of an indicator beyond its final steady deflection when a new constant value of the measured quantity is suddenly applied to the instrument.
3. excursion of the controlled variable beyond the differential or proportional band.

**owner's representative**

person(s) authorized to function in the owner's interests in matters pertaining to execution of testing, adjusting, and balancing of systems.

**ozone**

triatomic form of oxygen O<sub>3</sub>. Sometimes used as an oxidant in air conditioning and as an odor eliminator in cold storages or exhaust stacks. It is toxic in concentrations of 1 ppm and higher.

**packing**

1. stuffing around a shaft or valve stem to prevent fluid leakage. See also gland.
2. cooling tower packing. See stuffing box.

**shaft packing (gland packing)**

substance used in a stuffing box for packing a gland to prevent leakage.

**packing plant**

production operation for slaughtering, dressing, and processing animals; also used in connection with processing vegetables and fish.

**pallet**

tray or platform used with a forklift machine to lift and move packaged materials.

**pallet box (pallet crate; pallet bin)**

bin in which the base is a pallet.

**panel**

1. assembly of a starter, contactor, or relay which are wired together with one or more devices (such as a contactor, relay, transformer, terminals, pressure control, etc.) to perform one or more functions of an air-conditioning system; panel may or may not be enclosed.
2. unit of one or more sections of flat material suitable for mounting electric devices.
3. plate or enclosure for mounting control devices.

**parallax**

1. apparent displacement of an object as seen from two different points not on a straight line with the object.
2. inaccurate reading of a meter due to misaligned or angled line of vision between the scale and the indicator.

**particle**

1. any relatively small subdivision of matter, ranging in diameter from a few nanometres (as with gas molecules) to a few millimetres (as with large raindrops).
2. any very small part of matter, such as a molecule, atom, or electron. Also known as fundamental particle.

**particle concentration**

number of individual particles per unit volume of air.

**particle size**

apparent maximum linear dimension of a particle in the plane of observation.  
particulate (particulate matter) state of matter in which solid or liquid substances exist in the form of aggregated molecules or particles. Airborne particulate matter is typically in the size range of 0.01 to 100 micrometres. See also atmospheric dust, respirable particles, total suspended particulates.

**part-load value (PLV)**

single number figure-of-merit expressing part-load efficiency for equipment on the basis of weighted operation at various partial-load capacities for the equipment; expressed in kilowatts per ton of refrigeration.

**application part-load value (APLV)**

part-load value based on operation at actual design conditions; typically used in system design and specification.

**integrated part-load value (IPLV)**

part-load value based on operation at standard ARI conditions; typically used for ARI rating purposes.

**pasteurization**

heat treatment of a fluid, usually at 130 to 160°F (55 to 70°C) killing bacteria, as in milk, without greatly changing its chemical composition, and greatly extending its shelf life.

**pcm**

phase-change material.

**PD**

1. pressure dependent.
2. pressure difference ( $\Delta p$ ).
3. pressure drop.
4. partial derivative (piping).

**penthouse**

roofed structure incorporating louvers or louver blades in all or part of the walls, and usually designed to be on the roof of a building.

**perforated ceiling**

one composed of perforated panels used to distribute the air uniformly throughout the ceiling or portion of the ceiling.

**performance**

manner in which an individual, a building, a system, or a component fulfills specified behavior.

**acceptable performance**

performance of a component or system that meets specified design parameters under actual load.

**peripheral equipment (computer)**

auxiliary machines that may be placed under the control of a central computer. Examples include magnetic tape drives and printers. Peripheral equipment may be used on-line or off-line depending on computer design, job requirements, and economics.

**perm**

empirical unit of water-vapor permeance; one perm = one grain (avoirdupois) of water vapor per hour flowing through one square foot of a material or construction induced by a vapor-pressure difference of one inch of mercury across the two surfaces. *Note:* Mass flow rate may be restated in other units consistent with the defined units. One perm is the generally accepted maximum allowable permeance value for the residential building envelope in a 5000 heating degree-day climate.

**permafrost**

in polar regions, and at some high-altitude areas, perennially frozen soil. *Note:* It may have an active layer of varying thickness at the surface, and it is this active layer that causes most of the difficulties with permafrost.

**permeability**

time rate of water-vapor transmission through unit area of flat material of unit thickness induced by unit vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions. When permeability varies with psychrometric conditions, the spot or specific permeability defines the property at a specific condition. *Note:* Permeability is a property of a material, but the permeability of a body that performs like a material may be used. Permeability is the arithmetic product of permeance and thickness.

**permeance**

water-vapor transmission of a body between two specified parallel surfaces, induced by the vapor pressure difference between two surfaces. The test conditions must be stated. An accepted unit of water-vapor permeance is the perm. *Note:* Permeance is a performance evaluation and not a property of a material. See perm; rep.

**phase**

1. in thermodynamics, one of the three states of matter, solid, liquid, or gas.
2. in an alternating electric current, the definite time relation of the alternations to the rotational position of the alternator. (In a polyphase machine, the phases are separated by 360 electrical degrees divided by the number of phases.)
3. position in a cycle.
4. one conductor of several, each with different electrical phase.

**phase change**

shift of a material or system from one phase to another, such as liquid to gas, liquid to solid, solid to gas. See state.

**phase-change material (pcm)**

substance that undergoes changes of state while absorbing or rejecting thermal energy at constant temperature.

**phon**

unit of loudness level. Sound pressure level of a 1000 hertz reference tone, judged by the average listener to be equally loud to the sound being rated. Compare decibel.

**photometer**

radiometer designed for measuring luminous intensity, luminous flux, or illumination.

**photovoltaic**

*adj.* capable of generating a voltage as a result of exposure to visible or other radiation.

**photovoltaic cell**

device that detects or measures electromagnetic radiation by generating a potential at a junction (barrier layer) between two types of material, on absorption of radiant energy. Also known as barrier-layer cell, barrier-layer photocell, boundary-layer photocell, photronic photocell.

**physical laws**

properties of physical phenomena, or relationships between the various quantities or qualities which may be used to describe the phenomena, that apply to all members of a broad class, practically without exception.

**physical properties**

properties discussed in physics, exclusive of those described under mechanical properties; for example, density, electrical conductivity, coefficient of thermal expansion. Compare mechanical properties.

**PI**

1. pressure independent.
2. proportional + integral control mode.

**PIC**

product integrated control.

**piezometer**

instrument for measuring pressure or compressibility.

**pilot duty**

class of operation in which the ultimate load is controlled by auxiliary means.

**pilot duty rating**

volt-ampere rating that is applied to electric devices intended to control an electromagnetic load, other than an electric motor, such as a control coil or other solenoid.

**pipe**

hollow tube conduit for conveying gases, liquids, semiliquids, or finely divided solids; and having wall thickness sufficient to be threaded. Compare piping; tube.

**alloy steel pipe**

steel pipe with one or more chemical elements other than carbon, which give it greater resistance to corrosion and more strength than carbon steel pipe.

**butt-weld pipe**

pipe welded along a butted longitudinal seam, and not scarfed or lapped.

**carbon steel pipe**

pipe that owes its properties chiefly to the carbon content of the steel.

**copper pipe**

seamless copper pipe conforming to the particular dimensions commercially known as standard pipe sizes.

**galvanized steel pipe**

pipe coated with zinc to resist corrosion.

**sparge pipe**

pipe or tube containing a series of holes designed to equalize the distribution of one fluid stream into another.

**pipe coupling**

short internally threaded pipe for joining two externally threaded pipe ends. See also pipe fitting.

**quick-release pipe coupling (quick coupler)**

special type of connector which enables the easy coupling or uncoupling of fluid lines.

**pipe fitting**

parts used to join, adapt, or adjust other parts of the piping. See also flange; joint; manifold.

**close nipple**

nipple with a length twice the length of a standard pipe thread.

**cross pipe**

fitting with four branches in the same plane with right angles between them.

**diversion pipe fitting**

venturi jet or orifice in a tee that induces flow through branch lines by reducing the pressure in the main following the branch.

**elbow (ell)**

pipe fitting to make an angle between connected pipes. If angle is not specified, a 90° angle is implied.

**nipple**

short length of externally threaded pipe for connecting two internally threaded fittings.

**pipe bushing**

hollow plug with internal and external threads.

**reducing pipe**

bushing a reducing adapter with one end male and one end female.

**pipe grids**

1. in an ice rink, the network of pipes laid on the floor, through which refrigerant or a cooling medium circulates to produce the ice slab.
2. in cold storage construction, a network of pipes under the structure through which heated fluid is circulated to prevent freezing and consequent frost heave.

**pipe run**

1. assembly of more than one piece of pipe.
2. portion of a fitting having its end in line or nearly so, as distinct from the branch or side opening, as of a tee.

**pipe schedule**

pipe size system listing outside diameters and wall thicknesses for a variety of pressures.

**piping**

1. system of pipes for carrying fluids.
2. pipe or tube mains for interconnecting the various parts of a refrigerating system.  
Compare piping system.

**grooved-joint piping**

coupling system that joins pipes end-to-end by engaging circumferential grooves in the pipe, using split couplings and a gasket.

**refrigeration piping**

pipe or tube mains for interconnecting the various parts of a refrigerating system; including pipe, flanges, bolting, gaskets, valves, fittings, the pressure-containing parts of other components such as expansion joints, strainers, and devices that serve such purposes as mixing, separating, muffling, snubbing, distributing, metering, or controlling flow, pipe-supporting fixtures, and structural attachments.

**pipng cross connection (nonpressure)**

in a piping system, a connection in which a pipe carrying potable water is connected (or extended) below the overflow rim of a receptacle (or in an environment) that is at atmospheric pressure and that contains nonpotable fluid.

**pressure cross connection**

in a piping system, a connection in which a pipe carrying potable water is connected to a closed vessel (or system) that is above atmospheric pressure, and that contains nonpotable fluid.

**piston displacement (swept volume)**

volume displaced in one shaft revolution in a reciprocating compressor; may be given for one piston or all pistons for total displacement.

**piston stroke**

length of travel (twice its crank radius).

**pitot tube**

small bore tube inserted perpendicular to a flowing stream with its orifice facing the stream to measure total pressure. At present, the term is often used for a double-tube instrument from which the flow velocity can be calculated with one orifice facing the flowing stream to register total pressure and the other perpendicular to the stream to register static pressure.

**pitting**

formation of small depressions in a surface due to sand blasting, mechanical gouging, acid etching, or corrosion.

**plane radiant temperature**

uniform temperature of an enclosure in which the incident radiant flux on one side of a small plane element is the same as in the existing environment.

**plastic**

any of various nonmetallic compounds, synthetically produced (usually from organic compounds, by polymerization) that can be molded into various forms, and hardened for commercial use.

**plenum chamber**

in an air distribution system, that part of the casing, or an air chamber furnace, to or from which the air duct system delivers conditioned air.

**plug**

1. an external-thread pipe fitting that is inserted into the open end of an internalthread fitting to seal the end of a pipe.
2. sealing a hole in a vessel, such as a pipe or tank, by inserting material in the hole and then securing it.
3. material used to plug the hole.

**PLV**

part-load value.

**pollution**

destruction or impairment of the purity of the environment.

**polytrope**

graphical line representing a polytropic process.

**polytropic process**

one in which heat is being exchanged with the surroundings, represented by the equation  $pV^n = \text{constant}$  ( $n$  is the polytropic exponent).

**porthole (inspection window)**

small glazed opening in a partition which enables inspection of an enclosure without having to enter it.

**positive heat supply**

heat supplied to a space by design or by heat losses occurring from energy-consuming systems or components associated with that space.

**postpurge operation**

operating a burner fan after flame shutdown. See purge.

**potentiometer**

1. instrument for measuring or comparing small electromotive forces, such as those produced by thermocouples.
2. instrument for comparing small electromotive forces, or for measuring small electromotive forces, by comparison with a known electromotive force. Its principal advantage is that during the measurement, no current flows through the source of electromotive force.
3. three-terminal rheostat, or a resistor with one or more adjustable sliding contacts, that functions as an adjustable voltage divider.

**power**

time rate of doing work, usually expressed in horse-power (kilowatts). See horsepower.

**ppm**

parts per million.

**power plant**

equipment and buildings used in the production and generation of power; e.g., electricity and steam.

**practice**

definitive procedure for performing one or more specific operations or functions, that does not produce a test result. Compare test method. *Note:* Examples include procedures for conducting interlaboratory testing programs or other statistical procedures; for writing statements on sampling, or precision and accuracy; and for selection, preparation, application, inspection, necessary precautions for use, disposal, installation, maintenance, and operation of test equipment.

**precipitator**

device to remove fine ash, tars, dusts, or smoke particles from flue gases or other gaseous streams; the device may employ mechanical, electrostatic, or chemical means, or a combination of these. See air cleaner.

**electric precipitator**

device for removing dust from air by means of electric charges induced on the dust particles.

**electrostatic precipitator**

device for removing dust from the air by inducing an electric charge on the dust particles.

**precision**

closeness of agreement among repeated measurements of the same characteristic by the same method under the same conditions. See accuracy; reliability; repeatability.

**preheating**

1. heating a food product prior to a subsequent treatment.
2. in air conditioning, to heat the air ahead of other processes.

**prepurge operation**

operating a burner blower prior to flame ignition to blow out possible leaked gas. See purge.

**pressure**

1. thermodynamically, the normal force exerted by a homogeneous liquid or gas, per unit of area, on the wall of the container.
2. force exerted per unit area. *Note:* The terms head and pressure often are used interchangeably; however, head is the height of a fluid column supported by fluid flow, while pressure is the normal force per unit area. For liquids, it is convenient to measure the head in terms of the flowing fluid. With a gas or air, however, it is customary to measure pressure on a column of liquid.

**absolute pressure**

pressure above a perfect vacuum; the sum of gage pressure and atmospheric pressure.

**ambient pressure**

1. environmental pressure in which a device operates.
2. pressure of the medium surrounding a device.

**atmospheric pressure**

1. pressure of the outdoor atmosphere.
2. standard atmospheric reference pressure (assumed sea level) is defined by the ICAO (International Civil Aeronautics Organization) as 101.325 kPa. In I-P units the value is approximately 14.696 psi, or 29.921 inches of mercury at 32°F.

**balance pressure**

pressure in a system or container equal to that outside.

**condensing pressure**

pressure of a gas at which it condenses.

**critical pressure**

for a specific fluid, the vapor pressure at which the liquid and vapor have identical properties.

**design working pressure**

1. in the United States, the maximum working pressure for which an apparatus has been designed.
2. in some countries, the design pressure is greater than the maximum working pressure. See operating pressure.

**differential pressure**

difference in pressure between any two points in a system.

**discharge pressure**

operating pressure in a system measured in the discharge line at the compressor or fan outlet.

**dynamic pressure**

additional pressure exerted by a fluid due to motion.  
excess pressure pressure exceeding the design value or a standard value.

**final pressure**

pressure of a fluid leaving a process.

**gage pressure**

pressure above atmospheric pressure.

**head pressure**

operating pressure measured in the discharge line at a pump, fan or compressor outlet; i.e., at the head.

**hydrostatic pressure**

1. pressure exerted by a fluid at rest.

2. normal force per unit area that would be exerted by a moving fluid on an infinitesimally small body immersed in it if the body were carried along with the fluid.

**initial pressure**

pressure of fluid entering the system.

**intermediate pressure (interstage pressure)**

pressure prevailing between stages of multistage compression.

**maximum allowable pressure**

maximum gage pressure permitted on a completed system; the setting of the pressure-relieving devices protecting the system.

**negative air pressure**

in a building, pressure lower than pressure outside. *Note:* As the negative pressure increases, outside air is drawn in through any openings in the building envelope.

**operating pressure (working pressure)**

pressure indicated by a gage when the system is in normal operation.

**osmotic pressure**

differential pressure which must be applied to the fluid on one side of a semipermeable membrane to prevent diffusion through the membrane.

**partial pressure**

portion of total gas pressure of a mixture attributable to one component (Dalton's law of gases).

**positive air pressure**

in a building, pressure greater than pressure outside. *Note:* As the positive pressure increases, it forces indoor air out through any openings in the building envelope.

**residual pressure**

in freeze drying, the pressure of the gas (usually air) at the trap.

**reverse pressure**

1. pressure differential existing in a (heat pump) reversing valve to effect a reversal of flow through the valve.
2. output pressure of a reversing relay which changes in opposition of the input signal, i.e., as the input pressure increases, the output pressure decreases.

**saturation pressure**

for a pure substance at a given temperature, the pressure at which vapor and liquid, or vapor and solids, can exist in equilibrium.

**static pressure**

1. pressure exerted by a fluid at rest.
2. in a flowing fluid, the total pressure minus velocity pressure. See hydrostatic pressure.

**suction pressure**

operating pressure in a system measured in the suction line at the compressor inlet.

**supply pressure**

1. energy source to a controller or auxiliary device.
2. pressure of supply mains of a pneumatic control system.

**test pressure**

pressure, usually higher than the design working pressure, to which a piece of equipment is subjected for testing according to specified procedures.  
total pressure in fluid flow, the sum of static pressure and velocity pressure.

**velocity pressure**

in a moving fluid, the pressure due to the velocity and density of the fluid, expressed by the velocity squared times the fluid density, divided by two ( $\rho V^2/2$ ).

**pressure dependent (PD)**

*adj.* varying flow rate through a flow control device in response to changes in pressure.

**pressure drop**

1. loss in pressure, as from one end of a refrigerant line to the other, from friction, static, heat, etc.
2. difference in pressure between two points in a flow system, usually caused by frictional resistance to fluid flow in a conduit, filter, or other flow system. Compare pressure loss.

**pressure equalizing**

allowing high- and low-side pressures to equalize or nearly equalize during idle periods by an unloading valve or by a vapor lock liquid control, or nearly equalizing inlet and discharge pressures on compressors to reduce starting torque load.

**pressure-imposing element**

device for increasing the pressure on a fluid, e.g., refrigerant or other gases.

**pressure independent (PI)**

*adj.* uniform flow rate through a flow control device unaffected by changes in system pressure.

**pressure-limiting device**

pressure-responsive mechanism designed to stop automatically the operation of a pressure imposing element at a predetermined pressure.

**pressure loss**

change in total pressure due to friction and turbulence. Compare pressure drop.

**pressure regulator**

device to maintain controlled downstream fluid pressure with varying upstream pressure.

**pressure relief**

designed automatic reduction of excessive pressure in a vessel.

**pressure relief device**

1. valve or rupture member designed to relieve excessive pressure automatically.
2. means for relieving internal pressure and preventing explosive shattering of the housing.

**pressure relief vessel**

container or tank which allows the relief into it of excessive pressure automatically.

**pressure tubing**

1. practical designation for seamless steel tubing less than 1.5 in. outside diameter (37 mm). ASTM 106 pressure tubing in steam plant design.
2. any plastic or metal tubing to convey fluid under pressure.

**pressure vessel**

container for fluids at a pressure different from atmospheric pressure (vacuum to high), capable of withstanding associated stresses.

**refrigeration pressure vessel**

any refrigerant-containing receptacle in a refrigerating system. This does not include evaporators (each separate section of which does not exceed 0.5 ft<sup>3</sup> (0.014 m<sup>3</sup>) of refrigerant-containing volume, evaporator coils, compressors, condenser coils, controls, headers, pumps, and piping.

**prime mover**

engine, turbine, water wheel, or similar machine which drives an electric generator.

**process**

1. change in thermodynamic state that can be defined as any change in the properties of a system. *Note:* A process is described by specifying the initial and final equilibrium states, the path (if identifiable), and the interactions that take place across system boundaries during the process.
2. a sequence of events.

**produce**

generally, fruits, vegetables, and plants.

**product integrated control (PIC)**

direct digital control (DDC) panel, factory-mounted and connected, able to monitor, control, and diagnose the significant functions of the equipment of which it is a part. Compare field-installed device.

**product safety**

production and application of a product in a manner as to assure freedom from danger or hazard to property or life.

**proof test**

test to indicate that a material or structure is suitable for the purpose intended.

**propylene glycol**

clear, colorless liquid used to depress the freezing point of water for use as a secondary coolant in HVAC&R systems. *Note:* Inhibitors are required to control corrosion caused by glycol solutions.

**property**

of a system, any observable characteristic of the system. State of a system is defined by listing its properties.

**PRV**

pressure relief valve.

**psia**

pounds per square inch, absolute

**psig**

pounds per square inch, gage

**psychrometer**

instrument for measuring relative humidities with wet- and dry-bulb thermometers. See hygrometer.

**aspirated psychrometer**

psychrometer having mechanical means for rapidly circulating air to be tested over dry and wet bulbs.

**slings psychrometer**

hygrometer of two matched thermometers, one with its bulb wetted and the other dry, capable of being whirled rapidly on a sling, to indicate the temperature differences related to relative humidity.

**psychrometric**

*adj.* relating to the measurement or determination of atmospheric conditions, particularly regarding moisture mixed with air.

**psychrometric chart**

graphical representation of the properties of moist air, usually including wet- and dry-bulb temperatures, specific and relative humidities, enthalpy, and density.

**psychrometry**

branch of physics concerned with the measurement or determination of atmospheric conditions, particularly the moisture in air.

**psychrophilic**

*adj.* pertaining to microorganisms growing at low temperatures, and having an optimum growth temperature near 32°F (0°C).

**ptac**

packaged terminal air-conditioning system.

**published ratings (of unitary air conditioners)**

statement of the assigned values of those performance characteristics, under standard rating conditions, by which a unit may be chosen to fit its application.

**pull-down test**

first operational check on a refrigerating installation to measure the time taken to pull the temperature down to the desired conditions, while also measuring the temperatures, pressures, and associated data.

**pump**

machine for imparting energy to a fluid causing it to do work, drawing a fluid into itself through an entrance port, and forcing the fluid out through an exhaust port. Main types are air lift, centrifugal, diaphragm, positive displacement, reciprocating, and rotary.

**boiler feed pump**

pump which returns condensed steam, makeup water, or both directly to the boiler; normally installed with a large receiver.

**centrifugal pump**

pump having a stationary element (casing) and a rotary element (impeller) fitted with vanes or blades arranged in a circular pattern around an inlet opening at the center. The casing surrounds the impeller and usually has the form of a scroll or volute.

**condensate return pump**

pump used to transfer condensate from one point in a system to another receiver; usually installed with a receiver tank and a float valve; the pump being controlled by tank level.

**jet pump**

ejector or injector pump.

**liquid mechanical vacuum pump**

vacuum pump in which the flow of the gas is induced by a vaned rotor and a mass of liquid projected by centrifugal force against the stator.

**pressure-powered pump**

receiver device having inlet and outlet nonreturn valves and a float-operated mechanism, enabling a secondary medium (steam, compressed air, or inert gas) to pressurize the receiver body through a fill-and-discharge cycle actuated from the float mechanism.

**vacuum diffusion pump**

pump in which the motion of a gas is induced by its diffusion into the vapor phase of a working fluid in the pump.

**vacuum pump**

1. pump for exhausting a system; pump designed to produce a vacuum in a closed system or vessel.
2. pump used to remove air and moisture from the inside of a refrigeration system.
3. (ion pump) vacuum pump operated via the ionization of gases, the produced ions being transported by an electrical or magnetic field.

**pumpage**

general term for any fluid that is mechanically pumped.

**pump down**

of refrigerant, withdrawal of all refrigerant from the low side of a system by pumping it to either the condenser or the liquid receiver.

**pump laws**

see chapter on centrifugal pumps in the *ASHRAE Handbook—Applications*.

**purge**

1. removal of unburned gases from a combustion chamber.
2. removal of air from a water-heating system.
3. device to remove noncondensable gases from a refrigerating system.

**purge recovery system (purger)**

system used to recover refrigerant from purged mixture of gases and water. static purge system system in which differential pressure is used to remove noncondensables from a centrifugal system.

**pyranometer**

radiometer used to measure solar radiation received from the whole hemisphere ( $2\pi$  steradians). *Note:* The instrument is suitable for measurement of global or diffuse solar radiation.

**pyrgeometer**

radiometer designed to measure terrestrial (long wavelength) radiation only.

**pyrheliometer**

radiometer used to measure the direct or beam solar irradiance incident on a surface normal to the sun's rays.

**pyrometer**

instrument for measuring temperature, usually above the range of mercury thermometers.

**quad**

one quadrillion;  $10$  to the 15th power ( $10^{15}$ ) (not an SI quantity).

**qualification test**

procedure used to verify the accuracy of the measurement techniques (temperature, airflow rates, duct heat calibration) employed in determination of heating or cooling effect.

**quality assurance**

testing and inspection of all or a portion of a final product, assembly, or system to ensure that the desired quality level is attained.

**quality control**

inspection, analysis, and action applied to a portion of a product, assembly, or system in the manufacturing or construction operation, to estimate overall quality, and to determine what, if any, changes must be made to achieve or maintain a desired quality level.

**quasi-steady state (solar collector)**

condition of operation of the collector and/or system in which the measured solar irradiance, flow rates, and thermodynamic states of temperature and pressure at various points in the collector and/or system do not vary during the period of test measurements.

**radial distance (chimney)**

shortest distance from receptor location to centerline of the chimney outlet.

**radiance**

total radiant flux emitted from a surface through unit projected area by unit solid angle. It includes the self-emitted radiation plus reflections from sources other than the object evaluated as interpreted from the direction of measurement. The term intensity of radiation is sometimes used as a synonym for radiance. See also radiosity.

**radiant**

*adj.* radiating rays of light; emitting or reflecting beams of light; vividly shining; glowing; brilliant.

**radiant flux (f)**

time rate of flow of radiant energy (watts).

**radiant flux density**

measure of radiant power per unit area flowing across or onto a surface. (Also called irradiance).

**radiant reflectance (luminous reflectance) (r)**

ratio of the reflected radiant (or luminous) flux to the incident radiant (or luminous) flux.

**radiant temperature asymmetry**

difference between the plane radiant temperature of two opposite sides of a small plane element.

**radiant transmittance (luminous transmittance) (g)**

ratio of the transmitted radiant (or luminous) flux to the incident radiant flux.

**radiation**

act or process of radiating, specifically the process by which energy is emitted from molecules and atoms, owing primarily to internal temperature change.

**electromagnetic radiation**

electromagnetic waves, and especially the associated electromagnetic energy.

**radiation angle factor (shape factor)**

when the space above an element of surface is partially occupied by a body exchanging radiant energy with the surface, the angle factor represents the fraction of the angular field of view where energy exchange is taking place.

**radiation pasteurization**

irradiation, using moderate doses, to enhance keeping quality by killing most of the spoilage microorganisms present; viruses are not affected.

**radiation shield**

1. device designed to intercept radiated heat.
2. in a furnace, a sheet of metal or other material supported between the heat exchanger and the casing to protect the casing from heat; not to be considered as a heat transfer surface.

**radiation sterilization**

irradiation using high doses to kill the microorganisms present.

**radiator (convector radiator)**

terminal unit used in hot water or steam systems to deliver heat to a space (but primarily by convection and not radiation).

**baseboard radiator**

heating device located at or replacing a room baseboard.

**finned-tube radiator**

wall-mounted heater with a plurality of fins bonded to a tube, usually carrying steam or hot water.

**radiometer**

instrument for measuring irradiance in energy or power units.

**radiosity**

total radiant flux that leaves unit area of a surface. The sum of radiant flux emitted and reflected by the surface, plus any radiant flux transmitted through that surface. Compare exitance.

**RAM**

random access memory (computer).

**range**

1. difference between the highest and the lowest operational values, such as pressure, temperature, rate of flow, or computer values.
2. region between limits within which a quantity is measured, transmitted, or received, expressed by stating the lower and upper range values.

**rate base (electric)**

monetary value established by a regulatory authority, on which a utility is permitted to earn a specified rate of return.

**rating**

assigned value of those performance characteristics (under standard rating conditions) by which a unit may be selected to fit its application. *Note:* These values apply to all units of like (nominal) size and type (identification) produced by the same manufacturer.

**application rating**

rating based on tests performed at other than standard rating conditions.

