

DEFINITIONS

absolute encoder An electronic or electromechanical device which produces a unique digital output (in coded form) for each value of an analogue or digital input; in an *absolute position encoder*, for instance, the position following any incremental movement can be determined directly, without reference to the starting position.

absolute humidity The weight of water vapour in a gas-water vapour mixture per unit volume of space occupied.

absolute measurement A measured value expressed in terms of fundamental standards of distance, mass and time.

absolute pressure The pressure measured relative to zero pressure (vacuum).

absolute stability A linear system is absolutely stable if there exists a limiting value of the Open loop gain such that the system is stable for all lower values of that gain and unstable for all higher values.

absolute value error The magnitude of the error disregarding the algebraic sign or, if a vector error, disregarding its direction.

absolute viscosity A measure of the internal shear properties of fluids expressed as the tangential force per unit area at either of two horizontal planes separated by one unit thickness of a given fluid, one of the planes being fixed and the other moving with unit velocity.

absorbance An optical property expressed as $\log (S/T)$, where T is the transmittance.

absorptance The fraction of the incident light absorbed.

absorption-emission pyrometer An instrument for determining gas temperature by measuring the radiation emitted by a calibrated reference source both before and after the radiation passes through the gas, where it is partly absorbed.

absolute pressure The pressure measured relative to zero pressure (vacuum).

absorption tower A vertical tube in which a gas rising through a falling stream of liquid droplets is partially absorbed by the liquid.

accelerometer A transducer used to measure linear or angular acceleration.

access time The interval between a request for stored information and the delivery of the information; often used as a reference to the speed of memory.

accuracy The ratio of the error to the full-scale output or the ratio of the error to the output, as specified, expressed in percent.

acidity Represents the amount of free carbon dioxide mineral acids and salts which hydrolyse to give hydrogen ions in water. pH is the measure of hydrogen ions concentration.

ACK Transmission control character transmitted by a receiving device as an affirmative response to a sending device.

acoustical ohm The unit of measure for acoustic resistance, reactance or impedance; it equals unity when a sound pressure of one microbar produces a volume velocity of one cubic centimetre per second.

acoustic compliance The reciprocal of *acoustic stiffness*.

acoustic dispersion Separation of a complex sound wave into its various frequency components, usually due to variation of wave velocity in the medium with sound frequency; usually expressed in terms of the rate of change of velocity with frequency.

acoustic impedance The complex quotient obtained by dividing sound pressure on a surface by the flux through the surface.

acoustic inertance A property related to the kinetic energy of a sound medium which equals $Z_a/2\pi f$, where Z_a is the acoustic reactance and f is sound frequency; the usual units of measure are g/cm⁴. Also known as "acoustic mass."

acoustic radiometer An instrument that measures sound intensity by determining unidirectional steady state pressure when the sound wave is reflected or absorbed at a boundary.

acoustic sensitivity The output of a transducer (not due to rigid body motion) in response to a specified acoustical environment. This is sometimes expressed as the acceleration in g rms sufficient to produce the same output as induced by a specified sound pressure level spectrum having an overall value of 140 dB referred to 0.0002 dyne per sq cm rms.

acoustic stiffness A property related to the potential energy of a medium or its boundaries which equals, where Z_a is the acoustic reactance and f is sound frequency; the usual units of measure are dyne/cm.

actuator A device responsible for actuating a mechanical device such as a control valve.

actuator, double acting An actuator in which the power supply acts both to extend and retract the actuator stem.

actuator, electric type A device which converts electrical energy into motion.

actuator, electrohydraulic type A self-contained device which responds to an electrical signal, positioning an electrically operated hydraulic pilot valve to allow pressurised hydraulic fluid to move an actuating piston, bellows, diaphragm or fluid motor.

actuator, electromechanical type A device which uses an electrically operated motor-driven gear train or screw to position the actuator stem. May operate in response to either analogue or digital electrical signals

actuator, fluid motor type A fluid powered device which uses a rotary motor to the actuator stem **actuator, hydraulic type** A fluid device which converts the energy of an incompressible fluid into motion

actuator, piston type A fluid powered device in which the fluid acts upon a movable cylindrical member, piston, to provide linear motion to the actuator stem

actuator, pneumatic A device which converts the energy of a compressible fluid, usually air, into motion.

actuator, single acting An actuator in which the power supply acts in only one direction. In a spring and diaphragm actuator, for example, the spring acts in a direction opposite to the diaphragm thrust.

actuator, vane type A fluid-powered device in which the fluid acts upon a movable pivoted member, the vane, to provide rotary motion to the actuator stem.

ADA A Pascal based, real time systems programming language developed for the United States Department of Defence.

adaptive control A control system which adjusts its response to its inputs based on its previous experience.

adaptive gain control A control technique which changes a feedback controller's gain based on measured process variables or controller set points.

adaptive tuning In a control system, a way to change control parameters according to current process conditions.

adiabatic Referring to a process which takes place without any exchange of heat between the process system and another system or its surroundings.

adsorption The concentration of molecules of one or more specific elements or compounds at a phase boundary, usually at a solid surface bounding a liquid or gaseous medium containing the specific element or compound.

agglomeration Any process for converting a mass of relatively fine solid material into a mass of larger lumps.

air bubbler liquid level detector A device for indirectly measuring the level of liquid in a vessel especially a corrosive liquid, viscous liquid or liquid containing suspended solids; it consists of a standpipe open at the bottom and closed at the top, which is connected to an air supply whose pressure is maintained slightly above maximum head of liquid in the vessel; air bubbles out of the bottom of the pipe, maintaining the internal pressure equal to the head of liquid in the vessel, pressure being measured by a simple gauge or transducer.

algorithm A prescribed set of well defined rules or processes for the solution of a problem in a finite number of steps

alias When varying signals are sampled at equally spaced intervals, two frequencies are considered to be aliases of one another if they cannot be distinguished from each other by an analysis of their equally spaced values.

aliasing False signals in the frequency domain caused by a measuring rate for digitising that is too slow.

alkalinity Represents the amount of carbonates, bicarbonates, hydroxides and silicates or phosphates in the water and is reported as grains per gallon, or ppm, as calcium carbonate.

ambient A surrounding or prevailing condition, especially one that is not affected by a body or process contained in it.

ambient air 1. Air to which the sensing element is normally exposed. 2. The air that surrounds the equipment. The standard ambient air for performance calculations is air at 80°F, 60% relative humidity, and a barometric pressure of 29.921 in. Hg, giving a specific humidity of 0.013 lb of water vapour per lb of air.

ambient conditions The conditions (pressure, temperature, etc..) of the medium surrounding a given device or equipment.

analogue Pertaining to data in the form of continuously variable physical quantities. Contrast with digital. A waveform is analogue if it is continuous and varies over an arbitrary range.

analogue back up An alternate method of process control by conventional analogue instrumentation in the event of a failure in the computer system.

analogue control Implementation of automatic control loops with analogue (pneumatic or electronic) equipment.

analogue signal An analogue signal is a continuously variable representation of a physical quantity, property, or condition such as pressure, flow, temperature, etc.

analogue simulation The calculation of the time or frequency domain response of electrical circuits to input stimulus. It assembles and solves a set of simultaneous equations associated with circuit topology.

angle of repose A characteristic of bulk solids equal to the maximum angle with the horizontal at which an object on an inclined plane will retain its position without tending to slide; the tangent of the angle of repose equals the coefficient of static friction.

angle valve A valve design in which one port is colinear with the valve stem or actuator, and the other port is at right angles to the valve stem.

angstrom A unit of length defined as $1/643\,84696$ of the wavelength of the red line in the Cd spectrum; largely replaced by the SI unit nanometer, or 10^{-9} meters.

angular momentum The product of a body's moment of inertia and its angular velocity.

angular momentum flowmeter A device for determining mass flow rate in which an impeller turning at constant speed imparts angular momentum to a stream of fluid passing through the meter; a restrained turbine located just downstream of the impeller removes the angular momentum, and the reaction torque is taken as the meter output. Also called an "axial flowmeter."

angular velocity Rate of motion along a circular path, measured in terms of angle traversed per unit time.

anhydrous Describing a chemical or other solid substance whose water of crystallisation has been removed.

anisotropic Exhibiting different properties when characteristics are measured along different directions or axes.

annealing Treating metals, alloys or glass by heating and controlled slow cooling, primarily to soften them and remove residual internal stress.

annular nozzle A nozzle whose inlet opening is ring shaped rather than an open circle.

annunciator A device or group of devices that call attention to changes in process conditions that have occurred. Usually included are sequence logic circuits, labeled visual displays, audible devices, and manually operated acknowledge and reset push buttons.

antialias filter A low-pass filter designed to block frequencies greater than one-half the measuring rate.

anti cavitation trim A combination of plug and seat ring or plug and cage that by its geometry permits noncavitating operation or reduces the tendency to cavitate, thereby minimising damage to the valve parts, and the downstream piping.

anti noise trim A combination of plug and seat ring or plug and cage that by its geometry reduces the noise generated by fluid flowing through the valve.

anti reset windup Device or circuit that prevents the saturation of the integral mode of a controller that develops during times when control cannot be achieved. Helps to prevent the controlled variable from overshooting its set point when the obstacle to control is removed.

anti surge control Control by which the unstable operating mode of compressors known as "surge" is avoided.

aperiodically damped Reaching a constant value or steady state of change without introducing oscillation.

apparent density The density of loose or compacted particulate matter determined by dividing actual weight by volume occupied; apparent density is always less than true density of a material comprising the particulate matter because volume occupied includes the space devoted to pores or cavities between particles.

armoured meter tube Variable area meter tube (rotameter) of all metal construction utilising magnetic coupling between the float and an external follower.

as built A document revision that includes all modifications performed as a result of actual fabrication or installation.

ASCII A widely used code (American Standard Code for Information Interchange) in which alphanumerics, punctuation marks, and certain special machine characters are represented by unique, 7 bit, binary numbers; 128 different binary combinations are possible ($2^7 = 128$), thus 128 characters may be represented.

ASCII file A text file that uses only the ASCII character set.

ASIC Application Specific Integrated Circuit.

aspirating burner A burner in which the fuel in a gaseous or finely divided form is burned in suspension, the air for combustion being supplied by bringing into contact with the fuel, air drawn through one or more openings by the lower static pressure created by the velocity of the fuel stream.

aspiration Using a vacuum to draw up gas or granular material, often by passing a stream of water across the end of an open tube, or through the run of a tee joint, where the open tube or branch pipe extends into a reservoir containing the gas or granular material.

asynchronous Circuitry or operation without common clock or timing signals.

asynchronous communication Often called start/stop transmission, a way of transmitting data in which each character is preceded by a start bit and followed by a stop bit.

asynchronous transmission Transmission in which information character, or sometimes each word or small block, is individually synchronised, usually by the use of start and stop elements. The gap between each character (or word) is not of a necessarily fixed length.

atmospheric pressure The barometric reading of pressure exerted by the atmosphere. At sea level 14.7 lb per sq in. or 29.92 in. of mercury.

atomic mass unit A unit for expressing atomic weights and other small masses; it equals, exactly, 1/12 the mass of the carbon 12 nuclide.

atomic number An integer that designates the position of an element in the periodic table of the elements; it equals the number of protons in the nucleus and the number of electrons in the electrically neutral atom.

atomic weight The weight of a single atom of any given chemical element; it is usually taken as the weighted average of the weights of the naturally occurring nuclides, expressed in atomic mass units.

attenuation Regulating the temperature of a substance eg passing superheated steam through a heat exchanger or injecting water mist into it to regulate final steam temperature.

attenuation The reciprocal of gain, when the gain is less than one. It may be expressed as a "dimensionless ratio," "scalar ratio," or in decibels as "20 times the log 10 of that ratio".

audio Pertaining to audible sound-usually taken as sound frequencies in the range

20 to 20,000 Hz.