**standard rating**

rating based on tests performed at standard rating conditions.

**rating conditions**

set of operating conditions under which a single level of performance results, and which causes only that level of performance to occur.

**application rating conditions**

rating conditions other than standard rating conditions.

**standard rating conditions**

rating conditions used as the basis of comparison of performance characteristics.

**reciprocating**

*adj.* moving forward and backward alternately.

**recirculation of discharge air**

1. condition pertaining to cooling towers and evaporative condensers in which a portion of the discharge air enters along with the fresh air; the amount of recirculation is determined by equipment design, placement in regard to adjoining objects, and atmospheric conditions. The effect is generally evaluated on the basis of the increase in entering wet-bulb temperature compared to the ambient.
2. a condition pertaining to air-cooled condensers in which a portion of the discharge air enters along with the fresh air; the amount of recirculation is determined by equipment design, placement in regard to adjoining objects, and atmospheric conditions. The effect is generally evaluated on the basis of the decrease in unit capacity.

**recirculation refrigerating system**

liquid overfeed system (preferred term). See refrigerating system.

recirculation-type evaporator circulating-type evaporator (preferred term). See evaporator.

**rectifier**

1. externally-cooled heat exchanger in the high side of a refrigerating absorption system for condensing absorbent and separating it from the refrigerant before passing it to the condenser.
2. in electricity, a device for converting AC to DC current.

**reefer**

refrigerated space or refrigerated transport carrier

**reflectance**

portion of the incident radiation on a surface that is reflected from the surface. *Note:* For an opaque surface, the sum of the reflectance and the absorptance is unity at equilibrium. Absorptances and reflectances are of various types, as are emittances. For most engineering purposes, the counterparts of the hemispherical total emittance suffice.

**diffuse reflectance**

directional hemispherical reflectance less the specular reflectance.

**reflectivity**

portion of the radiation striking unit area of a surface that is not absorbed or transmitted by the surface. See reflectance.

**refrigerant**

1. in a refrigerating system, the medium of heat transfer which picks up heat by evaporating at a low temperature and pressure, and gives up heat on condensing at a higher temperature and pressure.
2. (refrigerating fluid) fluid used for heat transfer in a refrigerating system which absorbs heat at a low temperature and low pressure of the fluid and transfers heat at a higher temperature and a higher pressure of the fluid, usually involving changes of state of the fluid. Compare coolant.

**alternate refrigerant**

replacement refrigerant that can accomplish the same task as the one being replaced, but may require that refrigeration or air-conditioning equipment be redesigned or replaced. Compare drop-in refrigerant.

**ammonia refrigerant**

anhydrous ammonia (NH<sub>3</sub>).

**azeotropic refrigerant**

blend of two or more component refrigerants whose equilibrium vapor-phase and liquid-phase compositions are the same at a given pressure. Compare zeotropic refrigerant.

**drop-in refrigerant**

replacement refrigerant that has thermodynamic properties similar to one being replaced, and does not require air-conditioning or refrigerating equipment to be replaced, but may require modifications.

**expendable refrigerant**

1. liquefied gas (generally liquid nitrogen) whose vapor is lost after change of phase.
2. solid carbon dioxide (dry ice).

**flammable refrigerant**

refrigerant that is ignitable when mixed with air, e.g., ethyl chloride, methyl chloride, and the hydrocarbons. *Note:* See ASHRAE *Standard* 34 for flammability categories.

**halocarbon refrigerant**

hydrocarbon compound with fluorine, chlorine, or bromine.

**primary refrigerant**

working fluid of a refrigerating cycle (as opposed to secondary refrigerant).

**secondary refrigerant (secondary coolant)**

volatile or nonvolatile substance in an indirect refrigerating system that absorbs heat from a substance in space to be refrigerated and transfers this heat to the evaporator of the refrigerating system.

**zeotropic refrigerant**

blend of two or more component refrigerants whose equilibrium vapor-phase and liquid-phase compositions are different at a given temperature.

**refrigerant charge**

1. actual amount of refrigerant in a closed system.
2. weight of refrigerant required for proper functioning of a closed system.

**critical refrigerant charge**

minimum refrigerant quantity required by a system to maximize performance when a capillary or fixed restriction expansion device is used.

**holding charge (service charge)**

reduced quantity of refrigerant or inert gas used to avoid the ingress of air and moisture into a component, before startup.

**limited refrigerant charge**

charge that does not exceed the design pressure at complete evaporation.

**optimum refrigerant charge**

charge achieving maximum possible refrigerant effect within design limitations.

**refrigerant compressor**

component of a refrigerating system which increases the pressure of a compressible refrigerant fluid and simultaneously reduces its volume, while moving the fluid through the device. See also compressor.

**accessible hermetic (semihermetic) refrigerant compressor**

hermetic refrigerant compressor whose housing is sealed by one or more gasketed joints and is provided with means of access for servicing internal parts in the field.

**welded hermetic refrigerant compressor**

hermetic refrigerant compressor whose housing is permanently sealed by welding or brazing and is not provided with means of access for servicing internal parts in the field.

**refrigerant cylinder (gas bottle)**

cylindrical steel pressure vessel with operable closure for the storage and transport of refrigerant.

**service cylinder (gas bottle)**

small refrigerant cylinder used by a service person.

**refrigerant distributor**

device used in conjunction with a thermostatic expansion valve to ensure equitable refrigerant distribution from the valve to individual parallel sections of an evaporator.

**refrigerant flow rate**

mass flow rate of refrigerant pumped or moved through a system at specified temperature and pressure.

**specific refrigerant flow rate**

flow rate in lb/min (g/s) required to produce one ton (kW) of refrigerating effect at the conditions indicated.

**refrigerant heat rejection**

total useful capacity of a refrigerant condenser for removing heat from the refrigerant circulated through it.

**condensing heat rejection**

that portion of the total refrigerant heat-rejecting effect of a condenser which is used for condensing the entering refrigerant vapor to a saturated liquid at the entering refrigerant pressure.

**desuperheating heat rejection**

sensible heat rejection in a condenser from gaseous refrigerant (generally occurring prior to the gas-to-liquid phase change).

**subcooling heat rejection**

sensible heat rejection in a condenser from liquid refrigerant (generally occurring after the gas-to-liquid phase change). See also cooling; refrigerant subcooling.

**refrigerant hydrolysis**

splitting of refrigerant compounds by reaction with water; e.g., reaction of dichlorodifluoromethane or methyl chloride with water, forming acid products.

**refrigerant-liquid pressure reducer**

device or devices, in a refrigerating system, in which the pressure of the fluid is reduced from that of condensed liquid to that of the evaporator.

**refrigerant metering device**

device which controls the flow of liquid refrigerant to an evaporator.

**refrigerant pressure-imposing device**

device or portion of equipment used for the purpose of increasing refrigerant pressure.

**refrigerant processing****reclaim**

to reprocess refrigerant to new conditions, by means which may include distillation. May require chemical analysis of the contaminated refrigerant to determine that appropriate process specifications are met. This term usually implies the use of processes or procedures available only at a reprocessing or manufacturing facility.

**recover**

to remove refrigerant in any condition from a system and to store it in an external container without necessarily testing or processing it in any way.

**recycle**

to clean refrigerant for reuse by oil separation and single or multiple passes through moisture absorption devices, such as filter driers with replaceable cores. This procedure is usually implemented at the field site or at a local service shop.

**refrigerant pump-out system**

dedicated apparatus for transfer of refrigerant from a chiller or other refrigerating system to a separate and distinct storage vessel.

**refrigerant receiver**

vessel in a refrigerating system designed to ensure the availability of adequate liquid refrigerant for proper functioning of the system, and to store the liquid refrigerant when the system is pumped down.

**controlled-pressure receiver (cpr)**

intermediate pressure receiver used to flash cool refrigerant and to control the feed pressure.

**liquid receiver**

vessel, permanently connected to a refrigerating system by inlet and outlet pipes, for storage of liquid refrigerant.

**low-pressure receiver (surge drum; accumulator)**

vessel on the low side of a refrigerating system into which liquid refrigerant can collect to be used to supply evaporators.

**refrigerant subcooler**

heat exchanger, after the condenser, for subcooling the condensed refrigerant.

**refrigerant subcooling**

process of cooling refrigerant below condensing temperature for a given pressure; also, cooling a liquid below its freezing point where it can exist only in a state of unstable equilibrium. See supercooling.

**specific heat of a subcooled refrigerant**

difference in specific enthalpies of a pure condensable fluid between the saturated (not subcooled) liquid state and the cooled liquid at a given temperature below its condensation temperature at the same pressure.

refrigerate to subtract heat from a substance or space to maintain the temperature below 30°F (−1°C). Above this temperature, the process is called cooling.

**refrigerated volume**

space under refrigeration.

**net freezer refrigerated volume**

that portion of the net refrigerated volume 1. below 32°F (0°C) (average) for household refrigerators, and 2. 8°F (−13°C) (average) or below for household combination refrigerator-freezers and household freezers (exception: see net general refrigerated volume).

**net general refrigerated volume**

that portion of the net refrigerated volume 1. above 32°F (0°C) average for household refrigerators and “all-refrigerators” or 2. above 8°F (−13°C) average for household combination refrigerator-freezers; including the volume of the refrigerated chiller tray and other special compartment(s) for storage of fresh foods approaching 32°F (0°C).

**net refrigerated volume**

for household refrigerators and combination refrigerator-freezers, the sum of the net general-cooled volume and the net freezer-refrigerated volume. For household all-purpose refrigerators, the net general refrigerated volume. For a household freezer, the net freezer-refrigerated volume.

**refrigerated warehouse**

building used to preserve goods under refrigerated conditions. See cold store.

**refrigerating capacity (gross)**

total rate of heat removal from all sources by the evaporator of a refrigerating system at stated conditions. It is numerically equal to the system refrigerating effect.

**net cooler refrigerating capacity**

rate of heat removal from a fluid flowing through a cooler (air, water, brine, etc.) at stated conditions; the difference in specific enthalpies of the cooling fluid entering and leaving the cooler. In case frosting occurs within the cooler, the latent heat of fusion and the subcooling heat of the ice (frost) must be added in determining the net cooler refrigerating capacity.

**net refrigerating**

remaining rate of heat removal remaining from all sources by the evaporator of a refrigerating system, at stated conditions, after deducting internal and external heat transfers to the evaporator that occur before distribution of the refrigerating medium and after its return.

**refrigerating capillary tube**

tube of small bore [down to 0.020 in. i.d. (0.50 mm)] used for the simultaneous purposes of metering the refrigerant and of accomplishing the expansion process between condenser and evaporator in refrigerating systems. See also tube. Compare refrigerant expansion valve.

**refrigerating cargo vessel**

vessel whose holds are totally or partly refrigerated.

**refrigerating heating system**

interconnected parts forming a closed circuit in which refrigerant is circulated, and having the condenser located to transfer heat to the zone to be heated.

**refrigerating plant**

refrigerating system.

**refrigerating process**

refrigeration.

**refrigerating system**

system that, in operation between a heat source (evaporator) and a heat sink (condenser) at two different temperatures, absorbs heat from the heat source at the lower temperature and rejects heat to the heat sink at the higher temperature. See also refrigerating unit.

**absorption-type refrigerating system**

refrigerating system in which refrigeration is created by evaporating a refrigerant in a heat exchanger (evaporator), with the vapor then absorbed by an absorbent medium from which it is subsequently expelled by heating at a higher partial vapor pressure (in a generator) and condensed by cooling in another heat exchanger (condenser).

**brine spray refrigerating system**

cooling of air by spraying brine into the airstream. *Note:* Process discontinued in meat refrigerating plants because of salt corrosion of meat-carrying rails.

**cascade refrigerating system**

one having two or more refrigerant circuits, each with a pressure imposing element, condenser, and evaporator, where the evaporator of one circuit cools the condenser of another (lower temperature) circuit.

**central-plant refrigerating system**

system with two or more low sides connected to a single, central high side; a multiple system.

**class of refrigerating system**

formerly in extensive use but now becoming obsolete as a result of code change to classification. See ASHRAE *Standard 15*.

**closed secondary coolant refrigerating system**

system in which the secondary coolant is completely enclosed and shut off from the atmosphere throughout the cycle, except for a vented expansion tank at the high point of the system.

**compound refrigerating system**

multistaged refrigerating system where a single charge of refrigerant circulates through all stages of compression.

**compression-type refrigerating system**

system in which the temperature and pressure of a gaseous refrigerant are increased mechanically. In most cases, the refrigerant undergoes changes of state.

**direct refrigerating system**

system in which the refrigerant evaporator or condenser is in direct contact with the air or substance to be cooled or heated.

**direct-expansion (dry-expansion) refrigerating system**

system in which the cooling effect is obtained directly from the refrigerant. See also expansion.

**engineered refrigerating system**

system that requires specific engineering analysis of all components as a group to accomplish the desired results.

**hermetically-sealed compression refrigerating system**

system that uses a sealed (hermetic) compressor.

**indirect refrigerating system**

system in which a secondary coolant, cooled or heated by the refrigerating system, is circulated to the air or substance to be cooled or heated.

**limited-charge system**

system in which, with the compressor idle, the design pressure will not be exceeded when the refrigerant charge has completely evaporated.

**liquid-circulation refrigerating system**

system in which refrigerant liquid is flashed to saturated suction pressure and temperature in an accumulator and is then fed by a mechanical pump or by refrigerant vapor pressure to the evaporators. This liquid is normally fed at a rate greater than the evaporating rate for the refrigerant to ensure wetting of the entire evaporator surface for greater heat transfer.

**liquid-overfeed system**

system feeding an evaporator with refrigerant at a rate to make the exit quality less than one. Compare liquid-recirculation refrigerating system.

**mechanical refrigerating system**

refrigerating system using mechanical compression to remove the refrigerant from the low-pressure side and to deliver it to the high-pressure side of the system.

**multiple refrigerating system**

system in which refrigerant is delivered to two or more evaporators in separate rooms or refrigerators.

**multistage refrigerating system**

system in which compression of refrigerant is carried out in two or more steps.

**no-frost refrigerating system**

1. system in which all the refrigerated surfaces in the cabinet are defrosted by an automatic defrost system.
2. use of a secondary coolant sprayed on evaporator surfaces to prevent formation of frost; water absorbed in the coolant being removed by distillation.

**open-brine refrigerating system**

system in which the circulating brine returns to an open tank which serves as a reservoir for the pump suction and as an inspection tank for the condition and flow of brine.

**partial-recovery refrigerating system**

historic system in which the evaporating refrigerant is partially recovered by bringing it into contact with a condenser (e.g., halocarbon freezing).

**piggyback refrigerating system**

two chilling plants, centrifugal and absorption, usually steam-driven, using the same steam supply in sequence, with chilled water running counterflow to steam.

**recirculation refrigerating system**

see preferred term, liquid overfeed system.

**regenerative air cycle system**

air cycle refrigerating system fitted with heat regenerators.

**removable-unit refrigerating system**

system, readily removable as one unit from the cabinet or space that it cools and from the building in which it is used without disconnecting any part of the system that contains refrigerant. See also refrigerating unit.

**resorption-type refrigerating system**

system in which the refrigerant vapor is not condensed to a pure liquid but is absorbed in a weak solution from which it is subsequently evaporated at a lower temperature to produce refrigeration.

**self-contained refrigerating system (single-packaged)**

unitary refrigerating system. See also refrigerating unit.

**steam-jet refrigerating system**

system in which high-pressure steam, supplied through a nozzle and acting to eject water vapor from the evaporator, maintains the requisite low pressure on one side and produces a high pressure on the other by virtue of compression in a following diffusion passage. Sometimes called ejector-cycle refrigerating system.

**total-loss refrigerating system**

expendable refrigerating system.

**unitary refrigerating system**

complete factory-assembled and tested refrigerating system comprising one or more assemblies which may be shipped as one unit or separately, but which are designed to be used together. See also refrigerating unit.

**vapor refrigerating system**

system using a condensable vapor as the refrigerant.

**water-vacuum refrigerating system**

one that employs a vacuum to boil water at the temperature desired; one in which evaporating water vapor is the refrigerant.

**wet compression system**

system of refrigeration in which some liquid refrigerant is mixed with vapor entering the compressor to cause the discharge vapor from the compressor to be saturated, rather than superheated.

**refrigerating system contaminants**

contaminants include water (most important and universal contaminant); dirt; particles; organic materials such as waxes, acids, and sludges; or other products of chemical reactions taking place while the system is operating.

**refrigerating system high side**

parts subjected to approximately the condenser pressure.

**refrigerating system low side**

parts subjected to approximately the evaporator pressure.

**refrigerating system machinery**

refrigerating equipment forming a part of the refrigerating system including any or all of the following: compressor, condenser, generator, absorber (adsorber), liquid receiver, connecting piping, and evaporator.

**refrigerating system pressure vessel**

refrigerant-containing pressure vessel of a refrigerating system, other than evaporators in which each separate section does not exceed 0.5 ft<sup>3</sup> (0.014 m<sup>3</sup>) of refrigerant-containing volume, evaporator coils, compressors, condenser coils, controls, headers, and piping.

**refrigerating system restrictor**

device capable of providing the necessary difference in pressure between the high- and low-pressure sides of the refrigerating system.

**refrigerating unit**

unit assembly comprising a compressor, evaporator, condenser, and expansion device, used for refrigerating and for extracting heat.

**clip-on refrigerating unit**

refrigerating unit which can be attached to an insulated cargo container to provide cooling.

**straddle refrigerating unit (saddle unit; plug unit)**

factory-assembled refrigerating system mounted at high level in the insulated wall of a cold store with the evaporator inside the store and the rest of the unit outside.

**thermoelectric refrigerating module (thermoelectric battery)**

small device using the Peltier effect, consisting of an assembly of semiconducting blocks fed by a direct current. One face of the device cools while the other face warms up, and the thermal effect may be reversed by reversing the direction of the current.

**underslung refrigerating unit**

unit that is attached under the chassis of a vehicle to be cooled.

**refrigeration**

1. process of extracting heat from a substance or space by any means; usually at a low temperature.
2. any use of mechanical or absorption refrigerating machinery for applications other than comfort of human beings. Compare cooling.

**air cycle refrigeration**

consists of four stages: compression of air, cooling the air down to ambient temperature, expansion of the air, and heating of the cold air by heat absorption in the space to be cooled.

**thermoelectric refrigeration (thermoelectric cooling)**

method for cooling by the Peltier effect.

**refrigerator**

cabinet or room for keeping food or other items cool.

**closed refrigerator**

food store self-service display refrigerator in which a packaged product is accessible for removal by opening vertically hinged doors or sliding doors. Chest-type cabinets, service delicatessen, and customer-service meat cases are not included.

**commercial refrigerator**

1. refrigerated enclosure containing goods which are accessible from the exterior through a door.
2. types of refrigerators used commercially, including reach-ins, walk-ins, and refrigerated display cases (all types being either service or self-service, which are used by business establishments).

**dual-temperature refrigerator**

two-compartment refrigerated cabinet, with one used for chilling foods and the other for either freezing foods or storing frozen products.

**electric refrigerator**

self-contained unit comprising an insulated cabinet, evaporator, and electric motor-driven condensing unit with controls.

**gas refrigerator**

one using the heat of burning gas to cool a cabinet.

**household refrigerator**

cabinet or any part of a cabinet which is designed for the refrigerated storage of food at temperatures above 32°F (0°C) but preferably below 40°F (5°C), has a source of refrigeration, and is intended for household use. It may include a compartment for the freezing and storage of ice and for the short-term storage of food at temperatures below 32°F (0°C).

**low-temperature refrigerator**

refrigerator in which the food product is frozen.

**medium-temperature refrigerator**

refrigerator in which the food product temperatures are normally above freezing.

**nursery refrigerator**

one having the cabinet interior designed to receive feed-bottle carriers.

**reach-in refrigerator**

self-contained, commercial refrigerator for product refrigeration, display, and merchandising.

**remote refrigerator**

refrigerator which has the condensing unit located separate from the refrigerator. Normally, several refrigerators may be connected to the same condensing unit.

**self-contained refrigerator**

refrigerator that has the condensing unit built into the cabinet, as opposed to a remote condensing unit.

**walk-in refrigerator**

refrigerated enclosure large enough for persons to walk into.

**refrigerator cabinet breaker strip**

separate insulating element or integral insulating extension of the cabinet interior surfaces around the periphery of the cabinet door or drawer opening(s), which functions as a thermal barrier to minimize heat flow to the cabinet interior; i.e., it breaks a thermal leakage path.

**refrigerator load limit**

maximum volume available within the display or storage compartments of the display refrigerator usable for food products.

**refrigerator shelf net area**

calculated value based on the net area of the main shelves, door shelves, bottoms of suspended containers or dispensers, and the bottom of the liner(s) of the general refrigerated and freezer compartments.

**regain of moisture**

mass of moisture reabsorbed by a dried material when exposed to humid air.

**register**

combination grille and damper assembly over an air opening. See air outlet.

**registered engineer**

appropriately qualified and licensed professional engineer. See also design professional.

**regulator**

device to establish or adjust the time, amount, degree, or rate of a unit or process.

**barometric draft regulator**

counterweighted damper set so that variations in chimney barometric pressure will cause the damper to open or close gradually to maintain a constant draft directly upstream of the damper.

**crankcase pressure regulator**

automatic control device used to maintain the maximum pressure in the crankcase of a reciprocating (positive displacement) compressor.

**draft regulator**

device installed in the breeching between a fuel-fired appliance and the chimney to control chimney draft.

**dual-pressure regulator**

upstream pressure regulator equipped with two controls, used in refrigerant suction lines to provide freeze-up protection or for safety pressure relief.

**evaporator pressure regulator**

automatic valve or control device used to maintain the pressure, and thereby the temperature in an evaporator above a predetermined minimum.

**power-operated draft regulator**

control that is capable of maintaining a constant pressure in a furnace under all normal operating conditions. In addition, it includes a low-draft cutoff that shuts off the burner when the draft falls below the preselected minimum value.

**thermostatic regulator**

evaporator pressure regulator that is sensitive to temperature.

**reheat**

application of sensible heat to supply air that has been previously cooled below the temperature desired for maintaining the temperature of the conditioned space.

**relative humidity**

1. ratio of the partial pressure or density of water vapor to the saturation pressure or density, respectively, at the same dry-bulb temperature, and barometric pressure of the ambient air.
2. ratio of the mole fraction of water vapor to the mole fraction of water vapor saturated at the same temperature and barometric pressure.

**relay**

1. electrical mechanism which uses the current in a control circuit to open or close electric contacts.
2. fluid (liquid or pneumatic) device that uses variations in fluid pressure to actuate final control devices.
3. thermal relay.

**reversing relay**

relay designed to reverse the direction of current flow or of function, on actuation.

**time-delay relay**

relay whose activation is delayed for a predetermined period of time. It may be either time-delay opening (TDO) or time-delay closing (TDC).

**voltage relay**

1. relay that responds to a predetermined voltage.
2. device that is voltage sensitive with the ability to sense between two or more voltage levels to operate a set of contacts.

**reliability**

1. mathematical probability that a device will perform its objective adequately for the period of time intended under the operating conditions specified.
2. probability that a device will function without failure over a specified time period or amount of usage. See accuracy; precision; repeatability.
3. probability that an instrument's repeatability and accuracy will continue to fall within specified limits.

**rep**

empirical unit of resistance to water-vapor flow through a material or construction. One rep = one hour  $\times$  square foot  $\times$  inch mercury pressure difference between the two surfaces per grain (avoirdupois) water vapor ( $\text{h}\cdot\text{ft}^2\cdot\text{in. Hg}/\text{gr}$ ). (The resistance may be stated in other units consistent with this value.) The rep is the reciprocal of the perm. It is not an SI unit.

**repair**

to restore to good or sound condition, within the following constraints: operation must be fully restored without embellishment; and failure must have occurred.

**repeatability**

1. closeness of agreement among repeated measurements of the same variable under the same conditions.
2. closeness of agreement among consecutive measurements of the output for the same value of input approaching from the same direction. Compare accuracy; precision; reliability.

**research**

studious inquiry; usually critical and exhaustive investigation or experimentation having for its aim the revision of accepted conclusions, in light of newly discovered facts.

**residential**

pertaining to use in or as a residence, or by residents; adapted to or occupied by residences.

**resistance**

1. property opposing movement of material, or flow of energy, and involving loss of potential (voltage, temperature, pressure level).
2. property of an electric circuit or of any object used as part of an electric circuit which determines for a given current the rate at which electric energy is converted into heat or radiant energy, and which has a value such that the product of the resistance and the square of the current gives the rate of conversion of energy.
3. thermal resistance. See electrical resistance; thermal resistance.

**RTD**

resistance temperature device

**resonance**

condition of high vibration response. The exact resonance of a system in forced vibration exists when any change, however small, in the frequency of excitation causes a decrease in the response amplitude; i.e., when the driving frequency equals the natural frequency.

**resonance frequency**

frequency at which resonance exists. Often called the natural frequency.

**resource energy impact**

product of an energy resource (includes application of RUF) anticipated to be used in providing fuel or energy to a building site, multiplied by a RIF for that particular form of energy resource. Total resource energy impact is the sum of all resource energy impacts for a building project.

**resource impact factor (RIF)**

multipliers applied to fuel and energy resources required by a building project to permit a quantitative evaluation on the economy of those resources resulting from the selection of on-site fuel and energy forms. Availability, social, economic, environmental, and national interest issues are considered.

**resource utilization factor (RUF)**

multiplier applied to the quantity of fuel or energy delivered to a building site, which provides a quantitative estimate of the energy resources consumed in providing that fuel or energy. Variant multipliers account for the burden of processing, transporting, converting, and delivering fuel or energy from the point of extraction to the building site.

**respirable particles**

particles small enough to be inhaled into a nonciliated portion of the lung. Peak deposition of respirable particles occurs within the size range of 0.2 to 5.0 micrometres. Particles greater than 10 micrometres aerodynamic diameter are not respirable.

**respiration**

1. production of carbon dioxide and heat by ripening of perishables in storage.
2. breathing process of animals.

**retrofit**

modification of existing equipment, systems, or buildings to incorporate improved performance, updated operation, or both. Derived from retroactive refit.

**retrofit project**

modification, in factory or field, of existing equipment, systems, or buildings to incorporate improved performance or operation.

**return**

pipe or duct to carry fluid back to the source.

**reverberation**

persistence of sound in an enclosed space after the sound source has stopped.

**reverberation time**

time for sound energy to decay 60 decibels.

**R-factor**

improper term. Use R-value.

**RFI (radio frequency interference)**

interference from sources of energy outside a system. Compare EMI.

**rh**

relative humidity

**ripple**

alternating current component from a direct-current power supply arising within a power supply.

**roof cover of any building.**

roof area (gross) of a building total surface of the roof assembly exposed to the outside air, including all roof/ceiling components through which heat may flow between indoor and outdoor environments, including skylights, but excluding service openings.

**rotary**

1. pertaining to turning as a wheel on an axis.
2. having parts that rotate.

**rotating blackouts (electric)**

process of deliberately interrupting preselected loads from a power system, as a non-routine remedy of energy management implemented through transmission supervision and substation automation, on a substation bus or distribution feeder basis in a sequentially timed pattern for the purpose of matching demand to temporarily limited supply.

**rpm**

revolutions per minute.

**rupture disc (pressure relief device; pressure-limiting device)**

valve or rupture member designed to relieve excessive pressure by mechanical failure of the disc.

**R-value (thermal resistance)**

1. quantity determined by the temperature difference, at steady state, between two defined surfaces of a material or construction that induces a unit heat flow rate through unit area ( $R = \Delta T/q$ ). The reciprocal of thermal conductance.
2. measure of the acoustical absorption properties of a room; the average absorption of all the surfaces in a room times the total surface, divided by the average reflection.

**sabin**

dimensionless unit of acoustical absorption, equal to the equivalent sound absorption of one square foot of a surface of unit absorptivity (*i.e.*, 1 ft<sup>2</sup> of surface that absorbs all incident sound energy).