austenitic stainless steel An alloy of iron containing at least 12% Cr plus sufficient Ni (or in some specialty stainless steels, Mn) to stabilise the face centred cubic crystal structure of iron at room temperature.

auto-tuning Controller feature that calculates PID settings based on calculations using measured process dynamics and combining those with the parameters of a PID controller. Calculations may be based on transient responses, frequency responses or parametric models.

autoclave An airtight vessel for heating its contents and sometimes agitating them; it usually uses high pressure steam to perform processing, sterilising or cooking steps using moist or dry heat.

autoignition temperature (AFT) The minimum uniform temperature required to initiate or cause self sustained combustion of solid, liquid, or gaseous substance independent of any other ignition source.

autotransformer A type of transformer in which portions of the windings are shared by the primary and secondary circuits.

availability The number of hours in the reporting period less the total downtime for the reporting period divided by the number of hours in the reporting period (expressed in percent).

available energy Energy that theoretically can be converted to mechanical power.

available heat In a thermodynamic working fluid, the amount of heat that could be transformed into mechanical work under ideal conditions by reducing the temperature of the working fluid to the lowest temperature available for heat discard.

available power An attribute of a linear source of electric power defined as $V_{rms}/4R$, where V_{rms} is the open circuit rms voltage of the power source and R is the resistive component of the internal impedance of the power source.

available power gain An attribute of a linear transducer defined as the ratio of power available from the output terminals of the transducer to the power available from the input circuit under specified conditions of input termination.

available work The capacity of a fluid or body to do work if applied to an ideal engine.

average position action A type of control system action in which the final control element is positioned in either of two fixed positions, the average time at each position being determined from some function of the measured value of the controlled variable.

averaging pitot tube An adaptation of the pitot tube in which a multiple ported pitot tube spans the process tube; total pressure is measured as a composite of the pressures on several ports facing upstream while static pressure is measured using one or more ports facing downstream.

axial fan Consists of a propeller or disc type of wheel within a cylinder discharging the air parallel to the axis of the wheel.

axial flow Describing a machine such as a pump or compressor in which the general direction of fluid flow is parallel to the axis of its rotating shaft.

azeotrope A mixture whose evolved vapour composition is the same as the liquid it comes from. This phenomenon occurs at one fixed composition for a given system. At either side of the *azeotropic point*, the vapours will have different compositions from that of the liquid they evolved from. Such mixtures act as pure substances in distillation and thus are inseparable by standard distillation methods. *Azeotropic distillation* is necessary to separate such a mixture.

azeotropic distillation A distillation technique in which one of the product streams is an azeotrope. It is sometimes used to separate two components by adding a third, which forms an azeotrope with one of the original two components.

back pressure The absolute pressure level as measured four pipe diameters downstream from the turbine flowmeter under operating conditions, expressed in pascals

baffle A plate or vane, plain or perforated, used to regulate or direct the flow of fluid.

balanced trim An arrangement of ports and plug or combination of plug, cage, seals and ports that tends to equalise the pressure above and below the valve plug to minimise the net static and dynamic fluid flow forces acting along the axis of the stem of a globe valve.

balanced draft A system of furnace pressure control in which the inlet air flow or the outlet flue gas flow is controlled to maintain the furnace pressure at a fixed value (typically slightly below atmospheric).

ball check valve A valve that permits flow in one direction only by lifting a spring loaded ball off its seat when a pressure differential acts in that direction and by forcing the ball more tightly against the seat when a pressure differential acts in the opposite flow direction.

ball type viscometer An apparatus for determining viscosity, especially of high viscosity oils and other fluids, in which the time required for a ball to fall through liquid confined in a tube is measured.

ball valve A valve which modifies flow rates with rotary motion of the closure member, which is either a sphere with an internal passage or a segment of a spherical surface.

bandwidth The difference, expressed in hertz, between the two boundaries of a frequency range.

bang-bang control The same as "two-position control."

Barkometer scale A specific gravity scale used primarily in the tanning industry, in which specific gravity of a water solution is determined from the formula: $sp\ gr = 1.000 + 0.001n$ where n is degrees Barkometer; on this scale, water has a specific gravity of zero Barkometer.

barometric pressure Atmospheric pressure as determined by a barometer usually expressed in inches of mercury.

barrel A unit of volume; for petroleum, it equals 9702 cubic inches

barrier Physical entity that limits current and voltage into a hazardous area in order to satisfy Intrinsic Safety requirements.

base 1. The fundamental number of characters available for use in each digital position in a numbering system. 2. A chemical substance that hydrolyses to yield OH^- ions. 3. A number that is multiplied by itself as many times as indicated by an exponent.

baseband Communications signals whose bandwidth is approximately equal to the highest frequency transmitted. Compare with modulated signals (RF) where the frequencies transmitted (at the modulated carrier frequency) are much higher than the bandwidth.

base load The term applied to that portion of a station or boiler load that is practically constant for long periods.

basis weight For paper and certain other sheet products, the weight per unit area.

batch 1. The quantity of material required for or produced by a production operation at a single time. 2. An amount of material that undergoes some unit chemical process or physical mixing operation to make the final product homogeneous or uniform. 3. A group of similar computer transactions joined together for processing as a single unit.

batch control (control, batch) Control system that controls a batch process, that is, a process that due to physical structuring of the process equipment or other factors, consists of a sequence of one or more steps or phases that must be performed in a defined order.

batch distillation A distillation process in which a fixed amount of a mixture is charged, followed by an increase in temperature to boil off the volatile components. This process differs from continuous distillation, in which the feed is charged continuously.

batch process A process that manufactures a finite quantity of material by subjecting measured quantities of raw materials to a time sequential order of processing actions using one or more pieces of equipment.

batch processing The technique of executing a set of programs such that each is completed before the next program of the set is started.

baud The measure of the rate at which digital data is transmitted, in bits per second.

Baume scale Either of two specific gravity scales devised by French chemist Antoine Baume in 1768 and often used to express the specific gravity of acids, syrups and other liquids; for light liquids the scale is determined from the formula: $^{\circ}\text{Be} = (140/\text{sp. gr.}) - 130$. For heavy liquids it is determined from: $^{\circ}\text{Be} = 145 (145/\text{sp. gr.})$. 60°F is the standard temperature used.

Bernoulli coefficient In any stream, if the area is changed, as by a reducer, there is a change in the velocity and a corresponding change in the static pressure, or "head. " This pressure change is measured in units of velocity head. The dimensionless coefficient used for this purpose is the Bernoulli coefficient.

bessel The filter characteristic in which phase linearity across the pass band, rather than amplitude linearity, is emphasised; known also as "constant delay."

best straight line A line midway between the two parallel straight lines closest together and enclosing all output vs. measurand values on a calibration curve.

bimetallic thermometer element A temperature sensitive strip of metal (or other configuration) made by bonding or mechanically joining two dissimilar strips of metal together in such a manner that small changes in temperature will cause the composite assembly to distort elastically, and produce a predictable deflection; the element is designed to take advantage of the fact that different metals have different coefficients of thermal expansion.

binary A term applied to a signal or device that has only two discrete positions or states.

binary code A code that uses two distinct characters, usually 0 and 1.

binary coded decimal (BCD) Describing a decimal notation in which the individual decimal digits are represented by a group of binary bits, e.g., in the 8 4 2 1 coded decimal notation each decimal digit is represented by a group of four binary bits.

binary distillation A distillation process that separates only two components.

Bingham body A non Newtonian substance that exhibits true plastic behavior that is, it flows when subjected to a continually increasing shear stress only after a definite yield point has been exceeded. **biphase** A method of bit encoding for serial data transmission or recording whereby there is a signal transition every bit period.

bit An abbreviation of binary digit

bit error rate The ratio of bits received in error to bits sent.

bit error rate tester (BERT) A system which measures the fraction of bits transmitted incorrectly by a digital communication system.

bits per second In a serial transmission, the instantaneous bit speed within one character, as transmitted by a machine or a channel. See "baud. "

bituminous Describing a substance that contains organic matter, mostly in the form of tarry hydrocarbons.

black liquor The solution remaining after cooking pulpwood in the soda or sulfite papermaking process.

blade type consistency sensor A pneumatic device for determining changes in consistency of a flowing non Newtonian substance such as a slurry; it senses the force required for a shaped blade to shear through the flowing stock, and transmits an output signal proportional to changes in consistency; its normal operating range is 1.75 to 6.0% suspended solids, with a sensitivity of 0.02% in many

blowdown 1. In a safety valve, the difference between opening and closing pressures. 2. In a steam boiler, the practice of periodically opening valves attached to the bottom of steam drums and water drums, during boiler operation, to drain off accumulations of sediment.

Bode diagram In process instrumentation, a plot of log gain (magnitude ratio) and phase angle values on a log frequency base for a transfer function.

body The part of the valve which is the main pressure boundary. The body also provides the pipe connecting ends, the fluid flow passageway, and may support the seating surfaces and the valve closure member .

body, split A valve body design in which trim is secured between two segments of a valve body.

body, wafer A thin annular section body whose end surfaces are located and clamped between the piping flanges by bolts extending from flange to flange.

body, wafer, lugged A thin annular section body whose end surfaces mount between the pipeline flanges, or may be attached to the end of a pipeline without any additional flange or retaining parts, using either through bolting and/or tapped holes.

body, weir type A body having a raised contour contacted by a diaphragm to shut off fluid flow.

boiler drum level Watertube boiler process variable that is measured and controlled by adding feedwater. Control may be single element, two-element or three-element control. Control strategy will depend on user requirements and the boiler design. Measured variables may include drum level, steam flow, feedwater flow, blowdown flow, drum pressure and feedwater pressure.

boilup Vapours that are generated in the column reboiler.

bomb calorimeter An apparatus for measuring the quantity of heat released by a chemical reaction; it consists of a strong walled metal container (bomb) immersed in about 2.5 liters of water in an insulated container; a sample is sealed in the bomb, the bomb immersed, the reaction started by remote control, and the heat released measured by observing the rise in temperature of the water bath.

bone dry A papermaking term used to describe pulp fibers or paper from which all water has been removed. Also known as "oven dry"; is moisture free."

bonnet That portion of the valve pressure retaining boundary which may guide the stem and contains the packing box and stem seal. It may also provide the principal opening to the body cavity for assembly of internal parts or be an integral part of the valve body. It may also provide the attachment of the actuator to the valve body

Boolean algebra A process of reasoning, or a deductive system of theorems using a symbolic logic, and dealing with classes, propositions, or on offcircuit elements. It employs symbols to represent operators such as and, or, not, except, if, then, etc., to permit mathematical calculation. Named after English mathematician George Boole.

booster relay A volume or pressure amplifying pneumatic relay that is used to reduce the time lag in pneumatic circuits by reproducing pneumatic signals with high volume and/or high pressure outputs.

bottoms The higher boiling product streams usually taken from the bottom of a distillation column sometimes from the reboiler and sometimes from a separate surge vessel.

boundary layer In a flowing fluid, a low velocity region along a tube wall or other boundary surface.

bound water In a moist solid to be dried, that portion of the water content which is chemically combined with the solid matter.

Bourdon tube A pressure sensing element consisting of a twisted or curved tube of noncircular cross section which tends to be straightened by the application of internal pressure. Also known as "Bourdon element" when used in a "Bourdon pressure gauge."

Brix scale A specific gravity scale used in sugar refining; the degrees Brix represent the weight percent pure sucrose in water solution at 17.5°C.

broadband A communication medium based on CATV technology where multiple signals are frequency division multiplexed.

broadband pyrometer See "wideband radiation thermometer."

broadcast A message addressed to all stations connected to a LAN.