**safe pressure**

maximum pressure a system can be subjected to without component failure.

**safety**

condition of being safe; freedom from danger or hazard.

**safety device**

ancillary device fitted to an apparatus or machine in order to prevent accident or damage in the event of abnormal functioning of the system.

**safety interlock**

1. device to indicate the physical state of a required operational condition and to furnish proof to the primary safety control circuit.
2. arrangement to make a system inoperable when an improper or unsafe condition exists.

**salinometer**

hydrometer calibrated in salt concentration.

**SAMA**

Scientific Apparatus Makers Association.

**saponification**

process of converting chemicals into soap, which involves the alkaline hydrolysis of an oil or fat or the neutralization of a fatty acid.

**saturation**

condition for coexistence in stable equilibrium of a vapor and liquid, or a vapor and solid phase of the same substance. As an example, steam over the water from which it is being generated. See vapor pressure.

**saturation deficiency**

dimensionless difference between the humidity ratio of an air sample and the saturation humidity ratio of air at the same temperature and pressure.

**scale inhibitor**

substance added to water used in condensers, boilers, piping, and cooling towers to prevent or minimize the formation of insoluble deposits.

**scale setting**

1. control set point at which temperature is to be maintained.
2. indicated temperature to which a thermostat is set.

**scan**

1. process of automatically or manually viewing all points connected to a data-processing system.
2. to examine sequentially part by part.

**scfm**

standard cubic feet per minute.

**scraper ring**

piston ring of special section, designed to prevent oil from the crankcase entering the cylinder head.

**scrubber (air washer)**

1. system to reduce noxious substances from a flowing stream, as in chimneys, or process discharges.
2. device for reducing the CO<sub>2</sub> content of a controlled atmosphere storage room.

**regenerative scrubber**

scrubber in which the active reagent can be regenerated.

**tower scrubber**

vertical vessel filled with plates or suitable packing, through which scrubbing fluid flows upward through the liquid, separating entrained liquids or solids from the gas.

**sealed absorption system**

unit in which all refrigerant-containing parts are made permanently tight by welding or brazing.

**seal**

device to prevent the passage of a gas or liquid into or out of a pipe, container, or along a shaft.

**bellows seal**

mechanical seal of flexible corrugated metal bellows with one end attached to a ring pressed against the shoulder of the shaft, the other end to a disc pressed against the housing.

**labyrinth seal**

device consisting of a series of grooves, fins, etc. machined into or fitted onto a shaft, piston, packing piece, etc., to prevent leakage of a fluid.

**mechanical seal**

shaft seal with small enough clearance between moving parts to provide pressure tightness between the inside and outside of a compressor or pump.

**rotary seal**

shaft seal in which a ring or collar encircling the shaft is held against the housing of the shaft.

**shaft seal**

1. mechanical system of parts for preventing fluid leakage between a rotating shaft and a stationary crankcase.
2. rubbing seal or stuffing box used to prevent fluid leakage between the shaft and bearing of a compressor or other fluid-moving device.

**SEER**

seasonal energy efficiency ratio.

**semiconductor**

class of substances having an electrical conductivity intermediate between those of metals and insulations at ordinary temperatures.

**sensor**

1. device or instrument designed to detect and measure a variable.
2. device placed in a medium to be measured that has a change in output signal related to a change in the sensed medium.

**remote sensor indication**

1. indication located away from the actual sensing location.
2. indication of position or condition of remotely located devices. *Note:* Remote indication may be over direct wire, other types of interconnecting channels such as carrier-current or microwave, or by mechanical means.
3. meter or gage at a point remote from the point of measurement.

**sequence**

1. to put a set of symbols into an arbitrarily defined order, i.e., to select A if A is greater than or equal to B, or select B if A is less than B.
2. arbitrarily defined order of a set of symbols, i.e., an orderly progression of items of information or of operation in accordance with some rule.

**sequencer**

instrument that provides sequence control.

**separator filter**

vessel that removes solids and entrained liquid from a liquid or gas stream, using a combination of a baffle or a coalescer with a screening (filtering) element.

**service**

provision of what is necessary, short of repair, to effect a maintenance program. It usually is based on manufacturer's recommended procedures.

**serviceability**

1. capability of a building, assembly, component, product, or construction to perform the function(s) for which it was designed and constructed, based on assumed levels of use and maintenance. Compare durability.
2. pertaining to the ease with which equipment in buildings can be serviced for maintenance purposes.

**service water heating**

heating water for domestic or commercial purposes other than space heating.

**set**

1. to place a control device into a specified state usually other than that denoting zero or blank.
2. to place a binary cell into the "one" state.

**setback**

1. reduction of heating or cooling during hours when a building is unoccupied, or during periods when lesser demand is acceptable.
2. intentional depression of the control point by means other than adjustment of the scale setting.

**set point**

1. in process control systems, a fixed or constant command for a relatively long time.
2. point at which the desired value of the controlled variable is set.

**set pressure**

pressure level at which a pressure-relief device is set to operate; the value marked on the valve or indicated on the switch.

**shall ("it is required")**

used in standards and regulations (as "shall" or "shall not") to indicate a provision that is mandatory.

**shape factor**

radiation angle factor.

**shift**

1. displacement of an ordered set of characters one or more places to the left or right. If the characters are the digits of a numerical expression, a shift may be equivalent to multiplying by a power of the base.
2. to move the characters of a unit of information column-wise right or left. Related to arithmetic shift and to cyclic shift.

**shop**

place, building, or room where manufacturing or repairing is done. Compare field.

**short-cycling**

excessive frequency of starting and stopping in an operating system.

**should ("it is recommended")**

used in standards and regulations to indicate a provision that is not mandatory, but that is recommended as good practice.

**shrink disassembly**

process of dismantling hollow members (bushings, sleeves, etc.) with the inner component cooled so that it can be extracted from its housing.

**sick building (sick building syndrome)**

building in which the indoor air quality is unacceptable to a substantial majority of people exposed. *Note:* Volatile organic compounds (various types) are present in concentrations sufficient to act synergistically on many occupants, resulting in a sick building syndrome, usually when concentrations are too high. This syndrome does not conform to a particular illness and is difficult to trace to a specific source. See indoor air quality; volatile organic compounds (VOC).

**sight glass**

transparent tube or window (bull's eye) used to indicate the liquid level in a boiler, tank, bearing, and similar fluid-containing equipment.

**signal converter**

device that changes one set of codes, modes, sequences, or frequencies to a different set.

**analog to digital converter**

device that converts a signal that is a function of a continuous variable into a representative number sequence (digital format).

**digital-to-analog converter** 1. device which transforms digital data into analog data. 2. in power-system communications, a circuit or device whose input is information in digital form and whose output is the same information in an analog form. 3. in data processing, a device that converts an input number sequence into a continuous variable.

**silencer**

device or unit installed in air duct systems to control air noise in the duct, or to control discharge noise.

**SI units**

Le Système International d'Unités; the international agreement on the metric system of units.

**slab-on-ground floor**

floor of concrete constructed on the ground.

**slime**

visible and tangible mucous layer of microbial colonies spread over a surface.

**slip**

1. phenomenon of a fluid slipping past a fixed surface with a finite velocity. A no-slip condition pertains to a boundary condition in a fluid flow problem where the slip velocity is assumed to be zero.
2. difference between the speed of rotation of a motor and the rotational speed of the alternating current. See also two-phase flow.

**sludge**

product of decomposition of oil resulting from impurities, moisture, or chemical reactions and favored by excessive temperature. Sludge may be mushy, gummy, or hard.

**slugging**

effect produced by droplets of liquid refrigerant or oil, or a mixture of both that reach the cylinder of a compressor.

**slurry**

suspension of a solid in a liquid. See ice slurry.

**smudging**

black marks on ceilings and air outlets, generally caused by dirt particles suspended in the room air. This dirt is entrained in the mixed airstream and is deposited on the ceiling and outlet.

**snow gun (snow maker)**

apparatus that can produce and shoot artificial snow over a long distance; used to make or improve a ski area.

**snubber pulsation suppressor**

restrictor placed in the liquid or vapor line to suppress pulsating or fluctuating pressures.

**soda fountain**

service counter containing a water cooler, a water carbonator, a refrigerated compartment for syrups and diced fruit, and a low-temperature compartment for ice cream.

**softening point**

temperature at which a solid loses rigidity or consistency in a standardized test procedure.

**solar collector**

device designed to absorb incident solar radiation and to transfer the energy to a fluid passing through it.

**concentrating collector**

solar collector which uses reflectors, lenses, or other optical elements to concentrate radiant energy by passing it through an aperture onto an absorber, the surface area of which is smaller than the aperture area.

**flat-plate collector**

nonconcentrating solar collector in which the absorbing surface is planar and approximately equal in area to the aperture.

**nonconcentrating collector**

solar collector in which the absorber heat flux is not greater than the solar irradiance across the aperture area. It may or may not contain optical elements to direct the radiant flux onto the absorber.

**solar collector absorber**

part of the solar collector that receives the incident radiation energy and transforms it into thermal energy. It may possess a surface through which energy is transmitted to the transfer fluid; however, the transfer fluid itself can be the absorber.

**solar collector aperture area**

maximum projected area of a solar collector through which the unconcentrated solar radiant energy is admitted.

**solar collector cover**

material covering the aperture to provide thermal and environmental protection.

**solar collector drain back**

system in which the collector fluid is allowed to drain back to storage whenever solar energy is not being collected, i.e., when the fluid circulating pump is not operating.

**solar collector drain down**

system in which the collector fluid is drained from the system under prescribed circumstances.

**solar collector gross area**

maximum projected area of the complete collector module including integral mounting means.

**solar collector instantaneous efficiency**

ratio of the energy removed by the transfer fluid per unit of collector area to the total solar radiation incident on the collector per unit area (aperture or gross) during a test period for which the condition of the test corresponds to the steady state or quasi-steady state.

**solar collector loop heater**

heater installed within the collector loop when testing the solar domestic water heating system with a nonirradiated array.

**solar collector tilt angle**

angle between the horizontal plane and the plane of the collector aperture.

**solar collector transfer fluid****primary transfer fluid**

fluid that flows through a solar collector.

**secondary transfer fluid**

fluid that flows through a condenser as a coolant.

**solar compensator**

1. device which takes into account the effect of the sun's radiation on a temperature-sensing element.
2. device that will reset the control point of the space to compensate for changes in sun load. See control.

**solar constant**

solar radiation incident on a surface normal to the sun's rays outside the earth's atmosphere at a distance from the sun equal to the mean distance between the earth and the sun. Its value is approximately 433 Btu/h-ft<sup>2</sup> (1367 W/m<sup>2</sup>).

**solar energy**

radiant energy originating from the sun. Approximately 99% of solar energy lies between wavelengths of 300 and 3500 nanometres.

**solar energy source**

source of thermal, chemical, or electrical energy derived from conversion of incident solar radiation.

**solar energy system**

configuration of equipment and components used to absorb, convey, store, convert, and distribute the energy from the sun.

**solar irradiance**

1. solar radiation.
2. rate at which solar energy is received, per unit area. See also irradiance.

**solar noon**

instant at which the sun reaches its highest point on the horizon at any given location.

**solar-optical properties**

spectral, radiant, or luminous transmittance, reflectance, and absorptance within the range of wavelengths characterizing solar radiation, *i.e.*, 300 to 3000 nanometres.

**solar time**

time of day as indicated by the apparent position of the sun. Compare true solar time.

**true solar time**

local standard time adjusted by the equation of time (determined from an astronomical almanac) and the longitude correction (four times the difference between the standard longitude of the observer's time zone and the observer's actual longitude). A time reference used to compute the apparent position of the sun.

**soldering**

general term for hot joining of metals by adhesion to both surfaces of a melted alloy (a solder).

**soft soldering**

hot joining operation in which the melting temperature of the filler metal is lower than 800°F (450°C).

**solid-state device**

electronic device made with semiconductor components.

**solubility**

quantity of dissolved substance (solute) which is contained in a unit quantity of saturated solution at a given temperature and pressure.

**solute**

substance which is dissolved in another.

**solvent**

substance capable of dissolving another substance.

**sorbate**

substance absorbed by or adsorbed on a sorbent.

**sorbent**

material which extracts one or more substances present in an atmosphere or mixture of gases or liquids with which it is in contact, due to an affinity for such substances.

**sorption** general term covering both absorption and adsorption.

**sound attenuation (noise reduction; sound damping; sound deadening)**

process in which sound energy is absorbed or otherwise diminished in intensity.

**sound decay rate**

rate at which the sound pressure level in an enclosed space decreases after the sound source has stopped. It is measured in decibels per second.

**sound insulation**

acoustical treatment of constructions and equipment such as fan housings, supply ducts, space enclosures, for isolation of vibration or to reduce transmitted noise.

**sound level** magnitude of a sound or a noise, usually determined by measuring the amplitude of variations in the sound pressure expressed in decibels.

**sound power level  $L_w$** 

airborne power measured in decibels. It is the base 10 logarithm of the source power output  $w$ , multiplied by 10, and referenced at  $10^{-12}$  W (1 pW). Or:

$$L_w = 10 \log(w/10^{-12}) = 10 \log w + 120 \text{ dB}$$

**sound pressure level  $L_p$** 

defined as  $L_p = 20 \log p + 94$  dB

where reference pressure = 20  $\mu$ Pa

**speech interference level (SIL)**

average of the sound pressure level measured in the three octave bands centered at 500, 1000, and 2000 hertz.

**space simulator**

device designed to produce an environment close to actual space conditions.

**specification**

precise statement of a set of requirements to be satisfied by a material, product, system, or service that indicates the procedures for determining whether each of the requirements is satisfied. *Note:* It is desirable to express the requirements numerically in terms of appropriate units, together with their limits.

**specific gravity**

ratio of the mass of a given volume of a substance to the mass of an equal volume of water, usually at 4°C. Obsolete term. Use density.

**specific heat**

ratio of the quantity of heat required to raise the temperature of a given mass of any substance one degree to the quantity required to raise the temperature of an equal mass of a standard substance one degree [usually water at 59°F (15°C)].

**specific humidity**

ratio of the mass of water to the total mass of a moist air sample.

**specific volume (SV)**

volume of a unit mass of a material. Usually expressed in cubic feet per pound (cubic metres per kilogram). The reciprocal of density.

**spill (water cooler)**

unconsumed portion of the projected stream of cooled water from the nozzle of a bubbler-type pressure water cooler.

**spinning reserve (electric)**

reserve generating capacity connected to the utility bus and ready to take load.

**spool piece**

piece of pipe with flanges on both ends that is inserted into a pipeline in place of a valve or instrument.

**spray deck**

overhead bunker where air is cooled and circulated by brine sprays.

**spray pond**

system for lowering the temperature of water by conductive and evaporative cooling of the water in contact with outside air. Water to be cooled is sprayed by nozzles into the air above a pond of water and allowed to fall by gravity into it.

**spread**

divergence of an airstream after it leaves an outlet.

**spring range**

1. range through which the signal applied must change to produce total movement of the controlled device from one position to another.
2. difference between the start and finish pressure on a pneumatic operator.

**stability**

1. for a feedback control system or element, the property such that its output is asymptotic, i.e., will ultimately attain a steady state within the linear range and without continuing external stimuli. For certain nonlinear systems or elements, the property such that the output remains bounded, e.g., in a limit cycle of continued oscillation, when the input is bounded.
2. (general) property of a system or element by virtue of which its output will ultimately attain a steady state.

**stack**

1. portion of the exhaust system downstream of the draft diverter, draft hood, or barometric draft regulator.
2. vertical train of a system of soil, waste, or vent piping extending through one or more stories.
3. an organized set of things fitting or resting one over another in a regular fashion.

**stack effect (chimney effect)**

movement of air or other gas in a vertical enclosure (e.g., duct, chimney, building), induced by the density difference between the air or other gas in the enclosure and the ambient atmosphere. *Note:* Stack effect is a significant concern in heating system design for tall buildings in cold climates.

**stacking density**

density to which a product can be stacked, taking into account sufficient free space around the product for proper cold air circulation.

**stand-alone system (energy)**

energy management system that performs all control functions without direction from any other unit.

**standard**

in ASHRAE, a document that defines properties, processes, dimensions, materials, relationships, concepts, nomenclature, or test methods for rating purposes.

**rating standard**

standard that sets forth a method of interpreting the results of tests of individual units, at specified conditions, in relation to a product manufactured in quantity.

**testing standard**

standard that sets forth methods of measuring capacity, or other aspects of operation, of a specific unit or system of a given class of equipment, together with a specification of instrumentation, procedure, and calculations.

**standard acceleration due to gravity**

32.174 ft/s<sup>2</sup> (9.806 65 m/s<sup>2</sup>).

**standard conditions**

1. set of physical, chemical, or other variables of a substance or system which defines an accepted reference state or forms a basis for comparison.
2. operating conditions of a refrigerating system corresponding to a standard such as evaporating temperature, condensing temperature, subcooling temperature, superheat.

**standard ton conditions**

conditions for comparing refrigerating systems are: 5°F (−15°C) evaporation; adiabatic compression of saturated gas; 86°F (30°C) condensation; and 86°F (30°C) liquid to expansion valve.

**standard cubic feet per minute (scfm)**

volumetric rate of flow of air at standard conditions [dry air at 70°F and 14.696 psia (20°C and 101.325 kPa)]. See standard air. Under these conditions, air has a mass density of 0.075 lb/ft<sup>3</sup> (1.20 kg/m<sup>3</sup>).

**standard rating**

capacity in energy units per unit time based on tests performed under standard conditions.

**standards review**

study to determine whether a standard is valid, or if it needs to be revised and the nature of the revisions.

**startup**

procedure to start a prime mover and supporting auxiliaries, including synchronizing and loading the generator.

**state**

condition or stage in the physical being of something.

**change of state**

1. change from one of the three phases, solid, liquid, or gas, to another.
2. occurrence in a remote system causing the contact of an alarm or status device to move from one of two possible positions to the other, e.g., into alarm, causing the contact of an alarm device to close or return to normal causing the contact to open.

**corresponding state**

states of fluids when the ratios of their state variables (pressure, temperature) to the critical values of these variable have equal values, respectively.

**critical state (critical point)**

state of a substance at which the corresponding physical properties (pressure, volume, temperature) of liquid and gas are identical.

**equation of state**

thermodynamic expression relating the volume, pressure, and temperature of a given substance.

**gaseous state**

one of the three states of matter characterized by the greatest freedom of molecules and the lack of any inherent fixed shape or volume.

**intermediate state**

thermodynamic state, exhibited by all type I superconductors and certain type II superconductors, in which a specimen of finite demagnetizing coefficient divides itself into macroscopic domains that are alternatively in the Meissner state and either the normal state (for type I superconductors) or the mixed state (for type II superconductors).

**liquid state**

one of the three states of matter characterized by limited freedom of molecules and by substantial incompressibility. See also liquid.

**solid state**

1. one of the three states or phases of matter characterized by stability of dimensions, relative incompressibility, and molecular motion held to limited oscillation.
2. device, circuit, or system whose operation is dependent on any combination of optical, electrical, or magnetic phenomena within a solid. Specifically excluded are devices, circuits, or systems dependent on the macroscopic physical movement, rotation, contact, or noncontact of any combination of solids, liquids, gases, or plasmas.

**steady state**

state of a system in which movement of matter or energy phenomena are taking place, when the various physical phenomena are independent of time.

**superconducting state (superconductive state)**

low-temperature thermodynamic state in which a superconductor exhibits the property of superconduction.

**triple-point state**

physical state temperature at which solid, liquid, and gaseous phases exist in equilibrium. See also triple-point (temperature).

**unsteady state**

state of a system when the various physical quantities at any location vary randomly.

**state diagram** diagram representing, in a system of suitable coordinates, the thermodynamic equilibrium states of a substance.

**static suction**

same as static suction head, but a negative value; measured at the inlet to the pumping device.

**static suction head**

same as static discharge head, but measured at the inlet to the pumping device. It is a positive value. See static suction lift.

**static suction lift**

vertical distance between the pump centerline and the source of liquid below the pump.

**status**

1. state, position, or condition of an item.
2. indication of a device's operating mode (ON or OFF).

**status device**

normally open, digital, contact device in which contact closure indicates a change of status, e.g., on-off, heating-cooling, day-night, etc.

**steam**

water in the vapor phase.

**dry saturated steam**

steam at the saturation temperature corresponding to the pressure and containing no liquid water in suspension.

**superheated steam**

steam at a temperature higher than the boiling temperature corresponding to the pressure at which it exists.

**wet saturated steam**

steam at the saturation temperature corresponding to the pressure and containing water particles in suspension.

**steam exhaust**

steam discharged from a machine or system.

**steam quality**

fraction of vapor in a mixture of liquid and vapor, expressed as a percentage by weight.

**steam separator**

device used to remove moisture from steam after it leaves the boiler.

**steam trap**

device for allowing the passage of condensate and preventing the passage of steam, or for allowing the passage of air as well as condensate. See trap.

**float and thermostatic steam trap**

trap that relies on the density of water to raise a float-and-lever mechanism to operate a valve head. It discharges condensate as it forms and enters the trap body. It includes a thermostatic balance pressure or bimetallic air vent to allow free passage of air on start-up, and discharges incondensable gases reaching the trap during operation.

**inverted bucket steam trap**

trap in which the inlet is channeled to the bottom of the trap body so that the condensate enters underneath the inverted bucket. A small hole in the top of the bucket helps discharge incondensable gases and entrapped air. The outlet from the trap is at the top, and as long as the trap is filled with steam, it floats in the condensate and keeps the outlet closed. The valve opens when the trap fills with condensate, sinks, and discharges the condensate into the return line.

**liquid-expansion steam trap**

trap with an adjustable bellows and steel valve head located downstream of the steam system. It operates on temperature rise, with the set point adjustable from the outside. It discharges at a fixed temperature for protection from freezing and for high-capacity venting requirements.

**thermodynamic steam trap (disc trap)**

trap constructed with a cap containing a steel disc, which fits against a flat seat. Condensate, discharging at close to saturation temperature, increases in velocity and draws the disc down toward the seat, due to the lower pressure caused by the increased velocity (Bernoulli effect). Condensate discharging from high to low pressure flashes off, and creates the closing pressure above the disc within the cap. As this flash steam condenses, pressure is dissipated, and the cycle repeats. The trap has limited air-venting capabilities.

**thermostatic balanced pressure steam trap**

trap installed on the discharge side of a heating unit and designed to pass air freely on start-up, and condensate at a subcooled temperature; but to prevent steam vapor passing into the return. It can have a bellows or encapsulated metallic diaphragm containing a small quantity of volatile liquid. At the bottom of the diaphragm or bellows is attached a hardened, self-centering valve head operating on the pressure side of the valve seat. At ordinary temperatures and atmospheric pressure, the valve is fully open to permit free passage of air and cold condensate. The trap discharges at a fixed temperature below that of steam saturation temperature and closely follows the steam pressure/temperature curve.

**thermostatic bimetallic steam trap**

trap installed where low-temperature discharge is required. It incorporates a bimetallic element that, when heated, deflects and causes a downstream valve head to be drawn up, closing the orifice. It discharges air and cold condensate freely on start-up. It is installed only where a high waterlogging effect is tolerated.

**upright bucket steam trap (open-top bucket trap)**

trap with a bucket that is usually hinged, so when condensate enters in sufficient quantity to fill the bucket and it sinks, the downward motion opens a valve. Water is then discharged into the return line through a tube which extends almost to the bottom of the bucket. After the discharge, the bucket returns to its normal position. Now seldom manufactured.

**steaming**

treating a food with steam or boiling water with the purpose of making a subsequent process easier and better.

**sterilization**

heating foods or other materials to kill microorganisms, usually to a temperature of 212°F (100°C) or higher. Compare pasteurization.

**stoichiometric reaction**

having the precise mass relationship of the elements in a chemical compound; or (quantities of reacting elements or compounds) in the same mass relationship as the theoretical combining mass of the elements involved. See combustion.

**storage**

see computer; cold storage; cold store; thermal storage.

**storage cell**

elementary unit of computer memory storage, e.g., binary cell, decimal cell.

**storage cycle (thermal storage)**

complete charge and discharge of a thermal storage device.

**storage disease**

injury to produce occurring during storage. Compare cold injury.

**store**

1. to transfer an element of information to a device from which the unaltered information can be obtained at a later time.
2. to retain data in a device from which it can be obtained at a later time. See also cold store.
3. to move a perishable commodity, such as vegetables or fruit, into a holding room for safekeeping.

**strainer (screen)**

device used to separate solids from the liquid containing them. Compare filter.

**stratification**

division into a series of layers, as with thermal gradients across a stream.

**stream splitter (water cooler)**

test device used to establish the percent spill.

**stress**

force applied to a structural member, component, or assembly per unit of its area. See also mechanical properties, pressure vessel.

**hoop stress (circumferential stress)**

stress imposed in the wall of a cylindrical tube in the circumferential direction by internal pressure.

**longitudinal stress**

tensile stress in an axial direction in tubular pipe or in vessels.

**stripping column**

section of a distillation column located above or below the inlet of liquid to be distilled. In this section, the concentration of volatile constituents is reduced.

**structural (gas) barrier**

vapor or gas seal integral with the structural materials of an enclosure. See water vapor retarder; airflow retarder.

**stuffing box**

1. packing gland surrounding a shaft, stem, or rod to prevent leakage.
2. device for use where a cable passes into a junction box or other piece of apparatus designed to render the joint watertight.

**subbase**

part containing terminals and switches, to which a thermostat is attached. It may also contain other auxiliary components.

**subcooled liquid**

liquid whose temperature is lower than the condensation temperature at its given pressure.

**sublimation**

change of state directly from solid to gas without passing through a liquid phase.

**sublimation front (sublimation interface)**

during the sublimation process, the dividing interface within the substance between a region which is fully hydrated and frozen and a region which is nearly completely dry.

**sharp sublimating front**

refers to a distinct and sharp transition on both sides of the sublimating front.

**submetering (electric)**

separated metering of energy purchased from a utility by a customer for distribution to his tenants through privately owned or rented meters.

**suction side**

side of a compressor connected to low pressure, or the outlet side of an evaporator.

**suction head**

positive head on a pump inlet when the source of liquid supply is above the pump centerline. See also head.

**dynamic suction head**

positive static suction head minus friction head and minus velocity head.

**net positive suction head (NPSH) (available)**

head at the pump inlet greater than the vapor pressure (expressed as head) at the operating temperature of the liquid being pumped.

**suction inlet**

port through which gas enters.

**suction lift**

combination of static suction lift and friction head in suction piping when the source of liquid is below the pump centerline.

**dynamic suction lift**

sum of suction lift and velocity head at the pump suction when the source is below the pump centerline.

**suction line**

1. tube or pipe which carries the refrigerant vapor from the evaporator to the compressor inlet.
2. tube or pipe which connects any line from a store to the suction side of a pump.

**double-riser suction line**

arrangement of two vertical suction lines in order to ensure oil entrainment or carry-over even at minimum load.

**suction stroke**

movement of a piston in a compressor or engine cylinder during which fluid is drawn into the cylinder.

**superchilling**

chilling a product to a temperature very near or sometimes below its freezing point.

**superconduction (superconductivity)**

property of certain substances characterized by their zero DC electrical resistivity for low currents when their temperature is sufficiently low.

**superconductor**

1. substance exhibiting or capable of exhibiting superconduction.
2. Type I: superconductor for which the Meissner state and the normal state can coexist in thermodynamic equilibrium.
3. Type II: superconductor capable of existing in the mixed state.

**supercooling**

cooling a substance below the normal freezing point without solidification.

**supercritical**

state of fluids at pressures and temperatures above their critical values. Also used, loosely, and especially for helium, for the state of the liquid at pressures exceeding the vapor pressure.

**superfluidity**

property of helium (He II) flowing without viscous resistance through thin capillaries or narrow slits.

**superheat**

extra heat in a vapor when at a temperature higher than the saturation temperature corresponding to its pressure.