Buna N A nitrile synthetic rubber known for resistance to oils and solvents.

buoyancy The tendency of a fluid to lift any object submerged in the body of the fluid; the amount of force applied to the body equals the product of fluid density and volume of fluid displaced.

buoyancy displacer The technique of measuring liquid level by measuring the buoyant force on a partially immersed volumetric displacing device (displacer).

burn-in Device operation, usually under accelerated environmental conditions that simulate life in the devices' intended application, used to detect early-life (infantile) failures.

bus A group of wires or conductors, considered as a single entity, which interconnects part of a system.

butterfly valve A valve consisting of a disc inside a valve body which operates by rotating about an axis in the plane of the disc to shut off or regulate flow; a similar device used in heating or ventilating ductwork is called a butterfly damper.

Butterworth The filter characteristic in which constant amplitude across the pass band is the objective; known also as "constant amplitude (CA)."

byte A sequence of adjacent binary digits (bits) operated upon as a unit and usually shorter than a word, commonly an eight bit segment of a computer word. A byte can be used to store one ASCII character.

Cage A part in a globe valve surrounding the closure member to provide alignment and facilitate assembly of other parts of the valve trim. The cage may also provide flow characterisation and/or a seating surface for globe valves and flow characterisation for some plug valves

cage guide A valve plug fitted to the inside diameter of the cage to align the plug with the seat.

calibration curve A plot of indicated value versus true value used to adjust instrument readings for inherent error; a calibration curve is usually determined for each calibrated instrument in a standard procedure and its validity confirmed or a new calibration curve determined by periodically repeating the procedure.

calibration gas A gas with known concentrations of components that is used as a standard for calibration of analysers or gas detector alarm level(s).

calibration traceability The relationship of the calibration of an instrument through a step by step process to an instrument or group of instruments calibrated and certified by a national standardising laboratory.

calibration uncertainty The maximum calculated error in the output values, shown in a calibration record, due to causes not attributable to the transducer.

Calorie The mean calorie is 1/100 of the heat required to raise the temperature of 1 gram of water from 0°C to 100°C at a constant atmospheric pressure. Also defined as 3600/860 *joules*, a *joule* being the amount of heat produced by a *watt* in one second.

calorific value The number of heat units liberated per unit of quantity of a fuel burned in a calorimeter under prescribed conditions.

Calorimeter 1. A device for determining the amount of heat liberated during a chemical reaction, change of state or dissolution process. 2. Apparatus for determining the calorific value of a fuel.

Candela Metric unit for luminous intensity. The unit used to express the intensity of light visible to the human eye. It corresponds to the emission from 1/60th of a square centimeter of a black body operating at the solidification temperature of platinum, and emitting one lumen per steradian.

Capacitance The ability of a capacitor to store a charge. The greater the capacitance, the greater the charge that can be stored.

Capacitor A device used for storing an electrical charge.

Capacity 1. The rate of flow through a valve under stated test conditions. 2. A measure of the maximum quantity of energy or material which can be stored within a given piece of equipment or system.

capacity lag In any process, the amount of time it takes to supply energy or material to a

storage element at one point in the process from a storage point elsewhere in

the process. Also known as "transfer lag. "

capillary 1. Having a very small internal diameter. 2. A tube with a very small diameter.

capillary action 1. Spontaneous elevation or depression of a liquid level in a fine hair like tube when it is dipped into a body of the liquid. 2. Capillary action is induced by differences in surface energy between the liquid and the tube material.

capillary tube A tube sufficiently fine that capillary action is significant.

capsule A pressure sensing element consisting of two metallic diaphragms joined around their peripheries.

carrier detect Modem interface signal defined by the RS-232 standard that indicates to a receiving device that a signal is coming from a distant modem.

carrier frequency The basic frequency or pulse repetition rate of a transmitted signal, bearing no intrinsic intelligence until it is modulated by another signal that does bear intelligence.

carrier sense multiple access with collision detect (CSMA/CD) A network access procedure where a device with data to transmit first listens to the medium. When the medium is not busy, the device starts transmitting. While the device is transmitting, it listens for collisions (simultaneous transmission by another station). If a collision occurs, the node stops transmitting, waits, and tries again.

cascade A control system composed of two loops where the set point of one loop (the inner loop) is the output of the controller of the other loop (the outer loop).

catalysis A phenomenon in which a relatively small amount of substance (catalyst) augments the

rate of a chemical reaction without itself being consumed.

catalytic cracking Conversion of high-boiling hydrocarbons into lower-boiling hydrocarbons by a catalyst.

CATV Community Antenna Television. See "broadband.

caustic soda sodium hydroxide that contains 76 to 78% sodium oxide.

cavitation A two stage phenomenon of liquid flow. The first stage is the formation of voids or cavities within the liquid system; the second stage is the collapse or implosion of these cavities back into an all liquid state.

cavitation erosion Progressive removal of surface material due to localised hydrodynamic impact forces associated with the formation and subsequent collapse of bubbles in a liquid in contact with the damaged surface. Also known as "cavitation damage"; "liquid erosion failure."

CCITT The Comite Consultatif Internationale de Telegraphie et Telephonie, an international consultative committee that sets standards for voice and data communications .

CCITT V.xx

International standards in communications concerned with modem interfaces,

speeds, and transmission modes (i.e., V.22). CCITT X.25 International standard defining the protocol used in access to a packet switching network.

CD ROM A compact disk used for computer data storage. The letters stand for "Compact Disk Read Only Memory."

Celsius A scale for temperature measurement based on the definition of 0°C and 100°

C as the freezing point and boiling point, respectively, of pure water at standard pressure.

centipoise (cp) A unit of viscosity which is equal to 0.01 poise. centistoke (cs) A cgs unit of kinematic viscosity in customary use, equal to the kinematic viscosity of a fluid having a dynamic viscosity of 1 centipoise and a density of 1 gram per cubic centimeter.

central processing unit (CPU) The part of a computing system that contains the arithmetic and logical units, instruction control unit, timing generators, and memory and I/O interfaces.

centrifugal compressor A machine in which a gas or vapour is compressed by radial acceleration in an impeller with a surrounding casing and can be multistaged to achieve high ratios of compression. **centrifugal fan** Consists of a fan rotor or wheel within a housing discharging the air at right

angle to the axis of the wheel.

centrifugal force A force acting in a direction along and outward on the radius of turn for a mass in motion.

centrifugal pump A machine for moving a liquid by accelerating it radially outward in an impeller to a surrounding volute casing.

characteristic curve 1. A graph (curve) which shows the ideal values at steady state or an output variable of a system as a function of an input variable, the other input variables being maintained at specified constant values.

characteristic, equal percentage The inherent flow characteristic which, for equal increments of rated travel, will ideally give equal percentage changes of the existing flow coefficient (Cv). **characteristic, inherent flow** The relationship between the flow rate through a valve and the travel of the closure member as the closure member is moved from the closed position to rated travel with constant pressure drop across the valve.

characteristic, installed flow The relationship between the flow rate through a valve and the travel of the closure member as the closure member is moved from the closed position to rated travel when the pressure drop across the valve varies as influenced by the system in which the valve is installed. **characteristic, linear flow** An inherent flow characteristic which can be represented by a straight line on a rectangular plot of flow coefficient (Cv) versus percent rated travel. Therefore, equal increments of travel provide equal increments of flow coefficient (Cv) at constant pressure drop.

characteristic, modified parabolic flow An inherent flow characteristic which provides fine throttling action at low valve plug travel and approximately a linear characteristic for upper portions of valve travel. It is approximately midway between linear and equal percentage.

characteristic, quick-opening flow An inherent flow characteristic in which there is a maximum flow with minimum travel.

characterised cam A component in a valve positioner used to relate the closure component position to the control signal.

characterised sleeve A part added to a plug valve to provide various flow characteristics. **characterised trim** Control valve trim that provides a predefined flow characteristic.

checksum Entry at the end of a block of data corresponding to the binary sum of all information in the block. Used in error checking procedures.

check valve A flow control device that permits flow in one direction and prevents flow in the opposite direction.

choke coil An inductor that allows direct current to pass but presents relatively large impedance to alternating current.

choked flow The condition that exists when, with the upstream conditions remaining constant, the flow through a valve cannot be further increased by lowering the downstream pressure. **chromatogram** The pattern formed by the chromatograph output represents zones of separated elements and compounds on a strip chart. The time the peak appears and the area under the peak identify the component and the concentration.

chromatograph Analytical instrument that uses chromatography to separate substances to analyse for chemical composition and concentration.

chromatography Procedure for separating components from a mixture of chemical substances which depends on selective retardation and physical absorption of substances by a porous bed of sorptive media as the substances are transported through the bed by a moving fluid; the sorptive bed (stationary phase) may be a solid or a liquid dispersed on a porous, inert solid; the moving fluid (moving phase) may be a liquid solution of the substances or a mixture of a carrier gas and the vapourised sample; various detection techniques are used, some of which can be automated.

Cipolletti weir An open channel flow measurement device similar to a rectangular weir but having sloping sides, which results in a simplified discharge equation.

circuit breaker A device designed to allow manual opening and closing of a circuit and also to open the circuit automatically on a predetermined overload of current without damage to itself.

classification of a location The assignment of a rating such as Division 1, Division 2, or nonhazardous.

clear-to-send (CTS) Modem interface signal defined by the U.S. standard EIA-RS-232-C that indicates to data terminal equipment that it may begin data transmission.

clipboard In data processing, an area of information can be stored in order to use it later in a different application.

closed loop A combination of control units in which the process variable is measured and compared with the desired value (or set point). If the measured value differs from the desired value, a corrective signal is sent to the final control element to bring the controlled variable as close as possible to the desired value.

closed-loop system A system with a feedback type of control, such that the output is used to modify the input.

coaxial cable Cable with a centre conductor surrounded by a dielectric sheath and an external conductor. Has controlled impedance characteristics that make it valuable for data transmission. **CODEC** A device which consists of an encoder (which translates an analogue signal to a digital code) and a decoder (which performs the reverse operation).

coefficient, flow A constant (C_v), related to the geometry of a valve, for a given valve opening, that can be used to predict flow rate.

coefficient of discharge The ratio of actual flow to theoretical flow. It includes the effects of jet contraction and turbulence.

coefficient, rated flow The flow coefficient (C_v) of the valve at rated travel.

coefficient, relative flow The ratio of the flow coefficient (C_y) at a stated travel to the flow coefficient (C_v) at rated travel.

coefficient, valve recovery See "liquid pressure recovery factor".

cold junction See "reference junction".

combustible dusts Dusts which (when mixed with air in certain proportions) can be ignited and will propagate flame.

combustible gas Any flammable or combustible gas or vapour (but not atomised liquid) that can, in sufficient concentration by volume in air, become the fuel for combustion.

combustion (flame) safeguard A system for sensing the presence or absence of flame and indicating, alarming or initiating control action.

COM file A computer file name ending in .COM which most often contains a machine code program. It is short for "command" file.

common A reference within a system having same electrical potential throughout. Usually connected to ground at a single point. Often multiple commons are used throughout a system such as power common and signal.

common carrier Company that furnishes communications services to the general public.

common mode In analogue data, an interfering voltage from both sides of a differential input pair (in common) to ground.

common mode interference A form of interference which appears between the terminals of any measuring circuit and ground.

common mode rejection (CMR) The ability of circuit to discriminate against a common mode voltage. NOTE: It may be expressed as a dimensionless ratio, a scalar ratio, or in decibels as 20 times the $\log_{10}$ of that ratio.

common mode rejection ratio (CMRR) A measure of the ability of a detector to damp out the effect of a common-mode-generated interference voltage; usually expressed in decibels.

common mode voltage In-phase, equal-amplitude signals that are applied to both inputs of a differential amplifier, usually referred to as a guard shield or chassis ground.

communications protocol The rules governing the orderly exchange of information between devices on a data link.

compensation Provision of a supplemental device, circuit, or special materials to counteract known sources of error.

complementary metal oxide semiconductor (CMOS) 1. One type of computer semiconductor memory. The main feature of CMOS memory is low power consumption. 2. A type of semiconductor device not specifically memory.

compliance The reciprocal of stiffness.

compressibility Volumetric strain per unit change in hydrostatic pressure.

compressibility factor (Z) A factor used to compensate for deviation from the laws of perfect gases. If the gas laws are used to compute the specific weight of a gas, the computed value must be adjusted by the compressibility factor Z to obtain the true specific weight.

compressible flow Fluid flow under conditions which cause significant changes in density.

compressor A machine-usually a reciprocating-piston, centrifugal/ or axial-flow design which is used to increase pressure in a gas or vapour.

computing relay A device that performs one or more calculations or logical functions or both, and sends out one or more resultant signals.

concatenate To combine several files into one file, or several strings of characters into one string, by appending one file or string after another.

concentric orifice plate A fluid-meter orifice plate having a circular opening whose centre coincides with the axis of the centre of the pipe in which it is installed.

Condensate 1. The liquid product of a condensing cycle. 2. A light hydrocarbon mixture formed by expanding and cooling gas in a gas-recycling plant to produce a liquid output.

condensate pot A section of pipe (100mm. diameter) typically installed horizontally at the orifice flange union to provide a large-area surge surface for movement of the impulse line fluid with instrument element position change to reduce measurement error from hydrostatic head difference in the impulse lines.

condensate trap 1. A device to separate saturated water from steam in a pipe or piece of process equipment. 2. A device used to trap and retain condensate in a measurement impulse line to prevent hot vapours from reaching the instrument.

condensation-type hygrometer A dew point instrument that operates by detecting the equilibrium temperature at which dew or frost forms on a thermoelectrically, mechanically or chemically cooled surface.

condenser The heat exchanger, located at the top of the column, that condenses overhead vapours. For distillation, the common condenser cooling media are water, air, and refrigerants such as propane. The condenser may be partial or total. In a partial condenser only part of the vapours are condensed, with the remainder usually withdrawn as a vapour product.

conditional stability A linear system is conditionally stable if it is stable for a certain interval of values of the open-loop gain, and unstable for certain lower and higher values.

condition monitoring system A system designed to monitor the condition of a machine or process.

conduction The transmission of heat through and by means of matter unaccompanied by any obvious motion in the matter.

conductivity (thermal) The amount of heat (Btu) transmitted in one hour through one square foot of a homogeneous material 1 in. thick for a difference in temperature of 1° F between the two surfaces of the material.

conductivity (electrical) The electrical conductance, at a specified temperature, between the opposite faces of a unit cube; usually expressed as ohm-l cm-1.

conductor Any material through which electrical current can flow.

conduit (liquid) 1. Any channel, duct, pipe or tube for transmitting fluid along a defined flow path.

conduit (electrical) thin-wall pipe used to enclose wiring.

cone-plate viscometer An instrument for determining the absolute viscosity of fluids in small sample volumes by sensing the resistance to rotation of a moving cone caused by the presence of the test fluid in a space between the cone and a stationary flat plate.

CONFIG.SYS An MSDOS computer file that establishes the MSDOS operating system environment and installs memory resident software such as device drivers.

configurable A term applied to a device or system whose functional characteristics can be selected or rearranged through programming or other "soft" methods. Excludes "hard" rewiring as a means of altering the configuration.

confined flow Flow of a continuous stream fluid within a process vessel or conduit;

conical orifice An orifice having a 45 bevel on the inlet edge to yield more constant and predictable discharge coefficient at low flow velocity (Reynolds number less than 10,000).

conservation of charge The principle that states the total charge of an isolated system is constant. Also known as "charge conservation. "

conservation of energy (Newton's law) The principle that energy cannot be created or destroyed, although it can be changed from one form to another. Also known as "energy conservation."

consistency A qualitative means of classifying substances, especially semisolids, according to their resistance to dynamic changes in shape.

constant-head meter A flow measurement device that maintains a constant pressure differential by varying the cross section of a flow path through the meter, such as in a piston meter or rotameter.

constant-volume gas thermometer A device for detecting and indicating temperature based on Charles Law- the pressure of a confined gas varies directly with absolute temperature; in practical instruments, a bulb immersed in the thermal medium is connected to a Bourdon tube by means of a capillary; changes in temperature are indicated directly by movement of the Bourdon tube due to changes in bulb pressure.

consumables Those materials or component are depleted or require periodic replacement through normal use of the instrument.

contactor A mechanical or electromechanical device for making and breaking electrical continuity between two branches of a power circuit, thereby establishing or interrupting current flow.

contention A condition on a multidrop communication channel when two or more locations try to transmit at the same time.

contiguous file A file consisting of physically adjacent blocks on a mass-storage device.

continuous blowdown The uninterrupted removal of concentrated boiler water from a boiler to control total solids concentration in the remaining water

continuous dilution A technique of supplying a protective gas flow continuously to an enclosure, housing electrical circuitry, containing an internal potential source of flammable gas or vapour for the purpose of diluting any flammable gas or vapour which could be present to a level well below the lower explosion limit (LEL).

continuous-duty rating The maximum power or other operating characteristic that a specific device can sustain indefinitely without significant degradation of its functions.

continuous rating The rating applicable to specified operation for a specified uninterrupted length of time.

control action of a controller or a controlling system, the nature of the change of the output effected by the input. See "proportional control action," "integral control action, and " derivative control action. "

control action, derivative (rate) (D) In process instrumentation, control action in which the output is proportional to the rate of change of the input.

control action, floating In process instrumentation, control action in which the rate of change of the output variable is a predetermined function of the input variable.

control action, integral (reset) (I) Control action in which the output is proportional to the time integral of the input.

control action, proportional (P) Control action in which there is a continuous linear relation between the output and the input.

control action, proportional-plus-derivative (rate) (PD) Control action in which the output is proportional to a linear combination of the input and the time rate of change of input.

control action, proportional-plus-integral (reset) (PI) Control action in which the output is proportional to linear combination of the input and the time integral of the input.

control action, proportional-plus-integral (reset) -plus-derivative (rate) (PID) Control action in which the output is proportional to a linear combination of the input, the time integral of input and the time rate of change of input.

control, adaptive Control in which automatic means are used to change the type or influence (or both) of control parameters in such a way as to improve the performance of the control system

control algorithm A mathematical representation of the control action to be performed.

control, cascade Control in which the output of one controller (primary of the cascade) is the set point for another controller (secondary of the cascade).

Control character A character whose purpose is to control an action rather than to pass data to a program; ASCII control characters have an octal code between 0 and 37; normally typed by holding down the-CTRL key on a terminal keyboard while striking a character key.

control, differential gap Control in which the output of a controller remains at a maximum or minimum value until the controlled variable crosses a band or gap, causing the output to reverse. The controlled variable must then cross the gap in the opposite direction before the output is restored to its original condition.

control, direct digital Control performed by a digital device which establishes the signal to the final controlling element. **control element** A component of a control system that reacts to manipulate a process attribute when stimulated by an actuating signal.

control, feedback Control in which a measured variable is compared to its desired value to produce an actuating error signal which is acted upon in such a way as to reduce the magnitude of the error.

control, feedforward Control in which information concerning one or more conditions that can disturb the controlled variable is converted, outside of any feedback loop, into corrective action to minimise deviations of the controlled variable.

control, high-limiting Control in which the output signal is prevented from exceeding a predetermined high limiting value.

controlled medium The process fluid or other substance containing the controlled variable.

controlled variable 1. The variable which the control system attempts to keep at the set point value. The set point may be constant or variable. 2. The part of a process to be controlled (flow, level, temperature, pressure, etc.). 3. A process variable which is to be controlled at some desired value by means of manipulating another process variable.

controller A device or program which operates automatically to regulate a controlled variable. **controller, derivative (D)** A controller which produces derivative control action only.

controller, direct-acting A controller in which the value of the output signal increases as the value of the input (measured variable) increases See *controller, reverse-acting*.

controller drift See "drift. "

controller, floating A controller in which the rate of change of the output is a continuous (or at least a piecewise continuous) function of the actuating error signal. The output of the controller may remain at any value in its operating range when the actuating error signal is zero and constant. Hence, the output is said to float.

controller, integral (reset) (I) A controller which produces integral control action only.

controller, multiposition A controller having two or more discrete values of output.

controller, on-off A two-position controller in which one of the two discrete values is zero.

controller, program A controller which automatically holds or changes set point to follow a prescribed program for a process.

controller, proportional (P) A controller which produces proportional control action only. **controller, proportional-plus-derivative (rate) (PD)** A controller which produces proportional-plus-derivative (rate) control action.

controller, proportional-plus-integral (reset) (PI) A controller which produces proportional-plusintegral (reset) control action.

controller, proportional-plus-integral (reset)plus-derivative (rate) (PID) A controller which produces proportional-plus-integral (reset)-plus-derivative (rate) control action.

controller, ratio A controller which maintains a predetermined ratio between two variables. **controller, reverse-acting** A controller in which the value of the output signal decreases as the value of the input (measured variable) increases. See *controller, direct-acting*

controller, sampling A controller using intermittently observed values of a signal to effect control action.

controller, self-operated (regulator) A controller in which all the energy to operate the final controlling element is derived from the controlled system.

control limits In statistical quality control, the upper and lower values of a measured quantity that establish the range of acceptability; if any individual measurement falls outside this range, the part involved is rejected and if the sample average for the same measurement falls outside the range, the entire lot is rejected.

control logic The sequence of steps or events necessary to perform a particular function. Each step or event is defined to be either a single arithmetic or a single Boolean expression.

control loop A combination of two or more instruments or control functions arranged so that signals pass from one to another for the purpose of measurement and/or control of a process variable. See *closed loop* and *open loop*.

control loop instability A regular oscillation of a feedback control system caused by excessive loop gain. It is independent of external disturbances.

control, low limiting Control in which output signal is prevented from decreasing beyond a predetermined low limiting value.

control mode A specific type of control action such as proportional, integral, or derivative.

control, optimising Control that automatically seeks and maintains the most advantageous value of a specified variable, rather than maintaining it at one set value.

control, supervisory Control in which the control loops operate independently subject to intermittent corrective action; e.g., set point change from an external source.

control system A system in which deliberate guidance or manipulation is used to achieve a prescribed value of a variable.

control system, automatic A control system which operates without human intervention.

control system, multielement (multivariable) A control system utilising input signals derived from two or more process variables for the purpose of jointly affecting the action of the control system. **control system, noninteracting** A control system with multiple inputs and outputs in which any given input-output pair is operating independently of any other input-output pair.

control, time-proportioning Control in which the output signal consists of periodic pulses where duration is varied to relate, in some prescribed manner, the time average of the output to the actuating error signal.

control valve gain The change in the flow rate as a function of the change in valve travel. **control, velocity limiting** Control in which the rate of change of a specified variable is prevented from exceeding a predetermined limit.

coprocessor A device added to a CPU to perform certain functions (eg floating point operations) more efficiently.

Coriolis effect An accelerating force acting on any body moving freely above the earth's surface. Caused by the rotation of the earth about its axis. The basis for *Coriolis Mass Flow Meters*.

Coriolis mass flow meter A mass flow meter which measures mass flow of a fluid by determining the torque resulting from radial acceleration of the fluid.