**expansion valve superheat**

difference between the temperature of the external bulb and the corresponding system refrigerant saturation temperature at the bulb location.

**expansion valve superheat change**

change in superheat of a thermostatic expansion valve required to open the valve a predetermined amount.

**expansion valve static superheat**

superheat at which the valve begins to open.

**specific superheat**

1. superheat in a unit quantity of fluid.
2. difference in specific enthalpies of a pure condensable fluid between vapor at a given temperature above saturation and vapor at the dry saturated state at the same pressure.

**superheated vapor**

vapor at a higher enthalpy than the enthalpy at saturation.

**superheater**

1. heat exchanger used on flooded evaporators, where hot liquid on its way to enter the evaporator is cooled by giving up heat to both dry and superheat the wet vapor leaving the evaporator.
2. group of tubes in a boiler which absorbs heat from the products of combustion to raise the temperature of the vapor passing through the tubes above the temperature corresponding to its pressure or saturation temperature.

**supersaturation**

1. condition of metastable equilibrium in which a vapor is at a pressure higher than the saturation pressure corresponding to its temperature.
2. condition of metastable equilibrium in a solution where the solute remains dissolved at a temperature lower than the initial solidification temperature.

**surface effect**

effect caused by entrainment of secondary air when an outlet discharges air directly against, or parallel to, a wall or ceiling.

**surface tension**

forces in a liquid surface that cause it to remain continuous by the attraction between molecules.

**surroundings**

immediate outside of a thermodynamic system.

**suspended ceiling (hung ceiling)**

suspension of the furring members below the structural members of a ceiling.  
SV specific volume.

**swaging tool**

tool to expand or "bell out" the end of a tube to fit over another tube of the same diameter, or over a special fitting to accept such a shape.

**sweating**

condensing of moisture on a surface.

**sweep rate (fan)**

time rate change of frequency,  $df/dt$ , where  $f$  is frequency and  $t$  is time.

**swept volume**

piston displacement.

**swirl**

1. vortex caused by suction at the bottom of a shallow fluid tank.
2. rotating movement produced in a flowing mass of fluid (e.g., when the fluid enters an impeller without any tangential velocity component).

**switch**

device for making, breaking, or changing the connections in an electrical or pneumatic circuit. See also computer switch.

**changeover switch (selector switch)**

switch for changing a circuit from one system of connections to another.

**double pole switch**

1. contact arrangement of two separate contacts, i.e., two single-pole contact assemblies.
2. two isolated contacts operated in unison.

**double throw switch**

three-contact switch that can change the circuit connections from one to the other of its two operating positions.

**electronic switch**

switch without mechanical contacts.

1. electronic device containing three or more layers of "P" or "N" type semiconductor material and no moving parts, e.g., SCR, SCS, Bipolar Transistor, FET.
2. semiconductor device designed to operate in one of two modes (ON or OFF) and used to interrupt an electronic circuit.

**external interrupt (switch)**

1. device designed to disconnect load from a power source or distribution center under an overload or short-circuit condition.
2. interrupt generated by an alarm point going into alarm. See also interrupt device.

**float switch**

device in which a float ball, through variations on the level of liquid, operates one or more sets of electrical contacts to activate or deactivate other controls or alarms.

**limit switch**

control to limit some function. Once tripped, it should require manual reset. Examples are pressure limit switches which shut off the fuel burner when the steam pressure reaches a predetermined point; similarly, temperature limit switches for hot water and warm air. See also control.

**manual switch**

1. device for interrupting or changing the path of electric current or mass flow by a physical means.
2. device used to manually turn on or interrupt an electric circuit.

**mercury switch**

glass tube partially filled with mercury. Electrical contact is established when the tube is tilted so that the mercury bridges the gap between contacts located at the same end. Tilting in the opposite direction opens the circuit.

**pneumatic-electric switch**

control device that makes and/or breaks an electrical circuit based on the level of a pneumatic signal. The device has an adjustable set point and optional adjustable differential.

**pressure switch (pressurestat)**

regulating or safety device actuated by change in pressure.

**selector switch**

1. manually operated multiposition switch for selecting alternative control circuits, e.g., heating, cooling, cycling fan, constant fan, etc.
2. switch arranged to permit connecting a conductor to any one of a number of conductors.
3. manually operated multipositioning switch for selecting alternative control circuits. single-pole switch in which a pair of mating contacts serves only one line.

**single-throw switch**

electric switch that can be opened or closed.

**thermostatic switch**

1. device within an electric controller for completing or interrupting an electrical circuit in response to a temperature change.
2. switch actuated by temperature.

**symbol**

letter, figure, other character or mark, or combination of letters used to represent a specific thing.

**system**

1. organized collection of parts united by regular interaction. See air-conditioning system; cooling system; heating system; heat pump; refrigerating system; thermal insulation system.

2. heating or refrigerating scheme or machine, usually confined to those parts in contact with a heating or refrigerating medium; an arbitrarily chosen group of materials and devices set apart for analytical study. See also air-conditioning system; control system; defrost system; expert system; heat-exchanger system; heating system; refrigerating system; water system.

**air agitating system**

combination consisting of a blower, distributing piping, and flexibly connected fittings for delivering air to the water in ice cans to agitate the water and promote production of clear ice.

**auxiliary electrical system**

assembly of electrical energy-using components necessary to make a main energy conversion function; such as a power burner, induced or forced-draft blower motor, ignition system (but not a resistance heating element supplied by the manufacturer as part of a water heater).

**brine spray system**

refrigerating system for cooling by a mist of spray or brine.

**building automation system (BAS)**

centralized control and/or monitoring system having several forms. Basic BAS may be a computer-based central for an energy management system (EMS) providing operator interface terminal and alarm display with optional audible and/or printout. BAS may further support networks of remote DDC, life safety, and/or security-intelligent processors. BAS may have monochromatic or color graphic monitors with printers for alarm, summary, and custom reports. BAS has one or more operator stations.

**central fan system**

mechanical indirect system of heating, ventilating, or air conditioning, in which air is treated or handled by equipment located outside the rooms served, usually at a control location, and is conveyed to and from the rooms by means of a fan and a system of distributing ducts.

**closed system**

heating or refrigerating piping system in which circulating water or brine is completely enclosed, under pressure above atmospheric, and shut off from the atmosphere, except that the expansion tank could be open to the atmosphere. See also water system.

**cold air distribution system**

system that uses a primary air supply with a temperature range of approximately 40 to 50°F (10 to 15°C). *Note:* Typically used with ice storage systems. Compare cold water distribution system.

**cold water distribution system**

system that uses a primary chilled water supply with a temperature range of approximately 34 to 40°F (1 to 10°C). *Note:* Typically used with ice storage systems. Compare cold air distribution system.

**combined heat and power (CHP) system**

system combining power production with the use of a lower quality heat byproduct of power generation for district heating.

**commercial system**

heating, cooling, or refrigerating system used in a commercial or business place.

**community energy system**

centralized facility for generation and distribution of the heating and cooling needs of a community, rather than individual heat or cold generators (i.e., furnace or air conditioner) at each residential, commercial, or institutional site.

**cycle defrosting system**

in household refrigerators and combination refrigerator-freezers only, a system in which the refrigerated surfaces of the general refrigerated compartments are defrosted while maintaining nominal refrigerated food temperatures. Defrost water is disposed of automatically or collected in a container for subsequent manual removal.

**diffusion-absorption system**

refrigerating absorption system that, in addition to refrigerant and absorbent, also has an inert medium (such as hydrogen) to balance pressure in the various parts of the refrigerating circuit.

**downfeed system** see heating system.

**duct system**

series of ducts, elbows, and connectors to convey air or other gases from one location to another.

**energy management system (EMS)**

formal system of building energy conservation through all available means.

**facility management system**

building automation system within a building complex.

**feedback system**

system that uses feedback.

**forced-circulating system**

heating, air-conditioning, or refrigerating system in which heating or cooling fluid is circulated by a fan or pump.

**gravity-circulating system**

heating or refrigerating system in which heating or cooling fluid is circulated by the forces induced by the differences in densities of cooler and warmer fluids in the system or surrounding atmosphere.

**industrial system**

system used in the manufacturing or processing of material, such as ice-making plants, cold-storage warehouses, ice-cream plants, dairy plants, packing houses, chemical plants, and other places of similar industrial enterprise.

**integrated system**

1. system in which many subsystems of a building are combined into a single package, e.g., fire, security, clock, and HVAC.
2. more than one building system, such as lights and air distribution, combined into a common design.

**isolated system**

in thermodynamics, a system which can interchange neither matter nor energy with its surroundings.

**off-peak system**

refrigerating or cooling system with control which normally avoids use of power during peak load periods, usually requires means for storage of energy.

**one-pipe steam system**

piping system in which the condensable vapor withdrawn from the supply main passes into a heating unit and returns as condensate to the same supply main.

**open system**

heating or refrigerating piping system in which the circulating water or brine return main is connected to an open-vented elevated tank which serves as a reservoir to accommodate expansion and contraction of the fluid, and as an inspection point for the condition of the fluid. See also downfeed heating system; water system.

**overhead system**

heating, air-conditioning, or refrigerating piping system in which the supply main is above the heating or cooling units supplied.

**pipng system**

system to carry fluids, including pipe, flanges, bolting, gaskets, valves, fittings, the pressure-containing parts of other components such as expansion joints, strainers and devices which serve such purposes as mixing, separating, snubbing, distributing, metering or controlling flow, and pipe-supporting fixtures and structural attachments. It does not include pressure vessels, compressors or pumps, and heat exchangers including coil type, but does include all connecting refrigerant and brine piping starting at the first joint adjacent to such apparatus. It does not include support structures.

**radial energy-distribution system**

system of radial feeders extending outward from a centrally-located district energy plant (heating or cooling). Each feeder normally is comprised of one supply pipe and one return pipe.

**runaround system**

regenerative-type closed secondary system in which a continuously circulated fluid absorbs heat from the primary system fluid at one place and sends it to the primary system fluid at another place.

**serial energy-distributing system**

system that connects clients in series. It requires only a single pipe connecting users to the central plant; but each downstream user sees a successively lower supply temperature.

**servo system**

combination of devices for controlling a source of power in which the output (or some function thereof) is fed back and compared to some reference at the input, the difference of this comparison being used to effect the desired control.

**split system**

1. system in which the heating and ventilating are accomplished by means of radiators or convectors supplemented by mechanical circulation of air (heated or unheated) from a central point.
2. air-conditioning system with remote condenser or remote condensing unit.
3. system that serves more than one zone.

**thermodynamic system**

in thermodynamics, a region in space or a quantity of matter bounded by a closed surface in which thermal actions occur. The surroundings include everything external to the system, and the system is separated from the surroundings by the system boundaries. These boundaries can be either movable or fixed, either real or imaginary.

**two-pipe system**

pipng system in which the fluid withdrawn from the supply passes through a heating or cooling unit to a separate return main.

**upfeed system**

pipng arrangement for a heating, air-conditioning, or refrigerating system, in which cooling fluid is circulated through supply mains which are below the levels of heating or cooling units they serve.

**water system (public water system)**

system operated as a public utility that supplies potable water to the service connection of the consumer's water system. It is the primary component of a public water system.

**closed water system**

system having a checking device installed in the service pipe. *Note:* A check valve, backflow preventer, or pressure-reducing valve would create a closed system.

**consumer's water system**

all potable water piping, valves, fittings, and appurtenances on the premises side of the service connection. It is the secondary component of a public water system.

**open water system**

system having no checking device installed in the service pipe. *Note:* Water from the consumer's system is free to backflow into the main.

**system analysis**

examination of an activity, procedure, method, technique, or a business to determine what must be accomplished and how the necessary operations may best be accomplished.

**system effects**

conditions in a distribution system that affect fan and pump performance and related testing, adjusting, and balancing work.

**TAB**

testing, adjusting, and balancing.

**TAB technician**

person who measures and adjusts a system.

**tamperproof**

*verb.* to prevent the alteration of a device for an improper purpose or in an improper way.

**tank**

receptacle, open or closed, for holding, transporting, or storing fluids. See also thermal storage device.

**balance tank**

reservoir for balancing pressures, levels, etc.

**brine tank**

1. in an ice plant, a main freezing tank, in which cans are immersed while ice is being produced.
2. in a brine-circulating system, a storage or balance tank for brine.
3. in domestic and commercial fields, a container surrounding the evaporator and filled with brine for storing refrigerant or equalizing temperature at various points of the evaporator, especially an ice-cream cabinet.

**brine expansion tank (head tank)**

vented reservoir in a closed circulating brine system for the accommodation of volume expansion of brine due to temperature change.

**brine return tank**

reservoir in an open circulating brine system for storing brine at the pump suction and for inspecting the condition and flow of brine.

**buffer tank**

tank fitted into a circuit to dampen fluctuations in flow.

**compression tank** pneumatic cushioning device, operating at system pressure, which absorbs fluid expansion as a result of temperature change and prevents unnecessary periodic operation of the relief valve. Compare expansion tank.

**dip tank**

liquid-holding process vessel in which components to be treated can be immersed.

**equalizer tank**

receiver fitted between the compressor suction line and the return lines of several evaporators in parallel.

**expansion tank**

partially filled tank, operating at atmospheric pressure, at the top of a water system for the accommodation of volume expansion and due to the contraction of water. Compare compression tank.

**freezing tank**

vessel holding low-temperature fluid for process freezing.

**head tank**

brine expansion tank.

**hot water storage tank**

tank used to store water that is heated externally.

**ice-bank tank (ice buildup tank)**

water cooling tank in which ice is allowed to build up on the evaporator tubes to provide a reserve for cooling.

**self-supporting tank (structural tank)**

in marine liquefied gas ship carriers, a structural barrier forming a tank that can resist the static and dynamic forces exerted by the cargo and is relatively independent of the ship's structure.

**spray-wall tank**

liquid cooling tank whose walls are sprayed with chilled water.

**water forecooling tank**

one in which inlet water is cooled prior to freezing.

**tap**

manually operated device on the end of a pipe in a fluid supply system to enable drawing off quantities of the fluid.

**TD**

temperature difference;  $\Delta t$ .

**temperature**

thermal state of two adjacent substances that determines their ability to exchange heat. Substances in contact that do not exchange heat are at the same temperature. Temperatures are indicated on defined scales, such as kelvin and Rankine for absolute temperatures, and Celsius and Fahrenheit for ordinary temperatures.

**absolute temperature (thermodynamic temperature)**

temperature as measured above absolute zero.

**absolute zero temperature**

zero point on an absolute temperature scale. See kelvin temperature; Rankine temperature.

**ambient temperature**

1. temperature of the medium surrounding an object. In a domestic or commercial system having an air-cooled condenser, it is the temperature of the air entering the condenser.
2. temperature of the medium, such as air, water, or earth, into which the heat of equipment is dissipated.
3. for self-ventilated equipment, the ambient temperature is the average temperature of the air in the immediate neighborhood of the equipment.
4. for air-or gas-cooled equipment with forced ventilation or secondary water cooling, the ambient temperature is taken as that of the ingoing air or cooling gas.
5. for self-ventilated enclosed (including oil-immersed) equipment considered as a complete unit, the ambient temperature is the average temperature of the air outside of the enclosure in the immediate neighborhood of the equipment.

**apparatus dew point**

dew-point temperature of the air leaving the conditioning apparatus, used interchangeably with maximum average coil surface temperature required to produce dew.

**apparent temperature**

temperature of an object as determined from the measured radiance.

**autogenous (spontaneous) ignition temperature**

temperature of spontaneous ignition of a product in the absence of a flame, determined under standardized conditions.

**autoignition temperature**

see autogenous ignition temperature, the preferred term.

**average temperature (mean temperature)**

arithmetic mean of temperatures measured at a given point during a given lapse of time, or at a given time in various points of a space or body.

**base temperature**

temperature from which temperature departure is calculated. See degree-day.

**blackbody equivalent temperature (apparent temperature)**

apparent temperature of an object as determined from the measurement of its radiance and the assumption that it is an ideal blackbody with emissivity of 1.0.

**boiling point**

temperature at which the vapor pressure of a liquid equals the absolute external pressure at the liquid-vapor interface.

**Celsius temperature**

temperature scale used with the SI system in which the freezing point of water is 0°C, the triple point is 0.01°C, and the boiling point is 100°C. (Formerly referred to as the centigrade scale.)

**centigrade temperature**

use Celsius temperature.

**cloud point**

temperature at which a clear liquid becomes hazy or cloudy due to the formation of crystals or particles, when tested under standardized conditions.

**color temperature**

temperature of a perfect radiator (blackbody) that would emit the same relative intensity at two wavelengths (usually red and green lights) as the relative intensity radiated by the subject surface.

**condensation point**

temperature at which a vapor liquefies if the latent heat is removed at standard or stated pressure. See also dew point; saturation temperature; boiling point.

**condensing temperature**

temperature of a fluid at which condensation occurs.

**corrected effective temperature**

effective temperature corrected by accounting for the effect of radiation. See also operative temperature.

**critical temperature**

saturation temperature corresponding to the critical state of the substance at which the properties of the liquid and vapor are identical.

**critical temperature (superconduction)**

temperature below which, in the absence of all external influences, a substance becomes superconducting.

**cryotemperature (cryogenic temperature)**

temperature within a few degrees of absolute zero (2.2 K).

**Curie point**

temperature above which a given ferromagnetic substance becomes paramagnetic.

**design air temperature**

air temperature which an HVAC system or apparatus is designed to maintain (inside design) or to operate against (outside design).

**dew point**

temperature at which water vapor has reached the saturation point (100% relative humidity). Compare frost point. *Note:* It is improper to refer to the dew point as the temperature at which condensation starts to occur, because condensation at the dew point requires removal of latent heat from the vapor to induce condensation, and this can occur only if the vapor is cooled below the dew point.

**differential temperature**

1. in control terminology, the difference in temperature between the high event and the low event.
2. difference in temperature existing between any two points or states when measured on the same temperature scale.

**discharge temperature (delivery temperature)**

temperature of compressed fluid as discharged from a fan or a compressor.

**dry-bulb temperature**

temperature of air indicated by an ordinary thermometer.

**effective temperature**

use operative temperature.

**evaporating temperature**

temperature at which a fluid vaporizes within an evaporator.

**Fahrenheit temperature**

temperature scale on which at standard atmospheric pressure, the boiling point of water is 212°F and its freezing point is 32°F; absolute zero is -459.69°F.

**flue temperature**

temperature of the flue gases leaving the boiler or furnace, and prior to any dilution caused by draft control devices.

**freezing point**

for a particular pressure, the temperature at which a given substance will solidify or freeze upon removal of heat. Compare solidification point.

**frost point**

temperature at which visible frost forms on a surface being chilled.

**heat pump balance point temperature**

temperature at which the installed heat pump capacity is equal to the heat requirement of the building.

**ignition temperature (ignition point; kindling temperature)**

temperature at which a combustible material will unite with oxygen in the atmosphere, and combustion will commence.

**kelvin temperature**

SI absolute temperature scale on which the triple point of water is 273.16 K and the boiling point is approximately 373.15 K (1 K = 1°C). The kelvin is the fraction 1/273.16 of the temperature of the thermodynamic triple point of water. See triple point.

**magnetic temperature**

as measured by a magnetic thermometer.

**mean radiant temperature (MRT)**

uniform surface temperature of a radiantly black enclosure in which an occupant would exchange the same amount of radiant heat as in the actual nonuniform environment.

**operative temperature**

uniform temperature of a radiantly black enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the actual nonuniform environment.

**pour point**

lowest temperature at which a fluid, such as an oil, will continue to flow when it is cooled by standardized procedures.

**Rankine temperature**

absolute temperature scale conventionally defined by the temperature of the triple point of water equal to 491.68°R, with 180 divisions between the melting point of ice and the boiling point of water under standard atmospheric pressure (1°R = 1°F). See triple point.

**room dew point**

temperature in a space at which the water vapor reaches saturation.

**saturation temperature**

boiling point.

**solidification point**

temperature at which a liquid substance will solidify, but not necessarily crystallize, on removal of heat (usually at standard atmospheric pressure). Compare freezing point.

**stack temperature**

temperature of the flue gases entering the exhaust stack or chimney, after any dilution.

**standard ambient temperature**

reference condition for the rating of equipment, usually 68°F (20°C).

**suction temperature**

temperature of the vapor drawn into the compressor inlet.

**transition temperature**

temperature below which a substance becomes superconducting in the presence of a specified external influence (e.g., a specified magnetic field).

**triple point**

particular temperature and pressure at which three different phases of one substance can coexist in equilibrium. Water is an example of a substance that has a well-known triple point.

**wet-bulb temperature**

temperature indicated by a psychrometer when the bulb of one thermometer is covered with a water-saturated wick over which air is caused to flow at approximately 900 ft/min (4.5 m/s) to reach an equilibrium temperature of water evaporating into air, when the heat of vaporization is supplied by the sensible heat of the air. See psychrometer; thermometer; dew-point depression.

**temperature difference**

difference between the temperatures of two substances, surfaces, or environments involving transfer of heat.

**arithmetic mean temperature difference**

in a parallel flow or counterflow heat exchanger, arithmetic mean of the temperature differences between the two fluids at both ends of the exchanger.

**diffusion temperature difference**

temperature difference between the air temperature at supply openings and design outdoor temperature.

**effective temperature difference**

difference between the room air temperature and the supply air temperature at the outlet in the room.

**wet-bulb depression temperature difference**

difference between dry-bulb and wet-bulb temperatures.

**temperature difference method (TD)**

procedure used in design and system analysis to calculate flow (of air, water, or steam) from load, or to determine load when flow and temperature differential are known.

**temperature fluctuation**

variation of temperature around a mean value.

**temperature gradient**

temperature variation per unit distance or time along the heat flow path.

**temperature profile**

graph representing the distribution of temperatures in a plane section of a body or a space, or over a period of time.

**terminal**

1. conductor point at which an electrical component may be connected to another electrical component.
2. conducting element of an equipment or circuit intended for connection to an external conductor.
3. device attached to a conductor to facilitate connection with another conductor.
4. point in a system or communication network at which data can either enter or leave.

**terminal element**

means by which the energy from a system is finally delivered, e.g., registers, diffusers, radiators, lighting fixtures, and faucets.

**terminology**

1. system of terms belonging to or peculiar to a science, art, or specialized subject.  
Compare nomenclature.
2. a compendium of terms.

**test method**

definitive procedure that produces a test result. Compare practice. *Note:* Appropriate functions of a test method are identification, measurement, or evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service.

**primary test method**

test procedure incorporating the preferred method of installing a test unit, and the preferred test apparatus, that produces the desired reproducibility and accuracy.

**primary-alternate test method**

test procedure using an alternate method of installing a test unit, or an alternate test apparatus, that produces reproducibility and accuracy equivalent to the primary test method.

**test package**

packaged material used as a standard product in a test of refrigeration temperature.

**thawing**

changing the solid phase of water, or frozen moisture within a substance, to the liquid phase by the application of heat.

**dielectric thawing**

process using dielectric heating with high voltage and high frequency or ultrahigh frequency electric fields.

**high-frequency thawing**

dielectric thawing using suitable frequencies of a few megahertz or higher.

**ultrahigh frequency thawing (microwave thawing)**

dielectric thawing using frequencies of the order of thousands of megahertz (usually 2450 MHz or 915 MHz in accordance with the International Telecommunication Union).

**therm**

quantity of heat equivalent to 100,000 Btu.

**thermal absorptance**

ratio of the radiant flux absorbed by a body to that incident on it.

**thermal anomalies**

heat loss characteristics of a structure that are not in accordance with intended design characteristics.

**thermal boundary resistance (thermal contact resistance)**

ratio of temperature difference to heat flux across the boundary between two distinct media (solid/solid or solid/fluid).

**thermal break (breaker)**

nonconducting frame around a door or window acting to retard heat flow.

**thermal bridge**

low thermal resistance path connecting two surfaces.

**thermal comfort**

condition of mind which expresses satisfaction with the thermal environment.

**thermal conductance (C-factor)**

time rate of steady-state heat flow through unit area of a material or construction, induced by a unit temperature difference between the body surfaces. Units of  $C$  are Btu/h·ft<sup>2</sup>·°F or W/(m<sup>2</sup>·K). Compare thermal resistance.

**surface-film thermal conductance**

time rate of heat flow from a unit area of a surface to its surroundings, induced by a unit temperature difference between the surface and the environment. *Note:* The environment is a fluid (liquids or gases).

**thermal conduction (heat conduction)**

process of heat transfer through a solid (in the absence of convection and radiation).

**thermal conductivity (k-factor)**

time rate of steady-state heat flow through unit thickness of unit area of a homogeneous material, induced by a unit temperature gradient in a direction perpendicular to that unit. Units of  $k$  are in Btu·in/(h·ft<sup>2</sup>·°F), Btu·ft/(h·ft<sup>2</sup>·°F), or W/(m·K). Compare thermal resistivity. See also thermal conductance.

**thermal conductor**

material that transmits heat by conduction.

**thermal convection**

1. transfer of heat by a fluid moving by natural variations in density (in the absence of conduction and radiation).
2. transfer of heat by the movement of fluid.

**forced thermal convection**

heat transmission by mechanically induced movement of fluid.

**free thermal convection (natural convection)**

heat transmission by movement of a fluid caused by density differences.

**thermal delay**

1. time period between the energization of a heat-producing device and the measurable effect of the heat produced.
2. lag in response of an external temperature change to reach equilibrium conditions.

**thermal diffusion**

phenomenon in which a temperature gradient in a mixture of fluids gives rise to a flow of one constituent relative to the whole mixture.

**thermal diffusivity**

physical quantity that determines the rate of heat propagation in transient-state processes. Thermal conductivity divided by the product of density and specific heat. Unit: ft<sup>2</sup>/s or m<sup>2</sup>/s.

**thermal efficiency**

energy output as a percentage of the energy input of a machine or process. See also thermal storage efficiency.

**thermal emissivity**

radiation property of a material, evaluated with its surface optically smooth and clean, and of sufficient thickness to be opaque.

**thermal emittance**

ratio of the radiant flux emitted by a body to that emitted by a blackbody at the same temperature and under the same conditions.

**directional thermal emittance**

ratio of the radiance from a surface in a particular direction to the radiance in that direction from a blackbody at the same temperature under the same conditions.

**hemispherical thermal emittance**

average directional thermal emittance over a hemispherical envelope over the surface.

**spectral thermal emittance**

thermal emittance based on the radiant energy emitted per unit wavelength interval (monochromatic radiant energy).

**total thermal emittance**

emittance that is an integrated average for all wavelengths of radiant energy emitted.

**thermal energy meter**

metering system capable of measuring the energy added to or extracted from a fluid stream. Also called Btu meter, heat meter, thermal meter.

**thermal energy source**

origin of heating or cooling effects.

**auxiliary thermal source**

source of thermal energy, other than solar, used, for example, to provide service water heating; usually in the form of electrical resistance heat or thermal energy derived from combustion of fossil fuels.

**thermal envelope**

elements of a structure which enclose conditioned spaces, and which control transmission of heat, air, and water vapor between the conditioned spaces and the exterior. See also building thermal envelope.

**thermal environment**

for human exposure, the surrounding atmosphere characterized by parameters such as air temperature, wet-bulb temperature, dew-point temperature, water-vapor pressure, total atmospheric pressure, relative humidity, and specific humidity.

**acceptable thermal environment**

environment in which 80% of normally clothed men and women living in the United States or Canada, while engaged in indoor sedentary or near sedentary activities, would express thermal comfort. Compare acceptable indoor air quality.

**thermal frequency response**

response of a thermal system to a periodic thermal excitation expressed as a function of frequency. *Note:* Thermal frequency response usually is displayed by polar plot of amplitude attenuation and time lag versus frequency.

**thermal inertia**

ability of a material, depending on its density and specific heat, to store heat and to resist temperature change.

**thermal input**

heating or cooling effect delivered to a product or space.

**thermal insulation**

material or assembly of materials used to provide resistance to heat flow.

**blanket thermal insulation**

relatively flat and flexible insulation in coherent form, furnished in units of substantial area.