CPU *central processing unit*

cracking Thermal decomposition of complex hydrocarbons into simpler components.

cracking furnace Furnace used to produce enough heat to reduce the molecular weight of hydrocarbons by breaking molecular bonds.

critical flow 1. The rate of flow of a fluid equivalent to the speed of sound in that fluid. 2. A point at which the characteristics of flow suffer a finite change. In the case of a liquid, critical flow could mean the point at which the flow regime changes from laminar to transitional or alternatively used to mean the onset of *choked flow*. In the case of a gas, critical flow may mean the point at which the velocity at the *vena contracta* attains the velocity of sound or it may mean the point at which the flow is fully choked.

critical point The temperature and pressure which two phases of a substance in equilibrium with each other become identical, forming one phase.

critical pressure 1. The pressure of the liquid-vapour critical point. 2. The equilibrium pressure of a fluid that is at its critical temperature.

critical-pressure ratio The ratio of downstream pressure to upstream pressure which correspond to the onset of turbulent flow in a moving stream of fluid.

critical strain The amount of prior plastic strain that is just sufficient to trigger recrystallisation when a deformed metal is heated.

critical temperature 1. The temperature of the liquid-vapour critical point, that is the temper above which the fluid has no liquid-vapour transition. 2. The temperature of a fluid above which the fluid cannot be liquefied by pressure alone

critical velocity For a given fluid, the average linear velocity marking the upper limit of streamline flow and the lower limit of turbulent flow given temperature and pressure in a given confined flow path.

cross talk The unwanted energy transferred from one circuit, the disturbing circuit, to another circuit, the disturbed circuit. Typically signals electrically coupled from another circuit.

cyclic redundancy check (CRC) An error detection scheme in which a check character is generated from the remainder after dividing all bits in a block of serial data by a predetermined binary number. The CRC is appended to the the transmitted data and recalculated by the receiver to verify transmission accuracy.

Dalton's law States that the total pressure exerted by a mixture of gases equals the sum of the partial pressures that would be exerted if each of the individual gases present were to occupy the same volume by itself.

damped wave A wave in which the source amplitude diminishes with each succeeding cycle.

damper A device for introducing a variable resistance for regulating the volumetric flow of gas or air

damping The progressive reduction or suppression of oscillation in a device or system.

critically damped when the time response is as fast as possible without overshoot,

underdamped when overshoot in the time response occurs

overdamped when the time response is slower than critical

damping factor In any damped oscillation, the ratio of the amplitude of any given half cycle to the amplitude of the succeeding half cycle.

database A collection of interrelated data stored together with controlled relationships. The data are stored so that they are independent of programs that use the data; a common and controlled approach is used in adding new data and in modifying and retrieving existing data within a database.

data compression The elimination of redundant data without loss of information

data highway A communication link between separate stations tied with a multidrop cable or optical connections. It eliminates a need for separate, independently wired data links. Each station on a highway can function independently.

data reduction The process of transforming large quantities of raw data, usually gathered by automatic recording equipment, into useful, condensed, or simplified information.

data set (DS) 1. A collection of data with predefined structure. 2. A device (such as a modem) which performs the modulation/demodulation and control functions necessary to provide compatibility between data processing equipment and communications facilities.

data set ready (DSR) Modem interface signal defined in RS-232 which indicates to the attached terminal equipment that the modem is attached to the telephone circuit.

data signalling rate In communications, the data transmission capacity of a set of parallel channels. The data signaling rate is expressed in bits per second.

data sink In communications, a device capable of accepting data signals from a transmission device. It also may check these signals and originate error control signals.

data, skewed Data sample that has been biased and is not representative.

data source In communications, a device capable of originating data signals for a transmission device. It also may accept error control signals.

data terminal equipment (DTE) 1. The embodiment of the media, modulation, and coding-dependent portion of a fieldbus-connected device, comprising the lower portions of the Physical Layer and all higher layers within the device. 2. The device providing the data source or end point for a transmission link.

data terminal ready (DTR) Modem interface signal defined in RS-232, which indicates to the modem that the terminal equipment is ready for transmission.

data type Any one of several different types of data, such as integer, real, double precision, complex, logical, and Hollerith. Each has a different mathematical or logical significance and may have different internal representation.

data unpacking The process of recovering individual items of data from packed information

datum A value that serves as a reference for measuring other values of the same quantity.

DC voltage A voltage that forces electrons to move through a circuit in the same direction continuously, thereby producing a direct current.

dead band The range through which an input can be varied without initiating an observable response. Dead band is usually expressed in percent of span

dead time The interval of time between initiation of an input change or stimulus and the start of the resulting response.

dead time correction A correction applied to an instrument reading to account for events or stimuli occurring during the instrument's dead time.

deadweight gauge A device used to generate accurate pressures for the purpose of calibrating pressure gauges; freely balanced weights (dead weights) are loaded on a calibrated piston to give a static hydraulic pressure output.

deaeration Removing a gas from a liquid or semisolid substance, such as boiler feedwater or food.

debug To submit a newly designed process, mechanism or computer program to simulated or actual operating conditions to detect and eliminate errors and inefficiencies.

decade A group or assembly of ten units, e.g., a counter which counts to ten or a resistor box which inserts resistance quantities in multiples of powers of 10.

decade counter Counter that produces one output pulse for every 10 input pulses.

decanting Boiling or pouring off liquid near the top of a vessel that contains two immiscible liquids or a liquid solid mixture which has separated by sedimentation, without disturbing the heavier liquid or settled solid.

decarburising Removing carbon from the surface layer of a steel or other ferrous alloy by heating it in an atmosphere that reacts selectively with carbon; atmospheres that are relatively rich in water vapour or carbon dioxide are typical deoxidising atmospheres.

decay The spontaneous transformation of a nuclide into one or more other nuclides either by emitting one or more subatomic particles or gamma rays from its nucleus or by nuclear fission.

decay ratio The ratio of the amplitude change of a series of cycles.

decay time The time in which a voltage or current pulse will decrease to one tenth of its maximum value. Decay time is proportional to the time constant of the circuit.

decibel (dB) 1. A unit of level, where: $\text{Level in dB} = 10 \log_{10} P_1/P_{\text{ref}}$. P_1 = a power, or, quantity directly proportional to power. P_{ref} = a reference power, or, a corresponding reference quantity proportional to power. 2. A measure of magnitude ratio; magnitude ratio is $\text{dB} = 20 \log_{10} (\text{magnitude ratio})$.

decision table A table of all contingencies that are to be considered in the description of a problem, together with the actions to be taken. Decision tables can be used in place of flow charts for problem description and documentation.

declaration As used in many programming languages, a statement that is not to be executed, but usually is used for descriptive purposes.

decoupling The technique of reducing process interaction through coordination of control loops. decoupling control A technique in which interacting control loops are automatically compensated when any one control loop takes a control action.

degree of freedom A number one less than the number of frequencies being tested with a chi-square test.

degree of protection of enclosures An international system of rating standard levels of protection provided by enclosures for the protection provided by an enclosure against ingress of solids and/or liquids. Definitions are found in IEC Publications 529 and 144.

deliquescence The absorption of atmospheric water vapour by a crystalline solid until the crystal dissolves into a saturated solution.

delta network A set of three circuit branches connected in series, end to end, to form a mesh having three nodes.

demodulation The process of retrieving intelligence (data) from a modulated carrier wave. The reverse of "modulation."

densimeter An instrument for determining the density of a substance in absolute units, or for determining its specific gravity (ie, its relative density with respect to that of pure water). Also known as "density gauge"; "density indicator"; "gravitometer."

densitometer An instrument for determining optical density of photographic or radiographic film by measuring the intensity of transmitted or reflected light.

density 1. The mass of a unit volume of a liquid at a specified temperature. The units shall be stated, such as kilograms per meter³. 2. Closeness of texture or consistency. 5. Degree of opacity, often referred to as "optical density".

density correction Any correction made to an instrument reading to compensate for the deviation of density from a fixed reference value; it may be applied because the fluid being measured is not at standard temperature and pressure, because ambient temperature affects density of the fluid in a fluid filled instrument, or because of other similar effects.

density transmitter An instrument used to determine liquid density by measuring the buoyant force on an air filled float immersed in a flowing liquid stream.

derivative This control action will cause the output signal to change according to the rate at which input signal variations occur during a certain time interval.

derivative action A type of control system action in which a predetermined relation exists between the position of the final control element and the derivative of the controlled variable with respect to time.

derivative control Change in the output that is proportional to the rate of change of the input. Also called "rate control."

derivative time The time interval by which rate action advances the effect of proportional action on the final control element.

describing function For a nonlinear element in sinusoidal steady state, the frequency response obtained by taking only the fundamental component of the output signal. The describing function depends on the frequency and on the amplitude of the input signal, or only on the amplitude of the input signal.

design pressure The maximum allowable working pressure permitted under the rules of the relevant Construction Code.

desorption Removing adsorbed material.

desuperheater Equipment used to remove superheat from steam, usually by the injection of water.

detergent A natural material or synthetic substance having the soaplike quality of being able to emulsify oil and remove soil from a surface.

developed boiler horsepower The boiler horsepower generated by a steam generating unit.

deviation A departure from a desired value or expected value or pattern.

dewars Insulated thermos like containers for cryogenic liquids, which can be designed to house detectors or lasers requiring cooling.

dewatering Removing water from solid or semisolid material (for instance, by centrifuging, filtering, settling or evaporation).

dew cell An instrument consisting of two bare electrical wires wound spirally around an electrical insulator and covered by wicking wetted with an aqueous solution containing an excess of LiCl; dew point of the surrounding atmosphere is determined by passing an electric current between the two wires, which raises the temperature of the LiCl solution until its vapour pressure is the same as that of the ambient atmosphere.

dew point The temperature, referred to a specific pressure, at which water vapours condense.

diamagnetic material A substance whose specific permeability is less than 1.00 and is therefore weakly repelled by a magnetic field.

diamond pyramid hardness A material hardness determined by indenting a specimen with a diamond pyramid indenter having a 136° angle between opposite faces then calculating a hardness number by dividing the indenting load by the pyramidal area of the impression. Also known as "Vickers hardness. "

diaphragm A sensing element consisting of a thin, usually circular, plate which is deformed by pressure differential applied across the plate.

diaphragm seal A thin flexible sheet of material clamped between two body halves to form a physical barrier between the instrument and process fluid.

diaphragm valve A valve with a flexible linear motion closure member that is forced into the internal flow passageway of the body by the actuator

dibit A grouping of two bits (i.e., 00, 01, 10, 11).

dichroic filter A filter which selectively transmits some wavelengths of light and reflects others. Typically such filters are based on multilayer interference coatings.

dielectric An insulating material, or a material that can sustain an electric field with very little dissipation of power.

dielectric absorption The persistence of electric polarisation in certain dielectrics after the discharge of a capacitor.

dielectric coating An optical coating made up of one or more layers of dielectric (nonconductive) materials. The layer structure determines what fractions of incident light at various wave lengths are transmitted and reflected.

dielectric constant A material characteristic expressed as the capacitance between two plates when the intervening space is filled with a given insulating material divided by the capacitance of the same plate arrangement when the space is filled with air or is evacuated.

difference equation An equation expressing a functional relationship of one or more independent variables, one or more functions dependent on these variables, and successive differences of these functions.

differential amplifier A device which compares two input signals and amplifies the difference between them.

differential gap The smallest increment of change in a controlled variable required to cause the final control element in a two position control system to move from one position to its alternative position.

differential input The difference between the instantaneous values of two voltages both being biased by a common mode voltage.

differential pressure 1. The difference in pressure between two points of measurement. 2. The static pressure difference generated by the primary device when there is no difference in elevation between the upstream and downstream pressure taps.

differential pressure gauge An instrument designed to measure the difference in pressure between two enclosed spaces, independent of their absolute pressures.

differential pressure transmitter A transducer designed to measure the pressure difference between two points in a process and transmit a signal proportional to this difference, without regard to the absolute pressure at either point.

differential pressure type liquid level meter A device designed to measure the head of liquid in a tank above some minimum level and produce an indication proportional to this value.

differentiation The act of taking a derivative. Converts displacement to velocity and velocity to acceleration.

differentiator A device whose output function is proportional to the derivative, i.e., the rate of change, of its input function with respect to one or more variables (usually with respect to time).

diffraction A phenomenon associated with the scattering of waves when they encounter obstacles whose size is about the same order of magnitude as the wavelength. Diffraction forms the basis for x ray crystallography, and also tends to produce aberrations that must be accommodated in the design and construction of high quality acoustical and optical systems.

diffraction grating An array of fine, parallel, equally spaced reflecting or transmitting lines which diffract light into a direction characteristic of the spacing of the lines and the wavelength of the diffracted light.

diffuser A duct, chamber or enclosure in which low pressure, high velocity flow of a fluid, usually air, is converted to high pressure, low velocity flow.

diffusion Migration of atoms, molecules or ions spontaneously, under the driving force of compositional differences, and using only the energy of thermal excitation to cause atom movements.

digital filter An algorithm which reduces undesirable frequencies in the signal.

digital input A number value or binary (two state) input. See "input, digital."

digital logic A signal level is represented as a number value with a most significant and least significant bit. Binary digital logic uses numbers consisting of strings of 1s and 0s.

digital output Transducer output that represents the magnitude of the measurand in the form of a series of discrete quantities coded in a system of notation.

digital signal A signal that has only two (on or off, 1 or 0) possible values. 2. A discrete or discontinuous signal, one whose various states are discrete intervals apart.

digital to analogue converter (D/A or DAC) A device, or subsystem that converts binary (digital) data into continuous analogue data, as, for example, to drive actuators of various types, motor speed controllers, etc.

digital valve A single valve casing containing multiple solenoid valves whose flow capacities vary in binary sequence (1, 2, 4, 8, 16, ...); to regulate flow, the control device sends operating signals to various combinations of the solenoids; applications are limited to very clean fluids at moderate temperatures and pressures.

digitise To convert an analogue measurement of a physical variable into a numerical value, thereby expressing the quantity in digital form. see "analogue to digital converter. "

dilatometer An apparatus for accurately measuring thermal expansion of materials.

dilution Adding solvent to a solution to lower its concentration.

DIN Abbreviation for the standards institution of the Federal Republic of Germany.

diode A two electrode electronic component containing merely an anode and a cathode.

diode laser A laser in which stimulated emission is produced at a p n junction in a semiconductor material. Only certain materials are suited for diode laser operation, among them gallium arsenide, indium phosphide, and certain lead salts.

diopter A measurement of refractive power of a lens equal to the reciprocal of the focal length in meters. A lens with 20 centimeter focal length has power of five diopters, while one with a 2 meter focal length has a power of 0.5 diopter.

dipole antenna A centre fed antenna which is approximately half as long as the wavelength of the radio waves it is primarily intended to transmit or receive.

direct action 1. A controller in which the value of the output signal increases as the value of the input (measured variable or controlled variable) increases. 2. An actuator that extends the actuator stem when the power supply increases.

direct digital control (DDC) A computer control technique that sets the final control element's position directly by the computer output.

direct memory access (DMA) A method of fast data transfer between the peripherals and the computer memory. The transfer does not involve the CPU.

discrete Pertaining to distinct elements or to representation by means of distinct elements, such as characters.

discrete control On/off control. One of the two output values is equal to zero. **discrete increment** Providing an output which represents the magnitude of the measurand in the form of discrete or quantised values.

discrete input Inputs having a separate and distinct identity. A digital input that is either on or off.

discrete output Outputs having a separate and distinct identity.

displacement 1. The change in position of a body or point with respect to a reference point. 2. The volume swept out by a piston as it moves inside a cylinder from one extreme of its stroke to the other extreme.

displacement meter A meter that measures the amount of a material flowing through a system by recording the number of times a vessel or cavity of known volume is filled and emptied.

displacement type density meter A device that measures liquid density by means of a float and balance beam used in conjunction with a pneumatic sensing system; the float is confined within a small chamber through which the test liquid continually flows, so that density variations with time can be determined.

displacer type liquid level detector A device for determining liquid level by means of force measurements on a cylindrical element partly submerged in the liquid in a vessel.

displacer type meter An apparatus for detecting liquid level or determining gas density by measuring the effect of the fluid on the buoyancy of a displacer unit immersed in it.

dissociation The process by which a chemical compound breaks down into simpler constituents, as the CO_2 and H_2O at high temperature.

dissolved gases Gases which are "in solution" in water. **dissolved solids** Those solids in water which are in solution.

distillate 1. The distilled product from a fractionating column. 2. The overhead product from a distillation column. 3. In the oil and gas industry the term distillate refers to a specific product withdrawn from the column, usually near the bottom.

distillate fuel Any of the fuel hydrocarbons obtained during the distillation of petroleum which have boiling points higher than that of gasoline.

distillation vapourisation of a substance with subsequent recovery of the vapour by condensation.

distributed In a control system, refers to control achieved by intelligence that is distributed about the process to be controlled, rather than by a centrally located single unit.

distributed control system (DCS) Instrumentation system consisting of input/output devices, control devices and operator interface devices which in addition to executing the stated control functions also permits transmission of control, measurement, and operating information to and from multiple locations, connected by a communication link.

distributed processing Interconnection of two or more computers so that they can work together on the same problem, not necessarily under the direction of a single control program.

disturbance resolution The minimum change caused by a disturbance in a measured variable which will induce a net change of the ultimately controlled variable.

disturbance variable A measured variable that is uncontrolled and that affects the operations of the process.

Division 1 The (US) classification assigned to a location where either there is a high probability of a dust hazardous atmosphere occurring frequently, or regularly, or where the dust is electrically conductive.

Division 2 The (US) classification assigned to a location where there is a low probability of a dust hazardous atmosphere occurring and/or a high probability of the presence of a hazardous dust layer

Dodge Romig tables A set of standard tables with known statistical characteristics that are used in lot tolerance and AOQL acceptance sampling.

Doppler effect flowmeter A device that uses ultrasonic techniques to determine flow rate; a continuous ultrasonic beam is projected across fluid flowing through the pipe, and the difference between incident beam and transmitted beam frequencies is a measure of fluid flow rate.

Doppler shift A phenomenon that causes electromagnetic or compression waves emanating from an object to have a longer wavelength if the object moves away from an observer than would be the case if the object were stationary with respect to the observer, and to have a shorter wavelength if the object moves toward the observer; it is the physical phenomenon that forms the basis for analysing certain sonar data and certain astronomical observations.

dose The amount of radiation received at a specific location per unit area or unit volume, or the amount received by the whole body.

dose rate Radiation dose per unit time.

dosimeter (dosemeter) An instrument for directly measuring the total dose of radiation received in a given period.

double-acting Acting in two directions, as in a reciprocating compressor or valve actuator where each piston has a working chamber at both ends of the cylinder.

double precision 1. Pertaining to the use of two computer words to represent a number. 2. In floating point arithmetic, the use of additional bytes or words representing the number, in order to double the number of bits in the mantissa.

dowtherm A constant boiling mixture of phenyl oxide and diphenyl oxide used in high temperature heat transfer systems (boiling point 494°F, 257°C).

dp cell A pressure transducer that responds to the difference in pressure between two pressure sources. Frequently, a diaphragm capsule and an integral part of a dp transmitter. Often used to measure flow by the pressure difference across a restriction in the flow line and level by measuring the pressure difference between the head pressure produced by the height of a liquid in a vessel or tank and a reference pressure.

D/P transducer Transducer that measures differential pressure and converts that to another signal.

draft gauge A type of manometer used to measure small gas heads, such as the draft pressure in a furnace.

draft loss A decrease in the static pressure in a boiler or furnace due to flow resistance.

drag body flow meter A device that measures the net force on a submerged solid body in a direction parallel to the direction of flow, and converts this value to an indication of flow or flow rate.

driving point impedance The complex ratio of applied sinusoidal voltage, force or pressure at the driving point of a transducer to resulting current, velocity or volume velocity, respectively, at the same point, all inputs and outputs being terminated in some specified manner.

driving point reactance The imaginary component of driving point impedance.

driving point resistance The real component of driving point impedance.

droop rate The rate at which the voltage output of a storage device decays.

drop leg The section of measurement piping below the process tap location to the instrument.

dry bulb temperature The temperature of the air indicated by thermometer not affected by the water vapour content of the air.

dry corrosion Atmospheric corrosion taking place at temperatures above the dew point.

dry gas Gas containing no water vapour.

dry steam Steam containing no moisture. Commercially dry steam containing not more than one half of one percent moisture.

dry test meter A type of meter used to determine gas flow rates for billing purposes and to calibrate other flow measuring instruments; it has two chambers separated by a flexible diaphragm which is connected to a dial by means of a gear train; in operation, the chambers are filled alternately, with a flow control valve switching from one chamber to the other as the first becomes completely filled, while flow rate is indicated indirectly from movement of the diaphragm.

dual-sealing valve A valve which uses a resilient seating material for the primary seal and a metal to metal seat for a secondary seal.

duplex control A control in which two independent control elements share a common input signal for the operation of separate final control elements both of which influence the value of the controlled condition.

duplex, full Method of operation of a communication circuit where each end can simultaneously transmit and receive.

duplex, half Permits one direction, electrical communication between stations. Technical arrangements may permit operation in either direction but not simultaneously.

dust 1. Any finely divided solid material 420 nm or smaller in diameter. 2. Particles of gas borne solid matter larger than one micron in diameter.

dust, combustible Dust that (when mixed with air in certain proportions) can be ignited and will propagate a flame.

dynamic characteristics Those characteristics of a transducer which relate to its response to variations of the measurand with time.

dynamic compensation A control technique used to compensate for dynamic response differences to different input streams to a process. A combination of lead and lag algorithms will handle most situations.

dynamic optimisation A type of control, frequently multivariable and adaptive in nature, which optimises some criterion function in bringing the system to the setpoints of the controlled variables. The sum of the weighted, time absolute errors is an example of a typical criterion function to be minimised.

dynamic pressure The increase in pressure above the static pressure that results from complete transformation of the kinetic energy of the fluid into potential energy.

dynamic programming In operations research, a procedure for optimisation of a multistage problem wherein a number of decisions are available at each stage of the process. Contrast with "convex programming," "integer programming," "linear programming, " "mathematical programming, " "nonlinear programming, " and "quadratic programming."

dynamic RAM Random access memory that must be refreshed periodically. Usually faster than "Static RAM "

dynamic range The difference between the highest signal level that will overload the instrument and the lowest signal level that is detectable. Dynamic range is usually expressed in decibels.

dynamic response The behavior of the output of a device as a function of the input, both with respect to time.

dynamic stability The property which permits the response of a positively damped physical system to asymptotically approach a constant value when the level of excitation is constant.

dynamic stiffness The apparent stiffness of a spring member under vibration or shock loading. This apparent stiffness is frequency dependent.

e The base of natural logarithms.

EAROM See "electrically alterable read only memory."

ebullition The act of boiling or bubbling.

eccentric orifice An orifice whose centre does not coincide with the centreline of the pipe or tube; usually, the eccentricity is toward the bottom of a pipe carrying flowing gas and toward the top of a pipe carrying liquid, which tends to promote the passage of entrained water or air rather than allowing entrained water or gas to build up in front of the orifice.

economiser Heat exchanger used to recover excess thermal energy from process streams.

eddy current A circulating current induced in a conductive material by a changing electromagnetic field.

edge filter An interference filter which abruptly shifts from transmitting to reflecting over a narrow range of wavelengths.

eductor A device that withdraws a fluid by aspiration and mixes it with another fluid. See "injector."

EEPROM See "electrically erasable and programmable read only memory."

effective bandwidth An operating characteristic of a specific transmission system equal to the bandwidth of an ideal system whose uniform pass band transmission equals maximum transmission of the real system and whose transmitted power is the same as the real system for equal input signals having a uniform distribution of energy at all frequencies.

effective value The root mean square value of a cyclically varying quantity; it is determined by finding the average of the squares of the values throughout one cycle and taking the square root of the average.

efficiency 1. The efficiency of a boiler is the ratio of heat absorbed by water and steam to the heat equivalent of the fuel fired. 2. In manufacturing, the average output of a process expressed as percent of its expected output under ideal conditions. 3. The ratio of useful energy supplied by a dynamic system to the energy supplied to it over a given period of time.