**block thermal insulation**

rigid insulation preformed into rectangular units.

**board (slab) thermal insulation**

semirigid insulation preformed into rectangular units having a degree of suppleness particularly related to their geometrical dimensions.

**cellular elastomeric (cellular rubber) thermal insulation**

insulation composed principally of natural or synthetic elastomers, or both, processed to form a flexible, semirigid or rigid foam, having a predominately closed-cell structure.

**cellular polystyrene thermal insulation board**

insulation composed of cellular polystyrene in the form of boards, produced by heat and pressure from (1) expansion of foamable polystyrene beads within a mold (beadboard), or (2) by in-situ foaming of molten polystyrene in an extrusion mode (extruded board).

**cellular polyurethane thermal insulation**

insulation composed principally of the catalyzed reaction product of polyisocyanate and polyhydroxy compounds, processed usually with fluorocarbon gas to form a rigid foam having a predominately closed-cell structure.

**corkboard thermal insulation**

cork granules, cleaned, compressed, and bonded by heat and used for thermal insulation.

**embedded thermal insulation**

insulation used for floors in which the insulation is located in the foundation framework which later receives the concrete flooring.

**evacuated thermal insulation (vacuum insulation)**

insulation consisting of double walls, with the space between them, with or without packing, evacuated.

**fill thermal insulation (loose-fill)**

insulation in granular, nodular, fibrous, powdery, or similar form designed for installation by pouring, blowing, or hand placement. Examples are mineral or glass fiber, cellulosic fiber, diatomaceous silica, perlite, silica aerogel, and vermiculite.

**foamed-in-place thermal insulation (foam-in-situ insulation)**

insulation formed by introducing into prepared cavities a chemical component and a foaming agent that react to fill the space with a foamed plastic.

**high-vacuum thermal insulation**

thermal resistance system that depends on a very high vacuum for its performance.

**mineral fiber thermal insulation**

insulation composed principally of fibers manufactured from rock, slag, or glass, with or without binders.

**multicellular metal foil thermal insulation**

thermal insulation consisting of waffled or corrugated sheets of metal foil to form a cellular structure.

**multilayer thermal insulation**

many thin layers of materials combined to obtain a very high thermal resistance (superinsulation).

**open-cell foamed plastic thermal insulation**

cellular plastic in which interconnected cells predominate.

**perlite thermal insulation**

insulation composed of natural perlite ore, a glassy volcanic rock expanded by heat to form a cellular structure.

**reflective thermal insulation**

insulation which reduces radiant heat transfer across spaces by use of one or more surfaces of high reflectance and low emittance, for example, aluminum foil.

**self-supporting thermal insulation**

thermally insulated structure where the insulation possesses sufficient mechanical strength to serve as a constructional material itself.

**slab insulation**

thermal insulation applied under slab-on-ground construction.

**sprayed thermal insulation (sprayed-on insulation)**

insulation formed by spraying fine fibrous material onto a surface previously covered with an adhesive; also by simultaneously spraying a chemical component and a foaming agent.

**structural thermal insulation**

insulation used as a part of the load-carrying frame of a structure, such as the walls of a cold room or the body of a refrigerated vehicle.

**thermal insulation finish**

material applied to insulation to provide a smooth, even finish, to strengthen and protect the surface, and to improve its appearance.

**thermal insulation system**

thermal insulation in place, complete with accessories, vapor retarders, and facings as required for expected performance.

**thermal lag**

delay in action of the sensing element of a control device due to the time required for the sending element to reach equilibrium with the property being controlled. See lag.

**thermal lift**

difference between evaporating and condensing temperatures and pressures. See also head.

**thermal radiance**

rate of radiant emission through unit solid angle over unit projected area of a source in a stated angular direction from the surface (usually the normal).

**thermal output**

heating or cooling effect put out by a source, or removed from a storage device.

**thermal radiant flux density**

rate of radiant energy emitted from unit area of a surface in all radial directions of the overspreading hemisphere. See also radiant flux density.

**thermal radiation**

transmission of energy by means of electromagnetic waves emitted due to temperature. Radiant energy of any wavelength when absorbed may become thermal energy that increases the temperature of the absorbing body. See also heat transfer radiation coefficient.

**equivalent direct radiation (EDR)**

thermal radiation expressed in terms of square foot of steam radiator surface emitting 240 Btu per hour. It is the same as an area in square metres, each of which radiates 757 watts per square metre. *Note:* Do not use this I-P term in SI.

**thermal reflectance**

fraction of the incident radiation on a surface that is reflected from that surface. *Note:* For an opaque surface, the sum of reflectance, transmittance, and absorptance is unity at any wavelength of radiation.

**thermal reflection**

portion of the radiosity from a surface which is contributed by reflection.

**thermal regenerator (thermal recuperator)**

heat transport apparatus designed for utilizing waste heat. Heat transport is achieved either by accumulation of heat in a suitable material through which alternately pass a warm fluid and the fluid to be heated, or in a heat exchanger where both fluids circulate counterflow. See heat exchanger.

**thermal relay**

1. relay activated by change in temperature.
2. relay in which the displacement of the moving contact member is produced by heating of a part of the relay under the action of electric currents.

**thermal resistance (R-value)**

under steady conditions, the mean temperature difference between two defined surfaces of material or construction that induces unit heat flow through unit area. *Note:* Thermal resistance and thermal conductance are reciprocals. Thermal resistances are R-values; to obtain the U-factor, overall thermal transmittance, the R-value for either materials or constructions must first be evaluated because, by definition, the U-factor is the reciprocal of the R-value.

**thermal resistivity**

under steady conditions, the temperature difference between parallel surfaces of a slab (large enough so there is no lateral heat flow) of unit thickness that induces unit heat flow through unit area. *Note:* Thermal resistivity and thermal conductivity are reciprocals. Thermal resistivity is the R-value of a material of unit thickness.

**thermal sensation**

conscious feeling, commonly graded into categories of cold, cool, slightly cool, neutral, slightly warm, warm, and hot.

**thermal shroud**

in a space simulator, surfaces (usually blackened) cooled to very low temperatures, which surround the test object.

**thermal storage**

1. temporary storage of high- or low-temperature energy for later use.
2. accumulation of energy in a body or system in the form of sensible heat (temperature rise) or latent heat (change of phase).
3. technology or systems of accumulating cooling or heating capacity for subsequent use. See also thermal storage system.

**cool storage**

technology or systems used to store cooling capacity.

**heat storage**

technology or systems used to store heating capacity.

**latent storage**

use of a phase change of a medium for storing heating or cooling capacity.

**naturally stratified storage**

thermal storage in which temperature stratification is achieved and maintained by density differences alone, and not by mechanical separators.

**sensible storage**

use of a change in temperature of a medium for storing heating or cooling capacity.

**stratified storage**

thermal storage vessel in which a thermocline exists.

**thermal storage capacity**

quantity of heat that can be retained by a thermal storage system and be available for future use.

**instantaneous thermal storage capacity**

actual rate at which heating or cooling capacity is supplied to, or withdrawn from, storage.

**integrated thermal storage capacity**

total amount of energy supplied to storage, or withdrawn from storage, during charging or discharging.

**thermal storage device**

container plus all the contents of the container used for storing thermal energy. The transfer fluid and accessories, such as heat exchangers, agitators, circulating pumps, flow-switching devices, valves, and baffles which are integral with the thermal storage container are considered a part of the storage device.

**ice-on-coil thermal storage**

container (tank) in which ice is formed on tubes or on pipes.

**thermal storage efficiency (cycle figure-of-merit)**

ratio of the integrated discharge capacity to the hypothetical maximum available capacity for a single cycle of operation. *Note:* Hypothetical maximum available capacity is computed as follows—for sensible storage, multiply the average specific heat of the storage medium by the mass of the medium in storage and the difference between the average storage inlet temperatures during charging and discharging, for a single cycle. For latent storage, multiply the change in specific enthalpy associated with the liquid-solid phase change by the mass of medium in storage that changes phase, for a single cycle.

**cycle thermal efficiency**

ratio of the integrated energy output to the integrated energy input of a process or machine, for a single cycle of operation.

**long-term thermal efficiency**

ratio of the total integrated discharge capacity to the total integrated charge capacity for a representative set of cycles of operation.

**storage efficiency**

discharge capacity divided by charge capacity. See also cycle thermal efficiency.

**thermal storage load leveling**

charging a thermal storage system at a constant rate during a complete cycle.

**thermal storage medium**

substance in which cooling or heating capacity is stored.

**thermal storage system**

system wherein the load demand is met by stored thermal energy. See instantaneous capacity.

**chiller-aided storage**

thermal storage system that has a chiller to supplement cooling capacity of the storage. Also called live load chilling.

**compressor-aided storage**

operation of the compressor of an ice storage system during the discharging period.

**demand limited storage**

thermal storage system controlled to limit the electric power demand.

**direct ice contact (external melt)**

ice storage system using a method of heat exchange in which ice is formed by direct refrigeration and melted by immersion in circulating water or secondary coolant. Also called static direct contact storage.

**full storage**

thermal storage system having capacity to meet all on-peak cooling or heating requirements by being charged off-peak, and without energy added on-peak.

**indirect ice contact (internal melt)**

ice storage system using a method of heat exchange in which ice in containers is formed and melted by a circulating secondary coolant enclosed in a pipe or tube.

**partial storage system**

1. system wherein the load demand is met by a combination of stored thermal energy and an energy conversion device.
2. system that has to be operated during on-peak as well as in off-peak periods. See demand-limited storage; compressor-aided storage; load-leveling storage.

**rockbed regenerative system**

system of air conditioning that uses packed gravel beds for both evaporative cooling and heat energy storage.

**thermal superinsulation**

insulation of very high thermal resistance. Usually refers to that used in cryoengineering.

**thermal time lag**

1. time interval by which the peak thermal response falls behind (lags) the peak thermal excitation in a thermal system.
2. phase difference in hours between the exterior and interior surface temperatures when the exterior surface is subjected to a sine-wave temperature change having a 24-hour period.

**thermal transfer fluid**

fluid circulated through closed circuits to transfer heat from one location to another.

**thermal transmittance (U-factor)**

heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side. *Note:* This heat transmission rate is also called the overall coefficient of heat transfer.

**W-factor**

U-factor converted into electrical terms for calculations in electric heating. The amount of heat flow, in watts per square foot per degree Fahrenheit temperature difference ( $W/ft^2 \cdot F$ ) between air on the inside and air on the outside of the building section (wall, floor, roof, or ceiling). For conversion,  $W = 0.293U$ .

**thermal unit**

quantity or rate of heat energy or equivalent in work or electrical energy. See Btu; therm; ton-hour; watt; joule.

**thermistor**

thermoelectrical element in which the electrical resistance falls appreciably with a rise in temperature; often used as a thermometer. See also anemometer (thermal).

**thermocline**

layer of fluid in which the temperature and density gradient is greater than, and which separates, the cooler fluid below it and the warmer fluid above it.

**thermocouple**

junction of two wires of dissimilar materials, not necessarily metal, with the property of generating an emf related to the temperature of their junction. Compare thermopile.

**thermocouple system**

combination of one or more thermocouples in a circuit with switching and measuring devices to enable temperatures to be indicated or recorded continuously or intermittently.

**thermodynamic equilibrium**

equilibrium in a system when the physical variables have uniform values that do not change in time. Furthermore, if the system is not an isolated one, these variables should have the same values for both the system and its surroundings.

**thermodynamic properties**

basic qualities used in defining the condition of a substance, such as temperature, pressure, volume, enthalpy, entropy, etc.

**thermodynamic shock**

implosive impact in liquid, caused by sudden condensation of vapor into its subcooled liquid. This phenomenon can occur when the liquid is about 60 to 85°F (33 to 47°C) cooler than the saturation temperature of the contact vapor. It creates a loud sound and can cause severe local pressure stresses in the container.

**thermodynamics**

science of the relation of heat to other forms of energy. See also thermodynamics laws.

**thermoelectric cooling**

see Peltier effect; refrigeration (thermoelectric).

**thermogram**

photograph or two-dimensional record of an image which maps the apparent temperature of a scene as sensed by an infrared imaging system.

**thermography**

process of generating a thermogram by using an infrared imaging system, usually with some means of temperature calibration.

**thermometer**

instrument for measuring temperature.

**acoustical thermometer**

one that evaluates temperatures from the measurement of the speed of sound in a gas; used for very low temperatures.

**alcohol thermometer**

bulb with a vertical capillary tube containing alcohol (colored) which expands or contracts with changes in temperature, having graduated markings so that the end of the alcohol column indicates the ambient temperature.

**bimetallic thermometer**

one that indicates temperature from flexing of two strips of materials of different coefficients of expansion bonded together.

**dial thermometer**

one that indicates temperature by a pointer moving over a circular scale.

**dry-bulb thermometer**

in general, any thermometer that indicates the temperature of air (or other fluids); distinguished from wet-bulb thermometer

**electric contact thermometer**

thermometer designed to indicate temperature by closing in succession a series of electrical contacts.

**electric resistance thermometer**

temperature-measuring and display instrument in which an electric resistance varies as a function of the temperature.

**indicating thermometer**

thermometer designed for the visual display of temperature.

**Kata thermometer**

alcohol thermometer used to measure low velocities in air circulation, by heating the large bulb of the thermometer above 100°F (38°C) and noting the time it takes to cool from 100 to 95°F (38 to 35°C) or some other interval above ambient temperature, the time interval being a measure of the air current at that location.

**magnetic thermometer**

one that indicates temperature from the measurement of magnetic properties (e.g., susceptibility) of any suitable substance; used for very low temperatures.

**mercury thermometer**

bulb and attached glass capillary tube containing mercury which expands or contracts with changes in temperature; so marked that the end of the mercury column indicates the ambient temperature.

**nuclear resonance thermometer**

one that uses the nuclear paramagnetism of metals to deduce the temperature from the spin-lattice relaxation time; used for very low temperatures.

**recording thermometer (temperature recorder; thermograph)**

one that indicates temperature by traces on a moving chart; recording may be done on a cylinder, a circular chart, or a strip chart.

**solid-expansion thermometer**

one based on the expansion of a solid substance (usually bimetallic).

**sonic thermometer**

acoustical thermometer.

**vapor pressure thermometer**

one based on pressure built up by the vapor evolved by liquid in a sealed container.

**wet-bulb thermometer**

one that measures wet-bulb temperature.

**thermometry**

part of applied physics relating to the measurement of temperature.

**thermophysics**

study of physical phenomena related to heat.

**thermopile**

1. several thermocouples in a bundle with all junctions at each end exposed to the same temperature so that the emf output is the sum of the several emfs.
2. number of thermocouples wired consistently in series or in parallel to measure small or average temperature differences.

**thermostat**

1. automatic control device responsive to temperature used to maintain constant (static) temperature.
2. temperature-actuated switch.

3. instrument which responds to changes in temperature, and which directly or indirectly controls temperature.
4. temperature-sensitive device that automatically opens and closes an electric circuit to regulate the temperature of the space with which it is associated. See also heat anticipation.

**aquastat**

thermostat designed for use in water.

**direct-acting thermostat**

1. thermostat in which the output increases proportionally to an increase in the value of the sensed variable.
2. pneumatic instrument which permits passage of control air when temperature of the controlled medium is higher than the temperature for which the instrument is set and cuts off the air when temperature goes below the temperature for which the instrument is set.

**dual thermostat**

1. pneumatic thermostat designed to maintain one temperature during the day and a lower temperature during the night or during unoccupied periods or changes action from direct acting (DA) to remote acting (RA) for seasonal changeover when switched from remote signal.
2. two temperature controls in one enclosure.

**freeze-stat**

limited-fill thermal element, usually 20 feet in length, located in the mixed-air portion of an HVAC unit which opens an electrical circuit if any one-foot portion of the element reaches its set point (usually 35°F or 2°C). It usually shuts down the HVAC unit and/or alarms.

**insertion thermostat**

1. thermostat which has an element that is inserted directly into the airstream of a duct or pipe.
2. thermostat with the sensing member in the sensed variable but with the controlling element outside.

**limited liquid-charged thermostat (gas-charged thermostat)**

vapor pressure thermostat charged with a restricted amount of liquid, so that above a given temperature the charge becomes a superheated vapor.

**line-voltage electric heat thermostat**

device which acts to control automatically the temperature of a room or space in which it is installed by switching directly the resistive noninductive electrical load.

**liquid-charged thermostat**

vapor thermostat charged with such an amount of liquid that a certain quantity of liquid remains in the bulb whatever the operating conditions may be.

**remote bulb thermostat**

thermostat in which the sensing bulb can be located at a distance from the instrument proper although remaining flexibly connected to it.

**reverse-acting thermostat**

1. thermostat in which the output decreases proportionally to an increase in the value of the sensed variable.
2. pneumatic instrument that permits passage of control air when temperature is lower than the temperature for which instrument is set and cuts off the air when the temperature goes higher than the temperature for which the instrument is set.

**room thermostat**

thermostat located in a room so as to respond to room temperature and thereby control heating or cooling devices.

**surface thermostat**

1. automatic control device having a sensing element responsive to the temperature of the surface being controlled.
2. temperature controlling device located on a surface to respond to surface temperatures and initiate control actions.

**tank thermostat**

device which senses changes in the temperature of stored water, and controls, by means of separate components, the flow of energy to maintain a selected temperature.

**two-stage thermostat**

1. thermostat that handles two separate circuits in sequence.
2. single temperature controller designed to control temperature at two distinct set points.

**water heater thermostat**

device that acts to control the energy flow to a water heater in relation to the water temperature sensed by its thermal element.

**thermostat absorber charge**

combination charge consisting of a solid adsorbent and an inert gas adsorbate, used in the power system of a thermostatic expansion valve.

**thermostat anticipator**

device that adds heat within a thermostat in anticipation of overshoot.

**thermostat bulb (thermostat phial; feeler)**

temperature-sensitive element of a thermostat.

**thermostat bulb well**

separate socket or well used with immersion thermostats so that the thermostat can be removed without disturbing the controlled system.

**thermostat compensator**

in a gas-charged thermostat, a device that compensates for fluctuations caused by temperatures, in certain parts of the power system; different from the temperature of the bulb.

**thermostat cross charge**

charge used in the power system of a thermostatic expansion valve that differs from the refrigerant charge used in the refrigerating plant. Compare thermostat straight-charge.

**thermostat liquid charge (wet charge; cross-ambient charge)**

charge in the power system of a thermostat or a thermostatic expansion valve (usually a straight charge).

**thermostat night setback**

manual or automatic reset of temperature control point of a thermostat, usually coupled with a start-up time for restoration of desired daytime temperature level.

**thermostat offset**

difference between the cut-in point and the scale setting.

**thermostat power system (power element)**

either a bimetallic element or a bulb connecting with a bellows directly or through a capillary tube.

**thermostat straight charge**

charge employed in the power system of a thermostat expansion valve which consists of the same refrigerant as used in the refrigeration plant. Compare thermostat cross-charge.

**thermosyphon**

circulation by the forces induced by the differences in densities of cooler and warmer fluids.

**thesaurus**

1. book of words and their synonyms.
2. list of subject headings or descriptors, usually cross-referenced, for use in organizing a collection of documents for reference and retrieval.
3. index to concepts (subjects) stored in a computer, comprising a controlled vocabulary of standard terms, formally organized so that existing relationships between concepts are made explicit; and providing retrieval of stored information and data. Also called access terminology.

**three-wire service**

1. electrical service supplied to the user by the utility company.
2. electrical service of a three-phase power form.

**throttling**

1. of a fluid, an irreversible adiabatic process which consists of lowering pressure by an expansion without work.
2. reduction in fluid or current flow by adding resistance.

**throttling expansion**

expansion (via flow restriction) across any orifice during which no mechanical work is transferred by the fluid to the surroundings.

**throttling range**

1. change in controlled variable required to move the throttle from one of its extreme limits of travel to the other.
2. amount of change in input required to produce a throttle control output that travels through its required range.

**thrust collar**

collar, the lateral surface of which is designed to bear the axial load of a shaft. Compare thrust bearing, under bearing.

**time (real time)**

1. actual time in which an occurrence transpires.
2. pertaining to the actual time during which a physical process transpires.
3. pertaining to the performance of a computation during the actual time that the related physical process transpires in order that results of the computations can be used in guiding the physical process.

**response time**

1. time (preferably in seconds; may also be in cycles of supply frequency) required for the output quantity to change by some agreed on percentage of the differential output quantity in response to a step change input. *Note:* In measurement, the initial and final output quantities shall correspond to the test output quantities. The response time shall be the maximum obtained including differences arising from increasing or decreasing output quantity or time phase of signal application.
2. output, expressed as a function of time, resulting from the application of specified input.

**rise time**

1. measure of the time required for a circuit to change its output from a low-voltage level to a high-voltage level, normally from 10 to 90 percentage points.
2. time required for the output of a system (other than first-order) to make the change from a small specified percentage (often 5 to 10%) of the steady-state increment to a large specified percentage (often 90 to 95%) either before overshoot or in the absence of overshoot.

**run time**

1. accumulated hours of equipment operation.
2. period of operation of a system on test.

**time constant**

in control theory and practice, for the output of a first-order (lag or lead) system forced by a step or impulse, time constant is the time required to complete 63.2% of the total rise or decay. (A system whose dynamic response can be expressed by a first order differential equation is a first order system, e.g., a mercury thermometer in air.)

**time delay**

1. time interval between the manifestation of a signal at one point and the manifestation or detection of the same signal at another point. *Note:* Generally, the term “time delay” is used to describe a process whereby an output signal has the same form as an input signal causing it, but is delayed in time; that is, the amplification of all frequency components of the output are related by a single constant to those of corresponding input frequency components but each output component lags behind the corresponding input component by a phase angle proportional to the frequency of the component.
2. time interval between when a command is given and when it is executed.

**tin pest (tin rot)**

polymorphic modification of tin that causes it to crumble into a powder known as gray tin. It is generally accepted that the maximum rate of transformation occurs at about  $-40^{\circ}\text{F}$  ( $-40^{\circ}\text{C}$ ), but transformation can occur as high as about  $55^{\circ}\text{F}$  ( $13^{\circ}\text{C}$ ).

**titanium tetrachloride ( $\text{TiCl}_4$ )**

chemical that generates white visible fumes on atmospheric contact; used in preliminary testing of laboratory fume hoods, or in the design and construction of the laboratory, or both. *Caution:* Titanium tetrachloride is corrosive and irritating; skin contact or inhalation should be avoided.

**ton (of refrigeration)**

time rate of cooling equal to 12,000 Btu/h (approximately 3517 W).

**cooling tower ton**

total heat-rejection capacity of a cooling tower; traditionally, 15,000 Btu/h. *Note:* This value is based on 25% compressor heat added to a ton of refrigeration.

**dry ton**

sensible heat load expressed in tons of refrigeration.

**total ton**

total heat load expressed in tons of refrigeration; the sum of the dry tons and the latent tons (wet tons).

**wet ton (moisture ton)**

latent heat load expressed in tons of refrigeration.

**ton day of refrigeration**

heat removed by a ton of refrigeration operating for a day, 288,000 Btu (approximately 84.3 kW). It is a quantity approximately equal to the latent heat of fusion or melting of 1 ton (2000 lb) of ice, from and at  $32^{\circ}\text{F}$ .

**ton hour**

quantity of thermal energy in tons (12,000 Btu) absorbed or rejected in one hour.

**tonne**

metric ton of 1000 kg. Equivalent to 1.10225 short ton (2000 lb).

**torsional excitation (fan)**

type of excitation in which the external force is applied to the fan through the hub in the form of torque pulsations. See also excitation.

**total suspended particulates**

mass of particulates suspended in a unit volume of air as collected by a high-volume air sampler.

**transducer**

1. device which converts energy from one form to another, e.g., a loudspeaker transforms electrical energy to acoustical energy.
2. element which receives information in the form of one physical quantity and transmits that information in the form of another physical quantity.
3. device by means of which energy can flow from one or more transmission systems or media to one or more other transmission systems or media. *Note:* The energy transmitted by these systems or media may be of any form (e.g., it may be electric, mechanical, or acoustical), and it may be of the same form or different forms in the various input and output systems or media.

**pneumatic-electric transducer (pneumatic-electronic transducer)**

device that converts a pneumatic value to an equivalent electric (volt, milliamp) value.

**transfer**

1. conveyance of control from one mode to another by means of instructions or signals.
2. conveyance of data from one place to another.
3. instruction for transfer.
4. to copy, exchange, read, record, store, transmit, transport, or write data.
5. instruction which provides the ability to break the normal sequential flow of control.

**transfer fluid (thermal storage)**

fluid that carries energy from one location to another. See also solar collector transfer fluid.

**transformer**

electromagnetic device for changing alternating current electrical energy to a different voltage.

**transient**

pulse or other temporary phenomenon occurring in a system prior to reaching a steady-state condition.

**transistor**

semiconductor device used for signal amplification, normally having three connections: an emitter E, a base B, and a collector C. It can also be used as a switch and exhibits considerable power gain under most circumstances.

**transition point**

at a stated pressure, the temperature (or at a stated temperature, the pressure) at which two solid phases exist in equilibrium; that is, an allotropic transformation temperature (or pressure).

**transmission**

transport of substances, energy, or indicated values from one place to another with or without impedances.

**analog transmission**

1. method by which analog values are transferred from the sensing location to a controlling location.
2. sending of a continuously variable signal from one point to another.

**duplex transmission**

1. (communications) pertaining to a simultaneous two-way independent transmission in both directions.
2. (double transmission) transmission of each data word twice and comparison bit by bit for accuracy.

**four-wire transmission**

1. in three-phase power transmission, the use of four wires WYE connected.
2. transmission of data in two directions simultaneously over two pairs of wires. Also known as full duplex transmission.

**liquid transmission**

in applications where the sensing point is always at a higher temperature than the rest of the system, vapor pressure is transmitted by a column of liquid.

**simplex transmission**

transmission in one direction at a time. The direction is manually switched.

**synchronous transmission (half-duplex)**

1. refers to transmission in which synchronization is achieved in the absence of any other character than a control character.
2. transmission in which the sending and receiving instruments are operating continuously at substantially the same frequency and are maintained, by means of correction, in a desired phase relationship.

**two-wire transmission**

1. electrical power transmission system that requires only two conductors; thus, it is a single phase system.
2. sending and receiving of electrical signals over the same pair of wires in both directions.

**transmission factor**

energy transmittance.

**transmission line**

coaxial cable, leased line, or other system of conductors used to transfer data or other signal energy from one location to another.

**transmission loss**

reduction in magnitude of some characteristic of a signal between two stated points in a system.

**transmission network**

entire system used for transmitting data from a central processor to remote panels, and vice versa. Includes the entire trunk cable system for single or multiple data channel access as well as all the transceivers (or repeaters). For leased lines, the interface, data modems, and carrier conductors are also included.

**transmissivity**

see transmittance.

**transmit (computer)**

1. to move data from one location to another.
2. to transfer information to a new location replacing whatever was previously stored.

**transmittance (radiation)**

portion of thermal radiation incident on a surface that is transmitted through the surface. Compare thermal transmittance. *Note:* Thermal transmittance usually is used for heat flow through walls, but transmittance (or transmissivity) is more often referred to as a radiation property.

**transport container (transcontainer)**

enclosable container of relatively large capacity, of standard size, designed for the carriage of goods usually in intermodal, especially sea, transport.

**trap**

device for preventing passage of something, often while allowing other matter to proceed. See steam trap.

**dead-end trap**

pipng arrangement for collecting oil or liquid refrigerant from suction gas prior to entry to a compressor.

**liquid trap**

device for collecting liquid refrigerant at a given point in a refrigerating circuit.

**scale trap**

in a refrigeration system, an arrangement for gravitational separation of the larger impurities from a refrigerant.

**suction trap (suction line accumulator; liquid separator)**

accumulator installed in the suction line between evaporator and compressor to trap liquid carryover from the evaporator and to prevent it from reaching the compressor.

**trend log (trend record)**

record of events taken on a regular schedule or equal time intervals.