EIA Electronics Industry Association who provide standards for such things as interchangeability between manufacturers.

ejector A device which utilises the kinetic energy in a jet of water or other fluid to remove a fluid or fluent material from tanks or hoppers.

elastomer A material that can be stretched to approximately twice its original length with relatively low stress at room temperature, and which returns forcibly to about its original size and shape when the stretching force is released.

elastomeric energised liner A resilient elastomeric ring under the main liner in a butterfly valve body is compressed by the disk acting through the main liner, thus generating a resilient sealing action between the disk and the main liner.

elbow 1. A fitting that connects two pipes at an angle, usually 90° but may be any other angle less than 100°. 2. A sharp bend in a pipe.

elbow meter A pipe elbow that is used as a flow measurement device by placing a pressure tap at both the inner and outer radius and measuring the pressure differential caused by differences in flow velocity between the two flow paths.

electrical apparatus category 'ia' An electrical apparatus that is incapable of causing ignition in normal operation, with a single fault and with any combination of two faults applied, with safety factors of 1.5 in normal operation and with one fault and 1.0 with two faults.

electrical apparatus category 'ib' An electrical apparatus that is incapable of causing ignition in normal operation and with a single fault applied, with safety factors of 1.5 in normal operation and with one fault and 1.0 with one fault, if the apparatus contains no unprotected switch contacts in parts likely to be exposed to a potentially explosive atmosphere and the fault is self revealing.

electrically alterable read only memory (EAROM) A type of computer memory for which its contents can be changed only under special conditions.

electrically erasable and programmable read only memory (EEPROM) Nonvolatile memory that may be electrically erased and reprogrammed.

electrical resistivity A material characteristic indicative of its relative resistance to the flow of electrons. Usual units are ohm m (SI) or ohms per circular mil foot (U. S.); it is the reciprocal of electrical conductivity.

electromagnetic interference (EMI) See "interference, electromagnetic."

electromagnetic radiation Any wave having both an electric and a magnetic component. Electromagnetic waves include in order of increasing photon energy, increasing frequency and decreasing wavelength: radio waves, infrared, visible light, ultraviolet, x rays, gamma rays and cosmic rays.

electromagnetic wave A wave in which both the electric and magnetic fields vary periodically, usually at the same frequency.

electrometer An instrument for measuring electric charge, usually by means of the forces exerted on one or more charged electrodes in an electric field.

element, primary The system element that quantitatively converts the measured variable energy into a form suitable for measurement. For transmitters not used with external primary elements, the sensing portion of the transmitter is the primary element.

elevated range See "range, suppressed-zero."

elevated span See "range, suppressed zero."

elevated zero range See "range, elevated zero."

elevation error A type of error in temperature measuring or pressure measuring systems that incorporate capillary tubes partly filled with liquid; the error is introduced when the liquid filled portion of the system is at a different level than the instrument case, the amount of error varying with distance of elevation or depression.

elute To wash out or remove by dissolving.

elutriation Separation of fine, light particles from coarser, heavier particles by passing a slow stream of fluid upward through a mixture so that the finer particles are carried along with it.

embrittlement cracking A form of metal failure that occurs in steam boilers at riveted joints and at tube ends, the cracking being predominantly intercrystalline.

EMI Electromagnetic interference. See "interference, electromagnetic."

emissivity 1. A material characteristic determined as the ratio of radiant energy emission rate due solely to temperature for an opaque, polished surface of a material divided by the emission rate for an equal area of a blackbody at the same temperature. 2. The rate at which electrons are emitted from a solid or liquid surface when additional energy is imparted to the system by radiant energy such as heat or light or by energetic particles such as a beam of electrons.

emulsifier A substance that can be mixed with two immiscible liquids to form an emulsion. Also known as "disperser"; "dispersing agent."

encapsulated body liner In a butterfly valve body, all surfaces of the body are covered by a continuous surface layer of a different material, usually an elastomeric or plastic material. A soft elastomer behind a harder encapsulating material may be used to provide interference for disk and stem sealing areas.

encapsulation An international term describing a type of protection in which the parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in an encapsulant in such a way that this explosive atmosphere cannot be ignited. This type of protection is referred to by CENELEC as "Ex m" in draft standard EN50028. NOTE: Encapsulation is the potting or casting of electrical components with epoxy, elastomer, silicone, asphaltic, or similar compounds for the purpose of excluding moisture or vapours.

end connections, flanged End connections incorporating flanges that mate with corresponding flanges on the piping. **end connections, split clamp** End connections of various proprietary designs using split clamps to apply gasket or mating surface loading.

end connections, threaded End connections incorporating threads, either male or female.

end connections, welded End connections that have been prepared for welding to the line pipe or other fittings. May be butt weld (BW), or socket weld (SW).

endothermic reaction A reaction which occurs with the absorption of heat.

end-point In titration, an experimentally determined point close to the equivalence point, which is used as the signal to terminate titration; it is used instead of equivalence point in most calculations, and corrections for the error between end point and equivalence point usually are not applied.

end to end dimension See "face to face dimension" and "centre to end dimension".

entrainment The conveying of particles of water or solids from the boiler water by the steam.

entropy Function of the state of a thermodynamic system whose change in any differential reversible process is equal to the heat absorbed by the absolute temperature of the system. Also known as "thermal charge."

erasable programmable read-only memory (EPROM) A read-only memory in which stored data can be erased (typically by ultraviolet light) and reprogrammed bit by bit with appropriate voltage pulses.

erg The unit of energy in the CGS system; it is the amount of energy consumed (work) when a force of one dyne is applied through a distance of one centimeter.

error squared Control technique of introducing the square of the error in the error term of a linear algorithm so as to produce a nonlinear correction.

error, systematic An error which, in the course of a number of measurements made under the same conditions of the same value of a given quantity, either remains constant in absolute value and sign or varies according to a definite law when the conditions change.

error, zero In process instrumentation, error of a device operating under specified conditions of use, when the input is at the lower range value. It is usually expressed as percent of ideal span. Zero error, when displayed on an input/output calibration graph, is represented by an as found line that is parallel to the ideal line. The zero error may produce a constant offset.

evaporator A device where liquid undergoes a change of state from liquid to gas under relatively low temperature and low pressure.

exception reporting An information system which reports on situations only when actual results differ from planned results. When results occur within a normal range they are not reported.

excess air Air supplied for combustion in excess of theoretical combustion air.

expert system Software system that provides a knowledge base (the symbolic representation of the knowledge and reasoning of experienced human experts in a particular field) and a rule interpreter, or inference engine, to analyse problems and recommend solutions.

explosion Combustion which proceeds so rapidly that a high pressure is generated suddenly.

explosion door A door in a furnace or boiler setting designed to be opened by a predetermined gas pressure.

explosionproof enclosure An enclosure that is capable of withstanding an explosion of a gas or vapour within it and of preventing the ignition of an explosive gas or vapour that may surround it and that operates at such an external temperature that a surrounding explosive gas or vapour will not be ignited thereby. Refer also to flameproof enclosure.

exponent In floating point representation, one of a pair of numerals representing a number that indicates the power to which the base is raised. Synonymous with "characteristic."

exponential notation A way to express very large or small numbers in data processing.

exponentiation A mathematical operation that denotes increases in the base number by a previously selected factor.

Extended Binary Coded Decimal Interchange Code (EBCDIC) An 8 bit code containing alpha, numeric, and control characters.

extension bonnet A bonnet with a packing box that is extended above the bonnet joint of the valve body so as to minimise the effect on the temperature of the packing above or below the temperature by the process fluid. The length of the extension bonnet is dependent upon the difference between the fluid temperature and the packing design temperature limit as well as upon the valve body design.

extractive distillation A distillation technique (employing the addition of a solvent) used when the boiling points of the components being separated are very close [within 3°C (5°F)] or the components are constant boiling mixtures. In extractive distillation, which is a combination of fractionation and solvent extraction, the solvent is generally added to the top of the column and recovered from the bottom product by means of subsequent distillation. The chemical added is a solvent only to the less volatile components. See "azeotrope."

face to face dimension The dimensions from the face of the inlet opening to the face of the outlet opening of a valve or fitting.

facing, flange The finish on the end connection gasket surfaces of flanged or flangeless valves

Fahrenheit A temperature scale where the freezing point of pure water occurs at 32°F and the span between freezing point and boiling point of pure water at standard pressure is defined to be 180 scale divisions (180 degrees).

fail close A condition wherein the valve closure member moves to a closed position when the actuating energy source fails.

fail in place A condition wherein the valve closure component stays in its last position when the actuating energy source fails

fail open A condition wherein the valve closure member moves to an open position when the actuating energy source fails.

fail safe 1. A characteristic of a particular valve and its actuator, which upon loss of actuating energy supply, will cause a valve closure member to fully close, fully open or remain in fixed position. 2. Protection against effects of failure of equipment, for example, burner fuel shut off on flame failure.

fail safe device A component, system or control device so designed that it places the controlled parameter in a safe condition in case of a power interruption, controller malfunction or failure of a load carrying member.

failure mode The position to which the valve closure component moves when the actuating energy source fails.

failure rate A measure of component reliability usually expressed as the probability of failure after a specified length of time in service.

fan performance A measure of fan operation in terms of volume, total pressures, static pressures, speed, power input, mechanical and static efficiency, at a stated air density.

fan performance curves The graphical presentation of total pressure, static pressure, power input, mechanical and static efficiency as ordinates and the range of volumes as abscissa, all at constant speed and air density.

farad Metric unit of electrical capacitance.

fast-Fourier transform (FFT) A computer technique to calculate the frequency components of a time waveform from the digitised voltage measurements. The result is a display of amplitude versus frequency, and phase versus frequency.

feedback 1. Process signal used in control as a measure of response to control action. 2. The part of a closed loop system which automatically brings back information about the condition under control. 3. Part of a closed-loop system which provides information about a given condition for comparison with the desired condition.

feedback control An error-driven control system in which the control signal to the actuators is proportional to the difference between a command signal and a feedback signal from the process variable being controlled. See "control, feedback." **feedback control signal** The output signal which is returned to the input in order to achieve a desired effect, such as fast response.

feedforward control A method of control that compensates for a disturbance before its effect is felt in the output. It is based on a model that relates the output to the input where the disturbance occurs. In distillation the disturbances are usually feed rate and feed compositions. Steady state feedforward models are usually combined with dynamic compensation functions to set the manipulative variables and combined with feedback adjustment (trim) to correct for control model accuracy constraints.

feedstock Material delivered to a process or processing unit, especially raw material delivered to a chemical process or reaction vessel.

feedwater Process water supplied to a vessel such as a boiler or still, as opposed to circulating water or cooling water.

feedwater treatment The treatment of boiler feedwater by the addition of chemicals to prevent the formation of scale or eliminate other objectionable characteristics.

ferrography Wear analysis conducted by withdrawing lubricating oil from an oil reservoir and using a ferrograph analyzer to determine the size distribution of wear particles picked up as the oil circulates between moving mechanical parts; the technique also may be used to assess deterioration of human joints

fibres and flyings Materials not normally in suspension in air; such materials are of larger particles size than dusts. Fibres and flyings include materials such as cotton lint, sawdust, textile fibres, and other large particles that are typically a fire hazard rather than an explosion hazard.

filled system thermometer A device consisting of a temperature sensitive element (bulb), an element sensitive to changes in pressure or volume (Bourdon tube, bellows or diaphragm), capillary tubing and an indicating or recording device; the bulb, capillary tube and pressure or volume sensitive element are partly or completely filled with a fluid that changes its volume or pressure in a predictable manner with changes in temperature.

final control element Component of a control loop (such as a valve) which directly changes the value of the manipulated variable.

first order system A system definable by a first order differential equation.

fixed point arithmetic A method of calculation in which operations take place in an invariant manner, and in which the computer does not consider the location of the radix point. Contrasted with "floating point arithmetic. ".

flame propagation rate Speed of travel of ignition through a combustible mixture.