**triple point**

particular temperature and pressure at which three different phases of one substance can coexist in equilibrium.

**troffer (luminaire)**

electric lighting fixture equipped for HVAC systems either with a diffuser to warm a room with the heat dissipated by lighting, or an exhaust vent to reduce the heat load.

**trombe wall**

solar energy-absorbent interior mass structural wall heated by south-facing glazing.

**trunking**

air duct, ductwork.

**tube**

1. long, usually cylindrical body with a hollow center used especially to convey fluids (tubing is an obsolete term).

2. tubular conduit for transport of fluids or finely divided solids; also, a hollow structural member; a hollow product of round or other cross section.

*Note:* A tube is designated by its exact outside diameter and its exact wall thickness, which may be described in gage numbers or other units. An exception exists for copper tubes as used in the plumbing industry. These are designated by the nominal size, which for 2-inch diameter or less approximates the inside diameter; while the exact outside diameter is 0.125 in. (3.2 mm) larger than the nominal size. A tube may be helical welded, lap welded, spiral welded, butt welded, or seamless. Compare tubing.

**Bourdon tube**

curved oval tube that tends to straighten when the pressure is increased, and recurves with pressure decrease.

**brazed tube**

tube made from sheet or strip with a longitudinal brazed joint.

**capillary tube**

1. small bore tube used for metering by controlling length and bore size. In refrigeration, a tube of small internal diameter used as a refrigerant pressure and flow control between high and low sides.

2. tube used to transmit pressure from the sensitive bulb of some temperature controls to the operating element. See also refrigeration capillary tube.

**condenser tube (heat exchanger)**

tube manufactured to special requirements, as to tolerances, finish, and temper.

**copper water tube**

seamless copper tube of certain standard sizes, in straight lengths and coils, used with flared or soldered joints for transporting gases and liquids.

**finned tube**

heat transfer tube or pipe with extended surface of fins, discs, or ribs.

**seamless drawn tube**

tube produced by drawing and forming operations from a pierced bar or hollow billet.

**soft copper tube**

deoxidized and dehydrated, seamless, soft-copper tube, thoroughly annealed to assure good bending and flaring characteristics.

**welded tube**

tube made from plate, sheet, or strip with welded longitudinal or helical seam.

**tubing**

system of tubes.

**turbine**

fluid-energized acceleration machine for generating rotary mechanical power from the energy in a fluid stream.

**gas turbine**

1. prime mover in which gas, under pressure or formed by combustion, is directed against a series of turbine blades; the energy in the expanding gas is converted into mechanical energy supplying power at the shaft. Also called a combustion turbine, simple-cycle turbine.
2. electric-generating station in which the prime mover is a gas turbine.

**combined-cycle gas turbine**

device that uses waste heat boilers to capture exhaust energy for steam generation.

**regenerative cycle gas turbine**

simple-cycle gas turbine to which has been added a heat exchanger to warm incoming combustion air with heat from exhaust gases to increase thermal efficiency.

**turbocompressor stall**

phenomenon of instability that may occur in centrifugal or axial flow compressors, characterized by aerodynamic blockage, or the breakaway of the flow from certain sections of the passage between the blades.

**turboexpander (expansion turbine)**

in cold air or gas refrigeration cycles, a turbine in which the compressed gas expands and produces mechanical energy.

**turbomachine**

turbine.

**turbulator**

flow enhancing device to increase coil heat transfer efficiency.

**turning vane (air splitter)**

curved strip of short radius placed in a sharp bend or elbow in a duct to direct air around the bend.

**UL (ULI)**

Underwriters' Laboratories, Inc. (ULC) Underwriters' Laboratories, Canada

**ultraviolet (UV) radiation**

range of electromagnetic radiation wavelengths from about 400 nm, just beyond the violet in the visible spectrum, to about 4 nm, on the border of the x-ray region. UV photons have enough energy to initiate some chemical reactions, to degrade most plastics, and to kill microorganisms.

**unconditioned space**

space within a building that is not conditioned space. Compare conditioned space.

**uniform velocity**

smooth, straight-line motion of gas or liquid across the area of flow.

**unit**

1. factory-made encased assembly of the functional elements indicated by its name, such as air-conditioning unit, room-cooling unit, humidifying unit, etc.

2. portion or subassembly of a computer which constitutes the means of accomplishing some inclusive operation or function.

**unit point selector**

device which selects the monitoring points to be used for observation or data sensing and collection.

**use factor**

percent capacity realized, time that a system is operated. Compare diversity factor.

**utilization factor**

same as use factor.

**U-value**

improper terminology. Use U-factor. See thermal transmittance.

**vacuum**

state in which the gas pressure is lower than atmospheric pressure.

**absolute vacuum**

space totally void of matter (theoretical).

**deep vacuum (high vacuum)**

vacuum having a pressure between  $1 \times 10^{-3}$  and  $1 \times 10^{-6}$  mm Hg (0.1333 and 0.0001333 Pa).

**ultrahigh vacuum**

absolute pressure below  $75 \times 10^{-9}$  mm Hg ( $10^{-5}$  Pa).

**vacuum breaking (vacuum cracking)**

increasing the pressure in an enclosure under vacuum by admitting gas (air).

**vacuum test**

test to check the gas tightness of an uncharged refrigeration system by drawing a vacuum on it.

**validity**

correctness; especially the degree of closeness by which iterated results approach the correct result.

**valve**

device to regulate or stop the flow of fluid in a pipe or a duct by throttling.

**adjustable capillary valve**

having male threads on a stem that fit female threads in the solid body, leaving a capillary channel between the threads regulated by the number of threads engaged.

**air valve**

device to control volume and flow in air distribution. See also damper.

**angle valve**

valve in which the inlet and outlet are at an angle, usually 45 or 90 degrees.

**antisiphon valve**

valve or mechanical device that eliminates siphon flow.

**automatic expansion valve**

controlling device for regulating automatically the flow of volatile refrigerant into a cooling unit, actuated by changes in evaporator pressure. The basic response is to regulate evaporator pressure.

**automatic valve**

valve that automatically regulates the flow of a fluid as a function of temperature, pressure, etc.

**back pressure valve (evaporator pressure regulator; EPR valve)**

automatic valve located between the evaporator outlet and compressor inlet that is responsive to its own inlet pressure, to prevent the evaporator pressure from falling below a selected value.

**backup valve**

head pressure control valve.

**ball valve**

1. check valve consisting of a ball resting on a spherical seat.
2. valve consisting of a rotatable ball with a hole through its center. See plug valve.

**beam valve (feather valve; leaf valve)**

reed valve in which the flexible metal strip is attached at both its ends.

**bellows valve**

packless valve in which a bellows forms the seal between the adjustment spindle and the valve body.

**bleed valve**

valve which has a fixed orifice incapable of being closed by an action of the valve, permitting a flow through or in parallel with the main valve port.

**blowdown valve**

valve used to remove excess undissolved solids from a steam boiler, by maintaining mud drums clear.

**blowoff valve**

safety valve that maintains a predetermined pressure in a vessel by discharging excess gas to the atmosphere. Compare relief valve. See safety valve.

**butterfly valve**

valve in which the regulating mechanism is a circular or elliptical disc that is rotatable about an axis.

**cantilever valve (flapper valve)**

reed valve in which the flexible metal strip is attached at only one of its ends.

**charging valve**

valve used to charge or add refrigerant to a system or add oil to a compressor crankcase.

**check valve (nonreturn valve)**

valve allowing fluid flow in one direction only.

**cock valve**

generally a plug valve, usually for regulating the flow of a fluid, and requiring a wrench for operating.

**companion valve (block valve)**

pairs of mating stop valves that allow sections of a system to be joined before opening these valves, or separated after closing them.

**condensing pressure valve**

automatic valve responsive to inlet pressure to prevent compressor discharge pressure from falling below a specific value. Normally used as a form of head pressure control (backup valve), but also used on refrigerating systems for maintaining hot-gas defrost systems.

**constant-level valve**

device for maintaining within a reservoir a constant level of fluid; e.g., oil fuel, for delivery to an oil burner.

**constant-pressure expansion valve**

valve that maintains a constant output pressure regardless of the input pressure.

**diaphragm valve (membrane valve)**

packless valve in which the seal between the adjustment spindle and the valve body is a diaphragm.

**direct-acting diaphragm valve**

valve that closes with the admission of fluid pressure to a diaphragm and opens when pressure is reduced.

**discharge valve (delivery valve, outlet valve)**

in a compressor, the valve that allows compressed fluid to flow from the cylinder and prevents return flow.

**discharge line valve (discharge stop valve)**

shutoff valve fitted to a compressor, or in the discharge line adjacent to it, which permits isolating the compressor from the discharge line.

**disc valve (diaphragm valve)**

compressor valve consisting of a metal disc.

**diverting valve**

three-way valve piped to supply a single source of fluid to either of two outlets.

**double-seated valve**

valve having two seats and two discs arranged so that the upstream pressure is acting on one side of one disc and the opposite side on the other disc. This acts to cancel system forces and allows the use of a smaller actuator.

**drain valve**

valve fitted to the lowest point of an apparatus or refrigeration system for the purpose of tapping or draining the system.

**dual-pressure regulator valve**

upstream pressure regulator equipped with two pressure controls, used in refrigerant suction lines to provide freeze-up protection or for safety pressure relief.

**electronic expansion valve**

controlling device for regulating flow of refrigerant in a cooling unit. It is actuated electrically, based on evaporator and superheat conditions, and typically controlled by a microprocessor. The basic response is to the superheat or to the liquid-vapor interface.

**emergency relief valve**

manually operated safety valve for discharge of refrigerant in case of fire or other emergency.

**firing valve**

lubricated, plug-type variable position valve, usually operated with an attached handle or, in the large sizes, by a loose-fitting key or extended handle wrench.

**float-type expansion valve (float valve)**

expansion valve operated by a change in liquid level.

**float valve**

valve actuated by a float in a fluid container.

**flow control valve**

one that shuts automatically when the circulator pump stops, thereby preventing gravity circulation.

**hand valve**

valve that is operated manually by a handwheel attached to the spindle.

**head pressure control valve**

automatic valve located between the air-cooled condenser and the receiver that will back up liquid in the condenser to reduce the effective area of the condenser, thus keeping the discharge pressure to a predetermined minimum value during low ambient temperatures. Used in conjunction with a pressure differential valve between the discharge line and the receiver.

**high-pressure float valve (high-side float valve)**

float-type expansion valve operated by changes in liquid level on the high-pressure side.

**hot-gas defrost valve**

solenoid valve located in a bypass line running from the outlet of the compressor to the evaporator.

**king valve (master valve)**

1. stop valve between receiver and liquid main.
2. stop valve on boiler head.

**lift check valve**

check valve with the mechanism lifting vertically from its seat to allow the passage of fluid.

**liquid-injection valve**

valve which controls the introduction of liquid refrigerant, e.g., into the intercooler in a multistage compression system.

**low-pressure float valve (low-side float valve)**

float-type expansion valve operated by changes in liquid level on the low-pressure side.

**lubricated plug valve**

valve of the pierced plug-and-barrel type, provided with means for maintaining a lubricant between the bearing surfaces.

**manual expansion valve (hand valve)**

manually operated needle-type valve for controlling the flow of liquid refrigerant to an evaporator.

**manual reset valve** automatic shutoff valve installed in gas supply piping and set to shut off when unsafe conditions occur. The device remains closed until manually reopened.

**mixing valve**

three-way valve to mix two fluids. Compare diverting valve.

**modulating control valve**

valve capable of increasing or decreasing by increments the fluid flow according to deviation from the set control value.

**motorized valve (motor-operated valve)**

valve operated by an electric motor.

**mushroom valve**

poppet valve whose head is mushroom-shaped.

**needle valve**

1. valve having a very small hole in the seat, fitted with a needle shaped plunger.
2. valve in which the obturator is a stem ending in a conical point which mates with a corresponding valve seat.

**nonreturn valve**

check valve.

**oil charge valve**

valve enabling one to charge or top a refrigerating system with oil.

**oil drain valve (oil purge valve)**

valve for draining out the oil from all collection points in a system.

**packless valve**

valve that does not use packing to seal against leaks around the stem, e.g., bellows valve.

**pilot valve**

small valve where the opening or closing directly influences a larger valve, as in a servo system.

**plug valve (plug cock)**

valve in which the fluid passage is a hole in a rotatable tapered plug in the valve body.

**pneumatic operated valve**

valve with the positioning mechanism actuated by compressed air.

**poppet valve**

valve comprising a mushroom-shaped circular head and integral stem.

**pressure controlled valve**

valve in which the position of the valve head in relation to the valve seat is determined by the deviation in pressure from the set value.

**pressure differential valve (spring-loaded check valve)**

automatic valve that opens in response to a pressure difference across the valve port. Commonly used in conjunction with a head pressure control valve (backup valve) between discharge line and receiver inlet.

**pressure-reducing valve**

1. valve used to reduce a high supply pressure to a usable level.
2. valve which maintains a uniform pressure on its outlet side irrespective of pressure variation on its inlet side.

**pressure relief valve**

safety valve that is held closed by a spring or other means and designed to automatically relieve pressure in excess of its setting.

**pressure-sustaining valve**

valve providing maintenance of designated pressure level within a system.

**pumpout valve**

valve enabling connection between a refrigerating system and a vacuum pump.

**purge valve**

device to allow fluid to flow out of system, particularly noncondensable gases; also called a drain valve. See purge.

**radiator valve**

manual or automatic valve that controls the flow of the fluid to a radiator.

**reed valve (flexing valve)**

compressor valve consisting of a plate having a number of slots and flexible steel strips fitted over the slots.

**refrigerant control valve (refrigerant expansion valve)**

valve that meters refrigerant and maintains pressure-difference between the high-pressure side and the low-pressure side of a mechanical refrigerating system while the unit is operating.

**relief valve**

safety valve actuated by inlet pressure which opens in proportion to the increase in pressure above the opening pressure.

**restrictor valve**

in a cooling and heating heat pump, a valve automatically ensuring that an additional length of capillary regulator is put into operation when the system is on heating cycle.

**reverse-acting diaphragm valve**

one which opens with the increase of fluid pressure to a diaphragm and closes when pressure is reduced.

**reversing valve (four-way valve)**

1. in a refrigerating system, a device which enables reversing the evaporator and the condenser for hot gas defrosting.
2. in a heat pump system, a device to effect changeover between heating and cooling cycles.

**ring-plate valve (ring valve)**

compressor valve consisting of a circular plate having a series of ports over which one or more ring plates seat.

**safety valve**

pressure relief valve actuated by inlet pressure, and characterized by rapid opening or pop action.

**service valve**

1. valve intended to isolate an apparatus from the rest of the system.
2. device used by service technicians to check pressures and charge refrigerating units.

**servo operated valve (pilot-controlled valve)**

valve operated by a mechanism that directly responds to some controlled conditions. See servo system.

**shunt valve (bypass valve)**

valve for diverting flow around a component, connection, or pipe, instead of through it.

**slave valve**

valve that receives its input signal from another valve.

**slide valve (piston valve)**

valve in which the sliding element has several ports that close or correspond with counterpart ports in the valve body.

**solenoid valve**

valve that is closed by gravity, pressure, or spring action and opened by the magnetic action of an electrically energized coil, or vice versa.

**solenoid liquid-line valve**

solenoid valve installed on the liquid-refrigerant line.

**spring-loaded pressure relief valve**

safety valve which opens at a predetermined pressure, but will also close when the pressure returns to normal, through the action of a spring.

**stop valve**

shutoff valve of any type, as distinguished from a flow control valve.

**suction valve**

in a compressor, the valve which allows refrigerant to enter the cylinder from the suction line and prevents return flow.

**suction-line valve (suction stop valve)**

shutoff valve fitted to the compressor, or in the suction line adjacent to it, to isolate the compressor from the suction line.

**suction-pressure regulating valve (C.P.R.) (holdback valve)**

automatic valve located between the evaporator outlet and the compressor inlet that is responsive to its own outlet pressure and functions to throttle the vapor flow to prevent the outlet pressure from exceeding a selected value. It is used primarily to prevent overload on compressor motors.

**swing-check valve**

nonreturn valve with a freely rotatable closure actuated by the resultant forces on both sides.

**thermally actuated valve**

automatic valve that opens or closes from heat generated by the resistance of an electrical component.

**thermostatic expansion valve (TXV)**

controlling device for regulating flow of refrigerant into a cooling unit, actuated by the changes in evaporator pressure and superheat of the refrigerant leaving the cooling unit. The basic response is to the superheat.

**thermostatically controlled valve**

valve in which the position of the plunger in relation to the seat is determined by the deviation of temperature from the set value.

**three-way valve**

valve having either a single inlet and two outlets (diverting) or two inlets and a single outlet (mixing), in which either one or the other is open. Service valve for dual-mounted safety relief valves. See also diverting valve; mixing valve.

**throttle valve**

valve used to restrict (throttle) the flow of fluid.

**tulip valve**

poppet valve whose conical head is tulip-shaped.

**two-temperature valve (evaporator pressure regulator)**

back pressure valve or constant pressure valve.

**two-way valve**

valve having a single inlet and single outlet. Also called throttle valve, shutoff valve, stop valve.

**two-way solenoid valve**

valve actuated by a solenoid, a coil that surrounds a movable iron core that is pulled to a central position (with respect to the coil) when the coil is energized by sending electric current through it.

**water valve**

condenser-water regulator valve capable of regulating flow of water through a condenser according to changes in condensing pressure or water temperature.

**zone valve**

valve that modulates water flow to a thermal zone in response to a downstream temperature signal.

**valve area**

variable area encountered by a fluid flowing through a valve.

**valve body**

shell or housing of a valve, into which the mechanism for regulating flow is fitted.

**valve cage**

device for holding and locating a valve disc, poppet, etc. in relation to a valve seat.

**valve cover**

removable part which allows access to the valve mechanism.

**valve disc**

disc or button fixed to the end of a valve stem and which meets the valve seat on closure.

**valve flutter (valve bounce)**

uncontrolled oscillation of a compressor valve on its seat during opening or closing.

**valve guard**

part which limits or controls the opening of a valve.

**valve lift** vertical distance through which a valve is raised to allow the passage of a fluid.

**valve plate**

plate on which the valves of a reciprocating or rotary compressor are located.

**valve plug** generic name for that part of a valve which mates with the seat to control or shut off flow.

**valve obturator**

that part of a valve that closes off or stops fluid flow.

**valve port**

opening for passage of a fluid in a valve.

**valve seat**

stationary portion of the valve which, when in contact with the movable portion, stops flow completely.

**valve stem**

spindle movable towards or away from a valve seat for guiding the valve head during closing or opening.

**valve trim**

internal parts (stem, plug, disc, seat, etc.) of a valve.

**vapor**

1. substance in the gaseous state that can also exist as a liquid or solid at normal atmospheric conditions. Compare gas.
2. gas, particularly one near equilibrium with its liquid phase and one that does not follow the gas laws. The term is usually used instead of gas to refer to a refrigerant, or in general, to any gas below the critical temperature.

**dry-saturated vapor (saturated vapor)**

vapor at the saturation temperature corresponding to the existing pressure and without any liquid phase.

**superheated vapor**

vapor at a temperature greater than the saturation temperature. The pressure and temperature of superheated vapor are independent properties, since the temperature can increase while the pressure remains constant. See superheat.

**supersaturated vapor**

vapor in a metastable equilibrium at a pressure higher than the saturation pressure corresponding to its temperature. See supersaturation.

**wet vapor**

saturated vapor containing liquid droplets in suspension.

**vapor barrier**

use vapor retarder. See water-vapor retarder.

**vapor control**

1. control device with a vapor-charged power element.
2. method of control using the expansion and contraction forces of a contained vapor.

**vapor lock**

formation of vapor in a liquid line that reduces mass flow compared to the flow of the total liquid at the same pressure differential.

**vapor lock device**

orifice capillary tube, or other device having a restricted passage of fixed size for liquid refrigerant. It restricts flow of vapor of that same liquid to a lower rate of flow with the same pressure difference.

**vapor pressure**

pressure exerted by a vapor. If a vapor is kept in confinement over its liquid or solid so that the vapor can accumulate above the substance with the temperature constant, the vapor pressure reaches a maximum called the saturated vapor pressure. *Note:* For a specific liquid or solid, at constant volume of vapor above it, the vapor pressure depends only on the temperature.

**saturation vapor pressure**

pressure at which vapor and liquid, or vapor and solid, can exist in equilibrium at a given temperature.

**vapor quality**

ratio of the mass of vapor to the total mass when a substance exists as part liquid and part vapor at the saturation temperature. *Note:* Quality has meaning only when the substance is in a saturated state, *i.e.*, at saturation pressure and temperature.

**vapor retarder**

material or construction that adequately impedes the transmission of water vapor under specified conditions. Compare structural barrier.

**vaporization**

change of phase from liquid to vapor.

**VAR**

unit of voltampere reactive power. For a two-wire circuit, the product of the voltage times the current times the sine of the angular phase difference by which the voltage leads or lags the current. VARs and watts combine in a quadrature to form voltamperes.

**variable**

anything which in concept or in practice is measurable or quantifiable, as a physical variable such as pressure, length, voltage, power, enthalpy, temperature, speed. "Quantity" often means variable but usually refers to an amount or numerical size. "Parameter" can be variable during design but is constant after construction and during use of equipment.

**controlled variable**

1. any variable that is controlled.
2. in a closed-loop system, variation in temperature, humidity, or pressure causes a controller to respond, and to reduce the deviation from a desired value.

**correcting variable**

output from controlling device which inputs to the controlled element.

**variable air volume (VAV)**

use of varying airflow to control the condition of air, in contrast to the use of constant flow (often) with varying temperature.

**variable volume, variable temperature (VVT)**

combination of varying both airflow and temperature in response to space load, for the purpose of resetting temperature to maintain greater low-load airflow to the space than in a true variable volume system.

**VAV**

variable air volume.

**VAV box**

variable air volume terminal device.

**parallel fan-powered VAV box**

terminal device that combines a true VAV box in parallel with a fan and optional heating coils. Fan operation is intermittent.

**reheat VAV box**

true VAV box with a reheat coil mounted on the discharge of the unit.

**series fan-powered VAV box**

terminal device that combines a true VAV box in series with a downstream fan and optional heating coil. Fan operation is constant.

**true VAV box**

terminal device that regulates the amount of conditioned air entering a space. Control typically is a function of space temperature.

**velocity**

1. time rate of distance moved.
2. vector quantity which denotes the simultaneous time rate and the direction of a linear motion.

**face velocity**

velocity obtained by dividing the air quantity by the component face area.

**mass velocity**

ratio of the mass flow rate of a fluid in a pipe to the cross-sectional area of the pipe.

**outlet velocity**

average velocity of air emerging from an outlet measured in the plane of the outlet.

**sonic velocity**

maximum velocity of a gas or of a pressure wave in a liquid.

**terminal velocity**

velocity of an airstream at the end of the throw.

**velocity pressure**

1. in a moving fluid, pressure existing due to velocity and density of the fluid; expressed as density times velocity squared, divided by two.
2. wind pressure.

**velocity profile**

graph that represents, in a plane section, the velocity distribution in a flowing fluid.

**vena contracta**

smallest area of a fluid stream leaving an orifice.

**vent**

1. opening in a tank or other piece of equipment, sealed to prevent escape of material within at normal pressures, but arranged to open automatically to relieve excessive pressure.
2. relief opening in a pressure regulator, normally open to the atmosphere.
3. air vent.

**vent gas**

flue gas.

**ventilating ceiling**

multiple ceiling supply openings with vertical discharge, in close proximity to each other, covering a significant part of the ceiling area and acting as a whole, not as individual units.

**ventilating rate (air change rate)**

number of complete air changes per unit time.

**ventilation**

process of supplying or removing air by natural or mechanical means to or from any space. Such air may or may not have been conditioned.

**attic ventilation**

introduction of cool outdoor air into an attic by exhausting its warm air to the outdoors.

**cross ventilation**

type of ventilating with air supply and exhaust points at opposite sides of ventilated space.

**underfloor ventilation**

in a refrigerated vehicle or a cold room, the circulation of cold air beneath the load, through a rack floor. See false floor.

**ventilation effectiveness ( $E_v$ )**

1. fraction of the outdoor that reaches the occupied zone of the destined space.
  2. evaluation of air delivery, regardless of the effectiveness of contaminant removal.
- Note:* Ventilation effectiveness has a different name and operational definition depending on the measurement procedure. See ASHRAE *Standard 129*.

**ventilator**

device for replacing air inside a room by outside air.

**power ventilator (roof or wall)**

fan consisting of a centrifugal-or axial-type impeller with integral driver in a weather-resistant housing with base designed to fit, usually by means of a curb, over a wall or roof opening.

**unit ventilator**

fan-coil unit package devised for applications in which the use of outdoor- and return-air mixing is intended to satisfy tempering requirements and ventilation needs.

**vent piping**

discharge piping connected to safety or relief valves.

**venturi**

contraction in a pipeline or duct that increases the fluid velocity to lower its static pressure, followed by a gradual expansion to allow recovery of static pressure. Used for metering and other purposes that involve change in pressure.

**venturi tube**

1. specially shaped constriction inserted in a pipe to measure the rate of flow from induced changes in pressure in the constricted section.
2. specially shaped construction that creates a vacuum in a steam/water refrigeration system.

**vessel**

container or structural envelope in which materials are processed, treated, or stored. Compare tank.

**vibration**

oscillation in a mechanical system.

**vibration cut-out switch**

safety switch used to deenergize a principal circuit should the mechanical equipment assembly vibrate excessively.

**vibration isolation****external vibration isolation**

in an air-handling unit, isolation of its vibration by devices external to the unit. *Note:* Examples are flex-duct connections, pipe-flex connections, and spring isolators.

**internal vibration isolation**

in an air-handling unit, spring-isolation of all moving parts within the unit that support the fan sled. *Note:* The fan-scroll discharge is typically isolated from the fan casing via a flex connection and snubber springs, thus obviating the need for external vibration isolation.

**vibration isolation hanger**

vibration isolator that is used to minimize vibration transmission into or out of a system that is suspended from a supporting structure.

**vibration isolation pad**

vibration isolator using neoprene, rubber, precompressed fibrous glass, or similar elastomer material.

**vibration isolator**

resilient support used to reduce the capacity of a system to respond to vibratory excitation.

**vibration snubber**

device to restrain vibration or movement of pipes or equipment.

**viscometer**

instrument for measuring viscosity.

**viscosity**

1. property of semifluids, fluids, and gases by which they resist an instantaneous change of shape or arrangements of parts. It causes fluid friction whenever adjacent layers of fluid move with relation to each other.
2. property of a fluid to resist flow or change of shape.

**absolute viscosity (dynamic viscosity)**

force per unit area required to produce unit relative velocity between two parallel areas of fluid unit distance apart, also called coefficient of viscosity.

**kinematic viscosity**

ratio of absolute viscosity to density of a fluid.

**viscosity index**

empirical number evaluated by comparing the viscosity of a substance with that of a standard substance.

**VOC**

volatile organic compound.

**volatile liquid**

liquid that evaporates readily at atmospheric pressure and room temperatures.

**volatile organic compounds (VOC)**

organic compounds in the vapor state present in an indoor atmosphere.

**volt**

unit of electrical potential, potential difference, or electromotive force (emf).

**voltage**

electric potential or potential difference expressed in volts.

**common-mode voltage**

signal of the same polarity and voltage on both wires of a differential input, often caused by a common path.

**design voltage**

specific voltage for which a line or piece of equipment is designed. A reference level of voltage for identification, and not necessarily the precise level at which it operates.

**undervoltage**

condition where voltage is lower than rated.

**voltampere (VA)**

basic unit of apparent power. The voltamperes of an electric circuit are the mathematical product of the volts and amperes of the circuit. The practical unit of apparent power is kilovolt-ampere (kVA), which is 1,000 voltamperes.

**volume/pressure control assembly (box)**

factory-made assembly for air distribution which, without altering the composition of the treated air from the distribution system, manually or automatically controls velocity or pressure of the air; or mixes airstreams of different temperatures and humidities, or both.

**VOM (volt ohmmeter)**

device for measuring voltage, or the resistance of an electrical circuit. Some models also measure current flow through components in electrical circuits.

**vortex amplifier**

fluidic control that throttles flow by causing a circular or vortex flow due to the impact of a tangential control jet. Amplification occurs when the control jet changes the vortex flow more than the change of control flow.

**VVT**

variable volume, variable temperature.

**wall area (gross) of a building**

for exterior walls enclosing a heated or cooled space as measured on the exterior, the opaque wall including between floor spandrels, peripheral edges of flooring, and window areas including sash and door areas, but excluding vents, grilles, and pipes. **wall plate** cover attached to an outlet box, or directly to the wall to which a thermostat is attached. It may contain terminals to which circuit wiring is attached.

**wall section**

cross section of wall, or a drawing of it, arranged to reveal thermal and moisture migration characteristics.

**wall sleeve**

opening in a wall having a shroud insert to accept the chassis of an air-conditioning unit.

**wall units (heat)** (either of two major types)

1. electrical wiring embedded in glass or ceramic tile to radiate heat.
2. fixture recessed into a wall deep enough to enclose resistance coils and sometimes fans. *Note:* This term may apply also to gas heaters.

**warming room (food)**

room designed to warm foodstuffs coming out of a cold room and thus avoid surface condensation on produce.

**warming-up allowance**

addition to the capacity of a heating system (as calculated for heat loss) to provide quick warmup in the morning.

**watch dog timer**

1. electronic internal timer which will generate a priority interrupt unless periodically recycled by a computer. It is used to detect program stall or hardware failure conditions.
2. time delay circuit which is closed when a computer system operates normally; when the computer system goes off-line, the circuit will begin a time delay and then open the circuit of which it is a part.

**water**

1. transparent, odorless, tasteless liquid; a compound of hydrogen and oxygen (H<sub>2</sub>O), containing 11.188% hydrogen and 88.812% oxygen by mass; freezing at 32°F (0°C); boiling near 212°F (100°C).
2. secondary coolant used in indirect refrigerating systems above 32°F (0°C).

**brackish water**

impure water with a lesser content of salt than seawater, but higher than that of potable water.

**chilled water**

water used as a cooling medium (particularly in air-conditioning systems or in processes) at below ambient temperature.

**circulating water**

water that circulates repeatedly around a loop, used in a water-cooled device or in a device that cools or heats water.

**cooling water**

water used for condensing a refrigerant.

**domestic hot water**

usually, potable hot water as distinguished from hot water used for house heating.

**makeup water**

water supplied to replenish the water of a system.

**potable water**

water that is drinkable.

**process hot water**

hot water needed for manufacturing processes over and above the domestic hot water that is for the personal use of industrial workers.

**raw water**

1. water used for ice making except distilled water.
2. untreated water.

**releasable water**

in freeze drying, that part of the water contained in the product which may be extracted without spoiling the quality of the product.

**soft water**

water free of calcium and magnesium salts.

**water column (wc)**

tubular column located at the steam and water space of a boiler to which protective devices, such as gage cocks, water gage, and level alarms are attached.

**water contaminant**

substance introduced into potable water thus creating a health hazard. Compare water pollutant.

**water draw rate**

rate at which hot water is withdrawn from the system over a specified period at a specified time.

**water gage (wg)**

1. gage glass with attached fittings which indicates water level within a vessel.
2. designation that water is the fluid in a manometer.

**water hammer**

see hydraulic shock.

**water heater**

closed vessel in which water is heated by the combustion of fuels, electricity, or any other source and is withdrawn for use external to the system at pressures not exceeding 160 psig [1100 kPa (gage)], including the apparatus by which heat is generated, and all controls and devices necessary to prevent water temperatures from exceeding 210°F (99°C). See also boiler.

**instantaneous water heater**

water heater that is not a storage water heater or a heat pump water heater. Compare storage water heater.

**storage water heater**

water heater that heats and stores water within the appliance at a thermostatically controlled temperature, for delivery on demand. *Note:* ASHRAE *Standard* 90.1-1989 requires that a storage water heater have an input rating of less than 4000 Btu/h per gallon of stored water (310 W/L) or a storage capacity of 10 gallons (38 L) or more. This standard designates a nonstorage water heater, as one that has an input rating of at least 4000 Btu/h per gallon of stored water (310 W/L), and a storage capacity of less than 10 gallons (38 L).

**tankless water heater**

heat exchanger for indirect heating of domestic water that is designed to be used without a domestic water storage tank. It may be attached directly to a boiler or installed external to a boiler and connected by piping.

**water-holding capacity**

during a drying process, the ability of a substance to retain water.

**water pollutant**

substance introduced into potable water, thus creating an objectionable condition, but not creating a health hazard. Compare water contaminant.

**water treatment**

process that alters supply water so that it can be used for process or HVAC purposes without deleterious effect.

**water vapor**

water in the vapor or gas phase.

**mol fraction water vapor**

in humid air, the ratio of the number of water-vapor mols to the total number of mols in the mixture. Compare humidity.

**water vapor content**

in a gas, the mass of water vapor per unit mass of dry gas.

**water vapor migration (vapor transfer; vapor transmission)**

transmission of water vapor through insulating or other material resulting from the difference in partial pressures on both sides.

**water vapor permeability**

time rate of water-vapor transmission through unit area of flat material of unit thickness induced by unit vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions. When permeability varies with psychrometric conditions, the spot or specific permeability defines the property at a specific condition. *Note:* Permeability is a property of a material, but the permeability of a body that performs like a material may be used. Permeability is the arithmetic product of permeance and thickness.

**water vapor permeance**

water vapor transmission of a body between two specified parallel surfaces, induced by the vapor pressure difference between two surfaces. The test conditions must be stated. An accepted unit of water-vapor permeance is the perm. *Note:* Permeance is a performance evaluation and not a property of a material. See perm; rep.

**water vapor pressure**

1. the portion of atmospheric pressure exerted by entrained water vapor, at a specified temperature.
2. pressure due to water vapor.

**water-vapor resistance** steady vapor pressure difference that induces unit time rate of vapor flow through unit area of a flat material (or construction that acts like a homogeneous body) for specific conditions of temperature and relative humidity at each surface. *Note:* Vapor resistance is the reciprocal of vapor permeance. It is the arithmetic product of the resistivity and thickness.

**water-vapor resistivity** steady vapor pressure difference that induces unit time rate of vapor flow through unit area and unit thickness of a flat material (or construction that acts like a homogeneous body), for specific conditions of temperature and relative humidity at each surface. Vapor resistivity is the reciprocal of vapor permeability.

**water-vapor retarder**

material or construction that adequately impedes the transmission of water vapor under specified conditions. Compare structural barrier.

**water-vapor transmission rate (WVTR)**

steady-state vapor flow in unit time through unit area of a body, normal to specified parallel surfaces, under specific conditions of temperature and humidity at each surface.

**watt (power) (W)**

1. energy flow at the rate of one joule per second.
2. work done or energy generated by one ampere induced by an emf of one volt.

$$P = EI = I^2 R.$$

**thermal watt**

heat power expressed in watts.

**waveform**

shape of a wave plotted against time.

**wax**

in petroleum oils, a material, usually a solid hydrocarbon, that may separate on cooling of an oil-refrigerant mixture.

**wax content**

wax contained in lubricating oil at a specified temperature.

**wc**

water column.

**weber (Wb)**

unit of magnetic flux in the metre-kilogram-second system, equal to the magnetic flux which, linking a circuit of one turn, produces in it an emf of 1 volt as it is reduced to zero at a uniform rate in one second.

**weep**

drip from frozen foods, or in construction from slow leaks.

**weight**

gravitational force with which the earth attracts a body. Compare mass.

**weld**

localized coalescence of metal produced by heating to a suitable temperature, with or without application of pressure, and with or without the use of filler metal. Filler metal has a melting point approximately the same as the base metal.

**butt weld**

weld formed by placing two edges or ends one against the other, and welding them.

**fillet weld**

weld of approximately triangular cross section, joining two surfaces approximately at right angles in a lap joint, tee joint, corner joint, or socket joint.

**lap weld**

weld formed by lapping two pieces of metal and then pressing or hammering; applied particularly to the longitudinal joint produced by a welding process for tubes or pipe, in which the edges of the skelp are beveled or scarfed so that when they are overlapped they can be welded together.

**tack weld**

weld made to hold parts of a weldment in proper alignment until final welds are made.

**welding process**

process used to join metals by the application of heat. Fusion welding, which includes gas, arc, and resistance welding, requires that the parent metals be melted. This distinguishes fusion welding from brazing.

**acetylene welding**

welding using an acetylene-gas torch for fusing a selected metal (welding rod) in such a position as to fill the space where a junction is to be made.

**arc welding**

group of welding processes wherein coalescence of metal is produced by heating with an electric arc or arcs, with or without the application of pressure, and with or without filler metal.

**gas metal-arc welding (GMAW)**

arc-welding process wherein coalescence is produced by heating with an arc between a continuous filler metal (consumable) electrode and the work. *Note:* Shielding is obtained entirely from an externally supplied gas or gas mixture.

**gas tungsten-arc welding (GTAW)**

arc-welding process wherein coalescence is produced by heating with an arc between a single tungsten (nonconsumable) electrode and the work. *Note:* Shielding is obtained from a gas or gas mixture. Pressure may or may not be added.

**gas welding**

group of welding processes wherein coalescence is produced by heating with a gas flame or flames, with or without the application of pressure, and with or without the use of filler metal.

**resistance welding**

welding with resistance heating and pressure, the work being part of the electrical circuit.

**shielded metal-arc welding (SMAW)**

arc-welding process wherein coalescence is produced by heating with an electric arc between a covered metal electrode and the work. *Note:* Shielding is obtained from decomposition of the electrode covering. Pressure is not used and filler metal is obtained from the electrode.

**spot welding**

welding of lapped parts in which fusion is confined to a relatively small circular area. It is generally resistance welding, but may also be gas tungsten-arc, gas metal-arc, or submerged-arc welding.

**submerged arc welding**

arc-welding process wherein coalescence is produced by heating an arc or arcs between a bare metal electrode or electrodes and the work. *Note:* The arc is shielded by a blanket of granular fusible material on the work. Pressure is not used, and filler metal is obtained from the electrode and sometimes from a supplementary welding rod.

**thermit (thermite) welding**

welding with heat produced by the reaction of aluminum with a metal oxide. Filler metal, if used, is obtained from the reduction of an appropriate oxide.

**weldment**

assembly whose component parts are joined by welding.

**white room**

obsolete term. Use clean room.

**wind pressure (velocity pressure)**

total force exerted on a structure by wind.

**wiredrawing**

erosion of a valve plug or seat due to very high fluid velocity, usually caused by prolonged operation in a nearly closed position.

**work**

mechanism that transfers energy across the boundary of systems with differing pressures (or force of any kind), always in the direction of lower pressure; if the total effect produced in the system can be reduced to the raising of a weight, then nothing but work has crossed the boundary.

**flow work**

energy carried into or transmitted across the system boundary because a pumping process occurs somewhere outside the system, causing fluid to enter the system. Flow work also occurs as fluid leaves the system.

**mechanical (shaft) work**

energy delivered or absorbed by a mechanism, such as a turbine, air compressor, or internal combustion engine.

**reversible work**

maximum useful work obtained for a given change of state. It includes heat supplied from other systems, but excludes work done on the surroundings.

**work cycle (expander cycle; work extraction cycle)**

thermodynamic cycle in which the working fluid gives up mechanical energy to some outside system (e.g., in a mechanical expander).

**work indicator**

indicator diagram.

**yield point**

stress at which a material exceeds its elastic limit. Below this stress, the material will recover its original size. Above this stress, it will not.

**zeolite**

group of aluminosilicates containing very loosely held cations, used in molecular sieves and ion exchangers.

**zeotrope**

nonazeotropic liquid mixture that may be separated by distillation, and in which the components are miscible in all proportions (homogeneous zeotrope); or not miscible in all proportions (heterogeneous zeotrope).

**zero principle**

if two systems are both in thermal equilibrium with a third one, they are in mutual thermal equilibrium (this principle is an introduction to the temperature concept).

**zone (control zone)**

space or group of spaces within a building with heating or cooling requirements sufficiently similar that comfort conditions can be maintained by a single controlling device.

**comfort zone**

1. operative temperature. See temperature.
2. range of effective temperatures under which most of a group of people feel comfortable.

**neutral zone**

see building air infiltration (neutral pressure level).

**occupied zone**

1. region in an occupied space between planes 3 and 72 inches (75 and 1800 mm) above the floor, and more than 2 feet (600 mm) from the walls or fixed air-conditioning equipment.
2. in air conditioning, the space in which people, animals, and/or processes are maintained.

**zoning**

1. division of a building or group of buildings into separately controlled spaces (zones), where different conditions can be maintained simultaneously.
2. practice of dividing a building into smaller sections for control of heating and cooling. Each section is selected so that one thermostat can be used to determine its requirements.

# Mathematics and Physics

## PHYSICAL LAWS

*Definition:* Physical laws are properties of physical phenomena or relationships between the various quantities or qualities that describe the phenomena and apply to all members of a broad class.

### Avogadro's law

under the same conditions of pressure and temperature, equal volumes of all gases contain equal numbers of molecules.

### Babo's law

addition of a non-volatile solid to a liquid in which it is soluble, lowers the vapor pressure of the solvent in proportion to the amount of substance dissolved.

### Beer's law

absorption of light by a solution changes exponentially with the concentration, all else remaining the same.

### Boyle's law

product of the volume of a gas times its pressure is a constant at fixed temperature. Also known as Mariotte's law.

### Brewster's law

index of refraction for a material is equal to the tangent of the polarizing angle for the material.

### Charles' law

at constant pressure, the volume of a fixed mass or quantity of gas varies directly with the absolute temperature; a close approximation. Also known as Gay-Lussac's law.

### combining weights law

if weights of elements that combine with each other are called their "combining weights", then elements always combine either in ratio of their combining weights, or of simple multiples of these weights.

### component substances law

every material consists of one substance, or is a mixture of two or more substances, each of which exhibits a specific set of properties, independent of the other substances.

### compression exponent (compression index)

exponent  $n$  in the equation  $pV^n = \text{constant}$ , representing the actual pressure-volume relationship during compression.

### conservation-of-energy law

energy can neither be created nor destroyed, and therefore the total amount of energy in the universe remains constant. See thermodynamics laws.

### conservation of momentum law

when a system of masses is subject only to internal forces that masses of the system exert on one another, the total vector momentum of the system is constant.

### Coulomb's law

the attraction or repulsion between two electric charges acts along the line between them, is proportional to the product of their magnitudes, and is inversely proportional to the square of the distance between them.

### Curie's law

magnetic susceptibilities of most paramagnetic substances are inversely proportional to their absolute temperatures.

### Curie-Weiss law

susceptibility of a paramagnetic substance above the Curie temperature varies inversely as the excess of the temperature above that point.

**Dalton's law**

each constituent of a mixture of gases behaves thermodynamically as if it alone occupied the space. The sum of the individual pressures of the constituents equals the total pressure of the mixture.

**definite composition law**

a given chemical compound always contains the same elements in the same fixed proportions by weight. Also known as the definite proportions law.

**distribution law**

if a substance is dissolved in two immiscible liquids, the ratio of its concentration in each is constant.

**Dulong-Petit law**

product of the specific heat per gram and the atomic weight of many solid elements at room temperature has almost the same value, about 6.3 calories per degree Celsius (264 J/K).

**fan laws**

1. flow rate varies in direct proportion to fan speed (rpm).
2. flow rate varies in direct proportion to pitch diameter of the motor sheave.

**Faraday's laws of electrolysis**

1. amount of any substance dissolved or deposited in electrolysis is proportional to the total electric charge passed.
2. amounts of different substances dissolved or deposited by the passage of the same electric charge are proportional to their equivalent weights.

**Fick's law**

rate of diffusion of matter across a plane is proportional to the negative of the rate of change of the concentration of the diffusing substance in the direction perpendicular to the plane.

**Graham's law**

rate of diffusion of a gas is inversely proportional to the square root of its density.

**Henry's law** mass of a slightly soluble gas that dissolves in a definite mass of liquid at a given temperature is nearly directly proportional to the partial pressure of that gas.

This holds for gases that do not unite chemically with the solvent.

**Hooke's law**

within the elastic limit of any body, the ratio of stress to strain produced is constant.

**ideal gas law (perfect gas law)**

the equation of state of an ideal gas is a good approximation to real gases at sufficiently high temperatures and low pressures; that is,  $pV = RT$ , where  $p$  is the pressure,  $V$  is the volume per mol of gas,  $T$  is the absolute temperature, and  $R$  is the gas constant.

**Kepler's laws**

three laws describing the motions of planets in their orbits: the orbits of planets are ellipses with the sun at the common focus; the line joining a planet and the sun sweeps over equal areas during equal intervals of time; the squares of the periods of revolution of any two planets are proportional to the cubes of their mean distances from the sun.

**Kirchoff's law**

1. algebraic sum of the currents that meet at any point is zero.
2. in any closed circuit, the algebraic sum of the products of the current and the resistance in each conductor in the circuit is equal to the electromotive force in the circuit.
3. ratio of the emissivity of a heat radiator to the absorptivity of the same radiator is the same for all bodies, depending on frequency and temperature alone, and is equal to the emissivity of a blackbody.

**Kohlrausch's law**

when ionization is complete, the conductivity of an electrolyte is equal to the sum of the conductivities of the ions into which the substance dissociates

**Kundt's law**

optical absorption bands of a solution are displaced toward the red when its refractive index increases because of changes in composition or other causes.

**Lambert's law**

1. illumination of a surface by a light ray varies as the cosine of the angle of incidence between the normal to the surface and the incident ray.
2. luminous intensity in a given direction radiated or reflected by a perfectly diffusing plane surface varies as the cosine of the angle between that direction and the normal to the surface.

**Lenz' law**

an electromotive force (emf) induced in a conductor is always in such a direction that the current it would produce would oppose the change that causes the induced emf.

**mass action law**

rate of a chemical reaction for a uniform system at constant temperature is proportional to the concentrations of the substances reacting. Also known as Guldberg and Waage law.

**Moseley's law square**

root of the frequency of an x-ray spectral line belonging to a particular series is proportional to the difference between the atomic number and a constant which depends only on the series.

**multiple proportions law**

if two elements form more than one compound, the weights of the first element which combine with a fixed weight of the second element are in the ratio of integers to each other.

**Newton's law of cooling**

rate of heat flow out of an object by both natural convection and radiation is proportional to the temperature difference between the object and its environment, and to the surface area of the object.

**Newton's laws of motion**

1. every body continues in its state of rest or of uniform motion in a straight line, except insofar as it may be compelled to change that state by action of some outside force.
2. change of motion is proportional to force applied, and takes place in the direction of the line of action of the force.
3. to every action there is always an equal and opposite reaction.

**Ohm's law**

direct current flowing in an electric circuit is directly proportional to the voltage applied to the circuit; it is valid for metallic circuits and many circuits containing an electrolytic resistance.

**Pascal's law**

confined fluid transmits externally applied pressure uniformly in all directions, without change in magnitude.

**pump laws (affinity laws for pumps)**

1. with constant impeller diameter and variable speed, flow of a constant-gravity pump varies directly with the speed change; head varies as the square of the speed change; and power changes as the cube of the speed change.
2. with variable impeller diameter and constant speed, flow varies directly with the diameter change; head varies as the square of the diameter change; and power varies as the cube of the diameter change.
3. Power varies directly with specific gravity or density changes of the fluid.

**periodic law**

properties of the chemical elements and their compounds are a periodic function of their atomic weights.

**Raoult's law**

molar weights of nonvolatile nonelectrolytes, when dissolved in a definite mass of a given solvent under the same conditions, lower the solvent's freezing point, elevate its boiling point, and reduce its vapor pressure equally for all such solutes.

**Snell laws of refraction**

when light travels from one medium into another, the incident and refracted rays lie in one plane with the normal to the surface; are on opposite sides of the normal; and make angles with the normal whose sines have a constant ratio to one another. Also known as Descartes laws of refraction.

**Stefan-Boltzmann law**

total energy radiated from a blackbody is proportional to the fourth power of the temperature of the body. Also known as the fourth power law.

**Stokes' laws**

1. at low velocities, the frictional force on a spherical body moving through a fluid at constant velocity is equal to  $6\pi$  times the product of velocity, fluid viscosity, and radius of the sphere.
2. wavelength of luminescence excited by radiation is always greater than that of the exciting radiation.

**thermodynamics laws:****First law**

law of conservation of energy, which can be expressed as follows: heat and work are mutually convertible; or because energy can neither be created nor destroyed, the total energy associated with an energy conversion remains constant.

**Second law**

conversion of heat to work is limited by the temperature at which conversion occurs. This can be expressed as the **Carnot cycle efficiency**, as  $(T_1 - T_2)/T_1$ , where  $T_1$  is the higher temperature (in °R or K) where heat is absorbed, and  $T_2$  is the lower temperature where heat is rejected. See also conservation of energy.

**Wien's displacement law**

when the temperature of a radiating blackbody increases, the wavelength corresponding to maximum energy decreases in such a way that the product of the absolute temperature and the wavelength is constant.

**Wien's radiation law**

intensity of radiation emitted by a blackbody per unit wavelength, at that wavelength at which this intensity reaches a maximum, is proportional to the fifth power of the temperature.

**ENGINEERING PRINCIPLES**

*Definition:* An engineering principle is a comprehensive and fundamental engineering law, doctrine, or assumption.

**Archimedes principle**

a body immersed in a fluid undergoes an apparent loss in weight equal to the weight of the fluid it displaces.

**combining volumes principle**

when gases take part in chemical reactions, the volume of the reacting gases and those of the products (if gaseous) are in the ratio of small whole numbers, provided that all measurements are made at the same temperature and pressure. Also known as Gay-Lussac law.

**Coriolis acceleration**

1. acceleration which, when added to the acceleration of an object relative to a rotating coordinate system and to its centripetal acceleration, gives the acceleration of the object relative to a fixed coordinate system.
2. vector that is equal in magnitude and opposite in direction to that of the first definition.

**Coriolis force**

velocity-dependent pseudoforce in a reference frame that is rotating with respect to an inertial reference frame; it is equal and opposite to the product of the mass of the particle on which the force acts and its Coriolis acceleration.

**Fermat's principle**

an electromagnetic wave takes a path that involves the least travel time when propagating between two points.

**LeChatelier's principle**

when an external force is applied to a system at equilibrium, the system adjusts so as to minimize the effect of the applied force.

**uncertainty principle**

accurate measurement of an observable quantity necessarily produces uncertainties in the knowledge of the values of other observables. Also known as Heisenberg uncertainty principle; indeterminacy principle.

**Van't Hoff's principle**

if the temperature of interacting substances in equilibrium is raised, the equilibrium concentrations of the reaction are changed, so that the products of that reaction which absorb heat are increased in quantity, or if the temperature for such an equilibrium is lowered, the products that evolve heat in their formation are increased in amounts.

**COEFFICIENTS**

*Definition:* A coefficient is a factor in a mathematical product.

**absorption coefficient**

ratio of the radiant flux absorbed by a body to that incident upon it.

**air discharge coefficient**

ratio of the net area at vena contracta of air flowing through an orifice to the total free area of the opening.

**compressibility coefficient (compressibility factor)**

coefficient required to correct the perfect gas equation when applied to real gases.

**contraction coefficient** 1. ratio of the minimum cross-sectional area of a jet of liquid discharging from an orifice, to the area of the orifice. 2. ratio of the net orifice of the vena contracta of a fluid flowing through an orifice, to the total free area of the opening.

**convective film coefficient**

constant of proportionality relating the convective rate of heat transfer at a surface to the temperature difference across the air film on that surface.

**coefficient of performance (COP) (performance coefficient)**

1. ratio of the rate of net heat output to the total energy input expressed in consistent units and under designated rating conditions.
2. ratio of the refrigerating capacity to the work absorbed by the compressor per unit time.

**coefficient of performance (heat pump)**

ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete operating heat pump plant or some specific portion of that plant under designated operating conditions.

**coefficient of performance (heat pump compressor)**

ratio of the compressor heating effect (heat pump) to the rate of energy input to the shaft of the compressor, in consistent units, in a complete heat pump, under designated operating conditions.

**coefficient of performance (refrigerating)**

ratio of the rate of heat removal to the rate of energy input in consistent units, for a complete refrigerating plant or some specific portion of that plant under designated operating conditions. Compare EER.

**coefficient of performance (refrigerating compressor)**

ratio of the compressor refrigerating effect to the rate of energy input to the shaft of the compressor, in consistent units, in a complete refrigerating plant, under designated operating conditions.

**degradation coefficient ( $C_D$ )**

factor of efficiency loss due to cycling of the unit. It is the effect of the reduction in performance under cycling operation.

**diffusion coefficient**

see mass diffusivity ratio.

**discharge coefficient**

in the flow of fluids through nozzles and orifices, the product of the velocity coefficient and the contraction coefficient. See also air discharge coefficient.

**drag coefficient**

coefficient expressing the resistance encountered by a body when moving in a fluid.

**expansion coefficient**

change in length per unit length, or the change in volume per unit volume, per degree change in temperature.

**film coefficient**

heat transferred between a surface and a fluid in unit time through unit area induced by unit temperature difference.

**flow coefficient**

1. experimentally determined proportionality constant, relating the actual velocity of fluid flow in a pipe, duct, or open channel to the theoretical velocity expected under certain assumptions.
2. dimensionless number used in studying the power required by fans, equal to the volumetric flow rate through the fan divided by the product of the rate of rotation of the fan and the cube of the impeller diameter.

**gas constant coefficient**

$R$  in the perfect gas relation  $pV = mRT$ .

**heat transfer coefficient (overall coefficient of heat transfer)**

see U-factor.

**heat transfer radiation coefficient**

an imaginary coefficient expressing the proportionality of radiant heat exchange between two bodies to their temperature difference.

**heat loss coefficient (thermal storage)**

rate at which heat is lost from the storage device per degree temperature difference between the average temperature of the storage medium and the average temperature of the surround.

**resistance coefficient**

1. dimensionless number used in the study of flow resistance, equal to the resistance force in flow divided by one-half ( $1/2$ ) the product of fluid density, the square of fluid velocity, and the square of a characteristic length.

2. dimensionless group, equal to four times the Fanning friction factor. Also known as Darcy-Weisbach coefficient; Darcy number 1.

**R-value (thermal resistance)**

quantity determined by the temperature difference, at steady state, between two defined surfaces of a material or construction that induces a unit heat flow rate through a unit area.  $R = \Delta T/q$ .

**shading coefficient**

ratio of absorbed and transmitted solar heat relative to fenestration fitted with shading devices to that occurring with unshaded single strength glass.

**temperature index coefficient of thermal performance**

ratio of the difference in temperature between the inside surface and the exterior ambient to the difference in temperature between the inside ambient and the exterior ambient across a component of the building envelope. The coefficient can be used to estimate the apparent thermal resistance of the component.

**velocity coefficient**

1. ratio of the actual velocity of gas emerging from a nozzle to the velocity calculated under ideal conditions; it is less than one because of friction losses.
2. ratio of the actual average fluid velocity in the vena contracta to the ideal fluid velocity.

**viscosity coefficient**

force per unit area required to produce unit relative viscosity between two parallel areas of fluid-unit distance apart.

**CONSTANTS**

*Definition:* A constant value is a value that does not change during a particular process.

**dielectric constant**

for an isotropic medium, the ratio of the capacitance of a capacitor filled with a given dielectric to that of the same capacitor having only a vacuum as a dielectric.

**gas constant**

constant of proportionality appearing in the equation of state of an ideal gas, equal to the absolute pressure of the gas times its molar volume divided by its absolute temperature. Also known as the gas-law constant.

**velocity constant**

ratio of the rate of change of the input command signal to the steady-state error, in a control system where these two quantities are proportional.

**CYCLES**

*Definition:* A cycle is a complete course of operation of working fluid back to a starting point, measured in thermodynamic terms (functions).

**binary-vapor cycle**

thermodynamic cycle relative to the varying condensing and evaporating temperatures of a nonazeotropic mixture of two fluids.

**Carnot cycle**

ideal reversible thermodynamic cycle comprising two isothermal processes and two adiabatic processes. It is representative of maximum theoretical conversion of heat energy into mechanical energy. Compare reverse Carnot cycle. See second law of thermodynamics; Carnot cycle efficiency (thermodynamics laws).

**reverse Carnot cycle**

(refrigeration) conversion of work to heat, where the ratio  $T_2/(T_1 - T_2)$  is the coefficient of performance, and where  $T_1$  is the higher temperature (in °R or K) where heat is rejected, and  $T_2$  is the lower temperature where heat is absorbed. Compare second law of thermodynamics.

**compressing cycle (refrigeration)**

refrigerating cycle comprising four principal stages: vaporization of refrigerant; compressing of vapor; liquefaction of vapor; and expansion of liquid.

**expander cycle (work-extraction cycle; work cycle)**

thermodynamic cycle in which the working fluid transfers mechanical energy to some outside system (e.g., in a mechanical expander).

**Rankine cycle**

theoretical thermodynamic cycle used in steam engines comprising four principal stages: (1) vaporization of water under high pressure, (2) expansion of steam, (3) condensation of steam, and (4) pumping of the water back to initial pressure.

**refrigerating cycle**

thermodynamic cycle of a system which transfers heat from a low-temperature reservoir to a high-temperature reservoir.

**reversible cycle**

theoretical thermodynamic cycle, composed of a series of reversible processes.

**standard rating cycle**

refrigerating cycle as defined by standard conditions.

**Stirling cycle**

theoretical thermodynamic cycle comprising two isothermal processes and two isochoric processes.

**DIMENSIONLESS NUMBERS**

*Definition:* A dimensionless number is a ratio of various physical properties (such as density or heat capacity) and conditions (such as flow rate or mass) of such nature that the resulting number has no defining units of mass, rate, etc.

**circulating number**

dimensionless number  $n$  used to describe the amount of liquid feed in overfeed refrigeration evaporators, expressing the ratio of liquid feed to the evaporating rate. Supplied with inlet quality of  $\chi_1 = 0$  liquid overfeed evaporator, it is equal to the reciprocal of the outlet quality,  $n = 1/\chi_2$ .

**dust-spot opacity index**

number that expresses the relative dust accumulation on a dust-spot sampling target, corrected for the nonlinearity of opacity increase at constant dust accumulation rate.

**Fourier number**

1. dimensionless number used in unsteady-state flow calculations, equal to the product of the dynamic viscosity and a characteristic time divided by the product of the fluid density and the square of a characteristic length.
2. (thermal) dimensionless number used in calculation of unsteady-state heat transfer, equal to the product of the thermal conductivity and a characteristic time, divided by the product of the density, the specific heat at constant pressure, and the distance from the midpoint of the body through which heat is passing to the surface. Symbol is  $F_o$ ,  $F_o$ , or  $N_{F_o}$ .

**Froude number**

1. dimensionless number used in studying the motion of a body floating on a fluid with production of surface waves and eddies; equal to the ratio of the square of the relative speed to the product of the acceleration of gravity and a characteristic length of the body. (Symbol is  $Fr$ ,  $Fr_1$ , or  $N_{Fr_1}$ ).

2. dimensionless number equal to the ratio of the speed of flow of a fluid in an open channel to the speed of very small gravity waves, the latter being equal to the square root of the product of the acceleration of gravity and a characteristic length. (Symbol is  $Fr_2$  or  $N_{Fr_2}$ ). See also gravity current.

**densimetric Froude number**

dimensionless form of the second Froude number  $N_{Fr_2}$  or  $Fr_2$ , expressing the ratio of inertia of an incoming fluid to buoyancy force based on the difference in density between the incoming and the existing (ambient) fluid. See also gravity current.

**Graetz number**

dimensionless number used in calculation of streamline flow, equal to the mass flow rate of a fluid times its specific heat at constant pressure, divided by the product of its thermal conductivity and a characteristic length. Also spelled Gratz number. Symbol  $Gz$ ,  $G_z$ , or  $N_{Gz}$ .

**Grashof number**

dimensionless number used in the calculation of free convection of a fluid caused by a hot body, equal to the product of the fluid's coefficient of thermal expansion, the temperature difference between the hot body and the fluid, the cube of a typical dimension of the body, and the square of the fluid's density, divided by the square of the fluid's dynamic viscosity. Also known as **free convection number**. Symbol  $Gr$ ,  $G_r$ , or  $N_{Gr}$ .

**Lewis number**

dimensionless number equal to thermal diffusivity divided by mass diffusivity. Symbol  $Le$ ,  $L_e$ , or  $N_{Le}$ .

**Mach number**

ratio of the speed of a body or of a point on a body with respect to the surrounding air or other fluid, or the ratio of the speed of a fluid to the speed of sound in the medium. Symbol  $M$  or  $N_{Ma}$ .

**Margoulis number**

see Stanton number.

**Nusselt number**

dimensionless number used in calculation of forced convection, which gives a measure of the ratio of total heat transfer to conductive heat transfer, equal to the heat-transfer coefficient times a characteristic length, divided by the thermal conductivity. Symbol  $Nu$ ,  $N_u$ , or  $N_{Nu}$ .

**Peclet number**

dimensionless number used in calculation of heat and mass transfer, consisting of the mass velocity times a characteristic length and the specific heat at constant pressure, divided by the thermal conductivity. Symbol  $Pe$ ,  $P_e$ , or  $N_{Pe}$ .

**Prandtl number**

1. dimensionless number used in calculation of diffusion in flowing systems, equal to the kinematic viscosity divided by the molecular diffusivity. Symbol is  $Pr$  or  $P_r$ . Also known as **Schmidt number 1** ( $Sc$ ,  $S_c$ , or  $N_{Sc1}$ ).
2. (thermal) dimensionless number used in calculation of forced and free convection, equal to the dynamic viscosity times the specific heat at constant pressure, divided by the thermal conductivity.

**Reynolds number**

dimensionless number that is significant in the design of a model of any system in which the effect of viscosity is important in controlling the velocities or the flow pattern of a fluid; equal to the density of a fluid times its velocity times a characteristic length divided by the fluid viscosity. Symbol  $Re$  or  $N_{Re}$ . Also known as **Damkohler number V** ( $DaV$ ). A Reynolds number above 2500 indicates turbulent flow; less than 2500, streamlined flow.

**inlet Reynolds number**

in thermal storage, volume flow rate leaving a diffuser per unit length divided by the kinematic viscosity of the incoming fluid.

**Richardson number**

dimensionless number used in studying the stratified flow of multilayer systems; equal to the acceleration of gravity  $g$  times the density gradient of a fluid divided by the product of the fluid's density and the square of its velocity gradient at a wall (Symbol  $N_R$ ).

**sabin**

dimensionless unit of acoustical absorption, equal to the equivalent sound absorption of one square foot of a surface of unit absorptivity (i.e., of 1 square foot of surface that absorbs all incident sound energy).

**Schmidt number**

dimensionless number consisting of the mass transfer coefficient times a characteristic length, divided by the mass diffusivity. Symbol  $Sc$ ,  $S_c$ , or  $N_{Sc}$ . See **Prandl number**.

**Sherwood number**

dimensionless number consisting of the mass-transfer coefficient times a characteristic length, divided by the mass diffusivity. Symbol  $Sh$ ,  $S_h$ , or  $N_{Sh}$ .

**Stanton number**

dimensionless number used in calculation of forced convection, equal to the heat-transfer coefficient of a fluid, divided by the product of the specific heat at constant pressure, the fluid density, and the fluid velocity. Symbol  $St$ ,  $S_t$ , or  $N_{St}$ . Also known as the **Margolis number M**.

**Strouhal number**

dimensionless number used in calculation of vibrations of a body past which a fluid is flowing; equal to a characteristic dimension of the body times the frequency of vibrations, divided by the fluid viscosity relative to the body. For a taut wire perpendicular to the fluid flow, with the characteristic dimension taken as the diameter of the wire, it has a value between 0.185 and 0.2. Symbol  $Str$  or  $S_r$ . Also known as reduced frequency.

**vapor concentration (absolute humidity; water-vapor density number)**

in a mixture of water vapor and dry air, the mass of water vapor in a specific volume of the mixture. Compare relative humidity.

**EFFECTS**

*Definition:* Effect is a state of being operative.

**barometric effect**

variations in barometric pressure caused by altitude or weather changes.

**chimney effect (stack effect)**

rising of air or gas in a duct or other vertical passage, as in buildings, induced when its density is lower than that of surrounding air or gas.

**Coanda effect**

characteristic of an airstream that causes it to cling to the surface along which it flows. The velocity of the airstream as it passes along the surface generates low pressures. This action causes surrounding air to be aspirated.

**compressor heating effect (heat pump)**

1. rate of heat delivery by the refrigerant assigned to the compressor in a heat pump system equal to the product of the mass rate of refrigerant flow produced by the compressor and the difference in specific enthalpies of the refrigerant vapor at thermodynamic state leaving the compressor and saturated liquid refrigerant at the pressure of the vapor leaving the compressor.
2. rate of heat delivery by the refrigerant assigned to the compressor in a heat pump.

**compressor refrigerating effect**

rate of heat removal by the refrigerant assigned to the compressor in a refrigerating system. This is equal to the product of the mass rate of refrigerant flow produced by the compressor and the difference in specific enthalpies of the refrigerant vapor at its thermodynamic state entering the compressor and refrigerant liquid at saturation temperature corresponding to the pressure of the vapor leaving the compressor.

**condenser heat rejection effect (condenser duty)**

amount of heat energy rejected to its surroundings by the condenser of a system.

**cooling effect****sensible cooling effect**

1. amount of sensible heat removed from air during cooling.
2. difference between total cooling effect and dehumidifying effect.

**total cooling effect**

1. difference between the total enthalpy of the dry air and the water-vapor mixture entering mixture and leaving the cooler.
2. amount of sensible and latent heat removed from the conditioned space.

**Coriolis effect**

1. deflection relative to the earth's surface of any object moving above the earth, caused by the Coriolis force. *Note:* An object moving horizontally is deflected to the right in the northern hemisphere, to the left in the southern.
2. the effect of the Coriolis force in any rotating system. Also called Coriolis deflection.

**dehumidifying effect**

mass of water condensed during cooling or the equivalent refrigerating capacity expressed in terms of the latent heat of the water condensed per unit of time.

**Doppler effect**

change in the observed frequency of an acoustic or electromagnetic wave due to relative motion of source and observer.

**acoustical Doppler effect**

change in pitch of a sound observed when there is relative motion between source and observer. *Note:* Results are different when the source moves relative to the listener who is fixed in the medium (atmosphere), compared with the listener moving relative to the source that is fixed.

**optical Doppler effect**

change in the observed frequency of light or other electromagnetic radiation caused by relative motion of the source and the observer. *Note:* The frequency change does not depend on whether it is the source or the observer that is moving.

**radar Doppler effect**

shift of a radar echo due to relative motion of target and radar source. *Note:* Doppler radar can differentiate between fixed and moving targets, and can measure target velocity.

**Hilsch-Ranque effect**

spot cooling effect produced in a tube into which gas is introduced tangentially producing vortex flow.

**humidifying effect**

product of the mass of water evaporated times the latent heat at the evaporating temperature.

**Josephson effect**

set of quantum-mechanical phenomena occurring when a current flows through an (electrically) weak link or junction connecting two superconductors, e.g., by tunneling through a dielectric barrier, or by flowing through a sufficiently narrow constriction in a superconducting material.

**Joule-Thomson effect**

ratio of temperature change to pressure change ( $dT/dp$ ) of an actual gas in a process of throttling or expansion without doing work or interchanging heat.

**Peltier effect**

evolution or absorption of heat produced by an electric current passing across junctions of two suitable dissimilar metals, alloys or semiconductors.

**refrigerating effect**

in a refrigeration system, the rate of heat removal.

**condensing unit refrigerating effect**

rate of heat removal by the refrigerant assigned to the condensing unit in a refrigerating system. This is equal to the product of the mass rate of refrigerant flow produced by the condensing unit and the difference in the specific enthalpies of the refrigerant vapor entering the unit at a specified superheat, and the refrigerant liquid leaving the unit at a specified subcooling.

**cooler refrigerating effect**

rate of heat absorption by a refrigerating medium flowing through a cooler (air, water, brine, etc.) at stated conditions. It is measured as the product of the mass flow rate of the refrigerating medium and the difference in specific enthalpies of the refrigerating medium entering and leaving the cooler.

**refrigerant heat rejection effect****condensing heat rejection effect**

portion of the total refrigerant heat rejecting effect of a condenser which is used for condensing the entering refrigerant vapor to a saturated liquid at the entering refrigerant pressure.

**subcooling heat rejection effect**

total refrigerant heat rejection effect less the condensing heat rejection effect.

**total refrigerant heat rejection effect** total useful capacity of a refrigerant condenser for removing heat from the refrigerant circulated through it.

**refrigerating effect**

rate of heat removal by the refrigerant.

**net refrigerating effect**

1. rate at which heat is removed by the primary refrigerant from the cooling medium (secondary coolant) that is used to transmit the refrigerating effect.
2. (brine cooler) product of the mass rate of water or brine flow and the difference in enthalpy of the entering and leaving water or brine expressed in heat units per unit of time. It is expressed also by the total refrigeration effect less the heat leakage losses.
3. (condensing unit capacity) rate at which heat is removed from outer media by a refrigerant in the low pressure side, or by the difference in total enthalpy between refrigerant liquid leaving the unit and the total enthalpy of the refrigerant vapor entering it.
4. (packaged air conditioners) rate at which heat is removed from the airstream, as measured entering the cooling coil and leaving the unit.

**subcooling refrigerating effect**

additional refrigeration effect made available by subcooling the refrigerant liquid in the condenser.

**system refrigerating effect**

rate of heat removal by the refrigerant in the evaporator of a refrigerating system.

**total refrigerating effect (water or brine cooler)**

product of the mass rate of refrigerant flow and the difference in enthalpy of the entering and leaving refrigerant fluid, expressed in heat units per unit of time.

**useful refrigerating effect**

rate at which heat is removed by the primary refrigerant, or by the secondary refrigerant, between two specified points, taking into account the conditions of use.

**Seebeck effect**

generation of an emf induced by a difference in temperature at the junctions of two dissimilar materials selected for their emf characteristics and temperature limits.

**sun effect (solar heat gain)**

solar energy flowing into a building, through both windows and structural materials.

**surface effect**

effect caused by entrainment of secondary air when an outlet discharges air directly against, or parallel to, a wall or ceiling.

**system effects**

conditions in a distribution system that affect fan and pump performance and related testing, adjusting, and balancing work.

**EFFICIENCY**

*Definition:* Efficiency is the ratio of the energy output to the energy input of a process or a machine. See also volumetric efficiency.

**adiabatic efficiency**

1. efficiency with which work is done with respect to heat gains or losses.
2. (indicated efficiency) ratio of the work absorbed in compressing a unit mass of refrigerant in a compressor to the work absorbed in compressing the same mass in an ideal compressor. See isentropic process.

**air-to-air energy recovery system efficiency**

ratio of the apparent heat recovered to the sum of the thermodynamically limited maximum possible in a counterflow heat exchanger of infinite heat-transfer area; plus all external energy inputs including, but not limited to, fan energy, auxiliary heaters, cross-leakage, and casing loss. *Note:* This ratio adjusts heat-exchanger effectiveness for auxiliary energy inputs of the energy recovery system.

**Carnot cycle efficiency**

conversion of heat to work, which is limited by the temperature at which conversion occurs as  $(T_1 - T_2)/T_1$ , where  $T_1$  is the higher absolute temperature where heat is absorbed and  $T_2$  is the lower absolute temperature where heat is rejected.

**compression efficiency**

ratio of work required to compress, adiabatically and reversibly, all the vapor delivered by a compressor (per stage) to the actual work delivered to the vapor by the piston or blades of the compressor.

**effective efficiency**

1. overall efficiency.
2. ratio of the work absorbed in conveying and compressing a unit mass of refrigerant in a perfect compressor and the work absorbed, per unit mass of refrigerant, by the shaft of an actual compressor.

**filter separation efficiency**

ratio of the mass of particles extracted to the mass of particles contained in the air before filtering.

**fin efficiency**

ratio of heat actually transferred by a fin to heat transferred if the whole fin were at the temperature of the primary surface to which it is attached.

**mechanical efficiency**

ratio of the compression energy or work of a compressor to the energy or work input.

**operating efficiency**

ratio of output to input.

**overall system efficiency**

ratio of the useful energy at the point of use to the thermal energy input over a designated time period.

**total-to-static efficiency (static efficiency)**

in a turbocompressor, the ratio of the variation of enthalpy of an isentropically compressed vapor to the work to be effectively supplied to the compressor (the enthalpy relating to the total pressure of the fluid at inlet and the static pressure at outlet).

**total-to-total efficiency (stagnation efficiency)**

in a turbocompressor, the ratio of the variation of enthalpy of the vapor isentropically compressed from the total pressure at inlet to the total pressure at outlet, to the work effectively supplied to the compressor.

**volumetric efficiency**

ratio of volume induced, at suction conditions, by a compressor in a given time to the swept volume as measured over the same time.

**apparent volumetric efficiency**

on an indicator card, the ratio of suction line length to stroke.

**volumetric efficiency (due to cylinder heating)**

ratio of the total to the apparent volumetric efficiency. Also called real or no-clearance volumetric efficiency.

**volumetric total efficiency**

ratio of the actual volume of gas moved by the compressor or pump to actual displacement of the compressor or pump.

**EQUATIONS**

*Definition:* An equation is a statement that each of two mathematical expressions is equal to the other.

**Colburn heat transfer equation**

dimensionless heat transfer equation used in calculating natural convection movement of heat from vertical surfaces or horizontal cylinders to fluids (gases or liquids) flowing past these surfaces. The symbol is  $j_H$ .

**Colburn mass transfer equation**

dimensionless mass transfer equation consisting of the Sherwood number divided by the Reynolds number and the Schmidt number to the 1/3 power. The symbol is  $j_D$ .

**FACTORS**

*Definition:* A factor is a quantity by which a given quantity is multiplied or divided in order to indicate a difference in measurement.

**air transport factor**

ratio of the rate of useful, sensible heat removal from the conditioned space to the energy input to the supply and return fan motor(s), expressed in consistent units and within designated operating conditions.

**ballast factor**

ratio of commercial electric ballast lamp lumens to a reference ballast lamp lumens, used to correct the lamp lumen output from rated to actual.

**C-factor (thermal conductance)**

time rate of steady-state heat flow through a unit area of a material or construction induced by a unit temperature difference between the body surfaces.  $C = q/_T$ .

**capacity factor (of a machine, equipment, or thermal storage)**

ratio of the average load required, in the period of time considered, to the capacity in mass, volume, or energy terms. Reciprocal of storage factor.

**cooling load factor (CLF)**

ratio of the total cooling of a complete cycle for a specified period consisting of an ON time and OFF time to the steady-state cooling done over the same period at constant ambient conditions.

**demand factor (electric)**

ratio of the maximum electric demand to the connected load, usually monthly or annually. See also electric power load factor.

**diversity factor**

ratio, or percentage, obtained when the total output capacity of a system is divided by the total output capacity of all the terminal devices connected to the systems.

*Example:* To express the ratio of VAV supply air fan capacity to the total capacity of the VAV terminal devices as a percentage.

**electric power factor (PF)**

1. ratio of real power (kW) to apparent power (kVA) at any given point and time in an electrical circuit. Generally expressed as a percentage.
2. factor equal to the cosine of the phase angle between voltage and current, by which the product of voltage and current is multiplied to convert volt-amperes to power in watts.

**electric power load factor**

ratio of average load in kilowatts supplied during a designated period to the peak or maximum load in kilowatts occurring in that period.

**energy factor**

measure of overall efficiency in terms of energy output compared to energy consumption over a 24-hour usage cycle.

**factor of safety**

ratio of a normal working condition to the ultimate condition, such as, in strength of materials, ratio of working stress to ultimate strength.

**friction factor**

1. any of several dimensionless numbers used in studying fluid friction in pipes, equal to the Fanning friction factor times some dimensionless constant.
2. coefficient used to calculate friction forces due to fluid flow.
3. quotient of the tangential force exerted by a fluid on a surface (per unit area) by half the product of the density and the square of the velocity.

**Fanning friction factor**

dimensionless number  $f$  used in studying fluid friction in pipes, equal to the pipe diameter times the drop in pressure in the fluid due to friction as it passes through the pipe, divided by the product of the pipe length and the kinetic energy of the fluid per unit volume.

**heating load factor (HLF)**

ratio of the total heating of a complete cycle for a specified period consisting of an ON time and OFF time to the steady-state heating done over the same period at constant ambient conditions.

**heating seasonal performance factor (HSPF)**

ratio of the total heat delivered over the heating season (not to exceed 12 months) to the total energy input over the heating season, in consistent units.

**heat loss coefficient**

rate at which heat is lost from a storage device per degree temperature difference between the average storage medium temperature and the average ambient air temperature (or ground temperature, if the storage device is buried).

**k-factor (thermal conductivity)**

time rate of steady-state heat flow through a unit area of a homogeneous material induced by a unit temperature gradient in a direction perpendicular to that unit area. Units are Btu in/h·ft<sup>2</sup>·°F, Btu/h·ft·°F, or W/(m·K).

**load factor**

ratio of actual mean load to a maximum load or maximum production capacity in a given period. See electric power load factor; cooling load factor; heating load factor.

**performance factor**

ratio of the useful output capacity of a system to the input required to obtain it. Units of capacity and input need not be the same. See coefficient of performance.

**refrigerating system performance factor**

ratio of the useful refrigerating effect of the system to the power input.

**roughness factor**

ratio of size of projections from the surface of a pipe or duct, to the diameter of the pipe or duct.

**storage factor**

1. reciprocal of capacity factor.
2. ratio of the volume occupied by the quantity of a particular product stored to the maximum that can be stored, taking into account the requirements of that particular product.

**U-factor (thermal transmittance)**

heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environment on each side. *Note:* This heat transmission rate has been called the overall coefficient of heat transfer.

**W-factor**

U-factor converted into electrical terms for calculations in electric heating. The amount of heat flow expressed in watts per square foot per degree Fahrenheit temperature difference between air on the inside and air on the outside of the building section (wall, floor, roof, or ceiling). For conversion,  $W = 0.293 U$ , where  $U$  is in Btu/h·ft<sup>2</sup>·°F.

**INDEXES**

*Definition:* An index is a numerical quantity, usually dimensionless, denoting the magnitude of some physical effect, such as the refractive index.

**air diffusion performance index (ADPI)**

single number rating of the air diffusion performance of a system of diffusers, as installed, at a specified air delivery rate and space load.

**comfort index**

index combining the properties of an environment for evaluating the sensation of comfort of occupants; equal to 15 plus 0.4 times the sum of the dry-bulb and wet-bulb temperatures in degrees Fahrenheit. See also thermal comfort.

**dust-spot opacity index**

number which expresses the relative dust accumulation on a dust-spot sampling target, corrected for the nonlinearity of opacity increase, at constant dust-accumulation rate.

**freshness index (sensory index)**

(usually a 9-point) scale of subjective assessment of the purity of air by occupants.  
**opacity index** see dust-spot opacity index.

**temperature index**

see temperature index coefficient of thermal performance.

**viscosity index (VI)**

1. empirical number evaluated by comparing the viscosity of a substance with that of a standard substance.
2. characteristic of lubricating oil that indicates the change in viscosity with temperature; i.e., a high VI oil has less change in viscosity with temperature change, than a lower VI oil.

**Wobbe index**

number which indicates interchangeability of fuel gases, obtained by dividing the heating value of a gas by the square root of its specific gravity.

**RATIOS**

*Definition:* A ratio of two quantities or mathematical objects A and B is their quotient or fraction A/B.

**air-gas ratio**

ratio of the air volume to the gas volume. A specified ratio is necessary to achieve a desired character of combustion.

**air-mass ratio**

ratio of the mass of atmosphere in the actual earth-sun path to the mass which would exist at sea level if the sun were directly overhead.

**air-to-air energy recovery effectiveness**

ratio of actual heat transfer to the thermodynamically limited maximum heat transfer possible in a counterflow exchanger of infinite transfer area. *Note:* Effectiveness may be stated as total, sensible, or latent when the ratio defined above uses these heats as the actual and maximum possible heat-transfer quantities. Compare air-to-air energy recovery with system efficiency.

**aspect ratio**

1. in any rectangular configuration, the ratio of the longer dimension to the shorter.
2. ratio of the length to width of a rectangular air duct.

**blast area ratio**

blast area divided by the fan outlet area.

**compression ratio**

ratio of the absolute pressure after compression to the absolute pressure before compression.

**compression volume ratio**

ratio of volume of compression chamber at intake of gas to volume at discharge in positive displacement compressors.

**compressor volume ratio**

ratio of volume of compression chamber at intake of refrigerant gases to the volume at discharge in positive displacement compressors.

**concentration ratio**

1. ratio of the quantity of one constituent to the total mixture.
2. process in which the proportion of a substance is increased.

**cooling efficiency ratio (CER)**

ratio calculated by dividing the total cooling capacity in Btu/h by the total power input in watts (excluding heaters and humidifiers) at any given set of rating conditions, expressed in Btu/h per watt.

**standard cooling efficiency ratio (SCER)**

ratio calculated from the capacity and power input values obtained at standard rating conditions.

**desiccation ratio**

in freeze-drying, ratio of the mass of the substance resulting from a freeze-drying process to the mass of the original product. **dryness ratio** in freeze-drying, ratio of the mass of dry matter to the mass of frozen substance. See lyophilization.

**effectiveness ratio (of a heat exchanger)**

ratio of the actual heat transfer to the thermodynamically limited maximum heat transfer possible in a counterflow exchanger of infinite transfer area.

**efficiency (ratio)**

ratio of the energy output to the energy input of a process or a machine. See also volumetric efficiency.

**energy efficiency ratio (EER)**

ratio of net cooling capacity in Btu/h to the total rate of electric input in watts, under designated operating conditions. See also coefficient of performance (COP).

**energy transmittance ratio (transmission factor; transmittivity)**

ratio of the energy flow rate traversing a body to the energy flow rate it receives by radiation. See thermal transmittance.

**entropy (ratio)**

ratio of the heat absorbed by a substance to the absolute temperature at which it was added.

**specific entropy**

entropy per unit mass of a substance.

**induction ratio (entrainment ratio in air diffusion)**

ratio of total (primary plus secondary) air to primary air.

**load diversity (ratio)**

in a thermal storage system, the ratio of average daily load to maximum capacity. A 100 kW chiller meeting an average load of 75 kW would have a diversity of 0.75.

**mass diffusivity (ratio) (diffusion coefficient)**

ratio of the mass flow of a substance diffusing through a surface of unit area to the rate of variation in the concentration of this substance normal to this surface.

**seasonal energy efficiency ratio, cooling (SEER)**

total cooling output of an air conditioner during its normal annual usage period for cooling, in Btu/h, divided by the total electric energy input during the same period, in watt-hours.

**sensible heat ratio**

ratio of the sensible heat to the sensible plus latent heat to be removed from a conditioned space.

**sensitivity (ratio)**

in instrumentation, ratio of a change in output magnitude to the change of input that causes it, after the steady state has been reached.

**specific infiltration (ratio)**

ratio of infiltration to leakage area; a normalized quantity that indicates the intensity of the weather relative to infiltration.

**vane ratio**

in air-distributing devices, the ratio of the depth of vane to shortest opening width between two adjacent bars in a grille.

**vapor content (ratio)**

ratio of the amount of vapor present compared to the amount present at saturated conditions.