flameproof enclosure A term describing an enclosure that can withstand the pressure developed during an internal explosion of an explosive mixture and that prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure and that operates at such an external temperature that a surrounding explosive gas or vapour will not be ignited thereby. Refer also to explosionproof enclosure. This type of protection is referred to by IEC as "Ex d"].

flammability Susceptibility to combustion. flammable (explosive) limits The flammable (explosive) limits of a gas or vapour are the lower (LFL or LEL) and the upper (UFL or UEL) percentages by volume of concentration of gas in a gas-air mixture that will form an ignitable mixture.

flanged body Valve body with full flanged end connections.

flangeless control valve A valve without integral line flanges, which is installed by bolting between companion flanges, with a set of bolts, or studs, generally extending through the companion flanges. Also called a "wafer style" or "wafer body control valve.

flange taps Refer to "orifice flange taps."

flashing Vapour produced by discharging liquid at saturation temperature into a region of lower pressure.

flash point The minimum temperature at which a liquid emits vapour in a concentration sufficient to form an ignitable mixture with air near the surface of the liquid but not sufficient to sustain combustion.

flip flop A bistable device, i.e., a device capable of assuming two stable states. A bistable device is capable of storing one bit of information.

floating ball A full ball positioned within the ball valve that contacts either of two seat rings and is free to move toward the seat ring opposite the pressure source when in the closed position to effect tight shutoff

floating control action A type of control system action in which a fixed relationship exists between a measured deviation and the rate of motion of the final control element. Floating control reduces the tendency to overshoot the setpoint by reducing power input to the system as the controlled variable approaches the setpoint value.

floating control mode A controller mode in which an error in the controlled variable causes the output of the controller to change at a constant rate. The error must exceed preset limits before controller change starts.

flooding The consequence of excessive column liquid loading where, in effect, the liquid on trays becomes too deep for the vapour to pass through or where the vapour flow rate is too high, creating an excessive differential pressure or a decrease in the differential temperature across the column.

flotation A process for separating particulate matter in which differences in surface chemical properties are used to make one group of particles float on water while other particles do not; it is used primarily to separate minerals from gangue but is also used in some chemical and biological processes.

flow nozzle A differential pressure producing element having a contoured entrance. Can be mounted between flanges and has a lower permanent pressure loss than an orifice plate.

flow rate instability (bistable flow) An abrupt change in the control valve flow rate that occurs independent of changes in valve position. It can be caused by variable wall attachment of the fluid stream at the valve orifice, by flashing, or by cavitation.

flow straightener A supplementary length of straight pipe or tube, containing straightening vanes or the equivalent, which is installed directly upstream of a flowmeter for the purpose of eliminating swirl from the fluid entering the flowmeter

fluidised bed A dynamic mixture of a gas and/or vapour and minute solid particles of such a size that the mixture resembles a fluid in motion.

flume An adaptation of the venturi concept of flow constriction for open channel flow measurement.

fluted rotor flowmeter A type of flow measurement device in which fluid is trapped between two fluted rotors which are dynamically balanced but hydraulically unbalanced so that they turn at a rate proportional to the volume rate of fluid flow.

foot pound A force of one pound applied to a lever one foot long.

force balance transmitter A transmitter design technique utilising feedback of the output signal to balance the primary input signal from the measuring element. The balanced output signal is proportional to the measured variable.

forced draft Air under positive pressure produced by fans at the point where air or gases enter a unit, such as a combustion furnace or boiler.

forced oscillation Oscillation of a system parameter where the period of oscillation is determined by an external periodic driving force.

forced vibration Oscillation occurring at the frequency of a driving force input.

forcing Applying control signals greater than those warranted by a given deviation in the controlled variable in order to induce a more rapid rate of adjustment in the controlled variable.

four wire What is normally required for a full duplex circuit. Two wires are used for the transmission and two are used for the reception.

four-wire transmitter Electronic transmitter that has separate pairs of wires for signal and power.

fraction 1. In classification of powdered or granular solids, the proportion of the sample (by weight) that lies between two stated particle sizes. 2. In chemical distillation, the proportion of a solution of two liquids consisting of a specific chemical substance.

fractional distillation A thermal process whereby a mixture of liquids that boil at different temperatures is heated at a series of increasing temperatures, and the distillates boiled off at each temperature are collected separately.

fractionating column An apparatus for fractional distillation in which rising vapour and falling liquid are brought into intimate contact.

fraction defective In quality control, the average number of units of product containing one or more defects for each 100 units of product in a given lot.

free vibration Oscillation occurring at a natural frequency, after an initial force input.

free water The amount of water released when a wet solid is dried to its equilibrium moisture content.

frequency, damped The apparent frequency of a damped oscillatory time response of a system resulting from a nonoscillatory stimulus

frequency division multiplex (FDM) A system for the transmission of information about two or more quantities (measurands) over a common channel, by dividing the available frequency bands; amplitude, frequency, or phase modulation of the subcarriers may be employed.

frequency domain Vibration represented as a graph of amplitude versus frequency.

frequency, gain crossover On a Bode diagram of the transfer function of an element or system, the frequency at which the gain becomes unity (and its decibel value zero).

frequency, natural The frequency that a part, or system, will oscillate at if excited with an impulse.

frequency, phase crossover Of a loop transfer function, the frequency at which the phase angle reaches $+180^\circ$.

frequency, resonant The measurand frequency at which a transducer responds with maximum output amplitude. When major amplitude peaks occur at more than one frequency, the lowest of these frequencies is the resonant frequency.

frequency response A measure of the effectiveness with which a circuit or device transmits signals of different frequencies, usually expressed as a graph of magnitude or phase of an output signal as a function of frequency. Also known as "amplitude frequency response"; "sine wave response."

frequency response characteristic In process instrumentation, the frequency dependent relation, in both gain and phase, between steady state sinusoidal inputs and the resulting fundamental steady state sinusoidal outputs. Frequency response is commonly plotted on a Bode diagram.

frequency response method A method of tuning a process control loop for optimum operation by proper selection of controller settings. This method is based on a study of the frequency response of the open process control loop.

frequency, ringing The frequency of the oscillatory transient occurring in the transducer output as a result of a step change in measurand.

frequency shift keying (FSK) Modulation accomplished by switching from one discrete frequency to another discrete frequency.

frequency, undamped (frequency, natural) 1 Of a closed loop control system or controlled system, a frequency at which continuous oscillation (hunting) can occur without periodic stimuli. In linear systems, the undamped frequency is the phase crossover frequency. With proportional control action only, the undamped frequency of a linear system may be obtained in most cases by raising the proportional gain until continuous oscillation occurs.

frost plug A device for determining liquid level when the contents of a tank are at a temperature below 0°C; a side tube resembling a sight glass but having a series of closed tubes (plugs) at different levels instead of the glass; the tubes below liquid level are cooled so that moisture from the atmosphere forms frost on them, while the tubes above liquid level remain frost free.

full ball A valve closure member that is a complete spherical surface with a flow passage through it. The flow passage may be round, contoured or otherwise modified to yield a desired flow characteristic.

full duplex Communications that appear to have information transfer in both directions (transmit and receive) at the same time.

full-face gasket A flat gasket which contacts the entire flat contact surface of two mating flanges, extending past the bolt holes. This term applies to flat face flanges only.

fusible alloy An alloy with a very low melting point, in some instances approaching 150°F (65°C), usually based on Bi, Cd, Sn or Pb; the fusible alloys have varied uses, the most widely known being solders and fusible links for automatic sprinklers and fire alarms.

fusible plug A hollowed threaded plug having the hollowed portion filled with a low melting point material.

g Acceleration due to gravity; equal to 980 cm/sec² (32.2 ft/sec²) on the surface of the earth.

gauge cock A valve attached to a water column or drum for checking water level.

gauge pressure Pressure measured relative to ambient pressure.

gain 1. Ratio of output signal magnitude to input signal magnitude; when less than one this is usually called attenuation. 2. The relative degree of amplification in an electronic circuit. 3. The ratio of the change in output to the change in input which caused the change. 4. In a controller, the reciprocal of proportional band Proportional band can be expressed as a dimensionless number (gain) or as a percent.

gain, closed-loop In process instrumentation, the gain of a closed-loop system, expressed as the ratio of the output change to the input change at a specified frequency.

gain, derivative action (rate gain) The ratio of maximum gain resulting from proportional-plus- derivative control action to the gain due to proportional control action alone.

gain, dynamic The magnitude ratio of the steady state amplitude of the output signal from an element or system to the amplitude of the input signal to that element or system, for a sinusoidal signal.

gain, loop In process instrumentation, the ratio of the absolute magnitude of the change in the feedback signal to the change in its corresponding error signal at a specified frequency. NOTE: The gain of the loop elements may be measured by opening the loop, with appropriate termination. The gain so measured is often called the open-loop gain

gain (magnitude ratio) For a linear system or element, the ratio of the magnitude (amplitude) of a steady state sinusoidal output relative to the causal input; the length of a phasor from the origin to a point of the transfer locus in a complex plane. NOTE: The quantity may be separated into two factors: 1. a proportional amplification often denoted as K, which is frequency-independent, and associated with a dimensioned scale factor relating to the units of input and output; 2. A dimensionless factor often denoted as G which is frequency dependent. Frequency, conditions of operation, and conditions of measurement must be specified. A loop gain characteristic is a plot of log gain vs. log frequency. In nonlinear systems, gains are often amplitude dependent.

gain margin The reciprocal of the open loop gain for a stable feedback system at the frequency at which the phase angle reaches -180°.

gain, proportional The ratio of the change in output due to proportional control action to the change in input.

gain, static (zero frequency gain) Of gain of an element, or loop gain of a system, the value approached as a limit as frequency approaches zero. Its value is the ratio of change of steady state output to a step change in input provided the output does not saturate.

gal A unit of acceleration equal to 1 cm/s². The milligal is frequently used because it is about 0.001 times the earth's gravity.

galling Localised adhesive welding with subsequent spalling and roughening of rubbing metal surfaces as a result of excessive friction and metal to metal contact at high spots.

gallon A unit of capacity (volume) usually referring to liquid measure in the British or U. S. customary system of units. The capacity defined by the British (Imperial) gallon equals 1.20095 U.S. gallons; one U.S. gallon equals four quarts or 3.785 10⁻³ m³.

galvanic corrosion Electrochemical corrosion associated with current in a galvanic cell, which is set up when two dissimilar metals (or the same metal in two different metallurgical conditions) are in electrical contact and are immersed in an electrolytic solution.

game theory A mathematical process of selecting an optimum strategy in the face of an opponent who has a strategy of his own.

gamma ray 1. Electromagnetic radiation emitted by the nucleus of an atom, each photon resulting from the quantum transition between two energy levels of the nucleus. 2. A term sometimes used to describe any high energy electromagnetic radiation, such as rays exceeding about 1 MeV or photons of annihilation radiation.

gas chromatography A separation technique involving passage of a gaseous moving phase through a column containing a fixed adsorbent phase; it is used principally as a quantitative analytical technique for volatile compounds.

gasket A sealing member, usually made by stamping from a sheet of cork, rubber, metal or impregnated synthetic material and clamped between two essentially flat surfaces to prevent pressurised fluid from leaking through the crevice; typical applications include flanged joints in piping, head seals in a reciprocating engine or compressor, casing seals in a pump, or virtually anywhere a pressure tight joint is needed between stationary members. Also known as "static seal."

gas lift The technique of raising a liquid in a vertical flow line by injecting a gas below a portion of the liquid column causing upward flow.

gate array A circuit consisting of an array of logic gates aligned on a substrate in a regular pattern.

gate valve 1. A valve with a linear motion closure member that is a flat or wedge shaped gate which may be moved in or out of the flow stream. It has a straight through flow path. 2. A type of valve whose flow control element is a disc or plate that undergoes translational motion in a plane transverse to the flow passage through the valve body.

gauss The CGS unit of magnetic flux density or magnetic induction; the SI unit, the tesla, is preferred.

Geiger Muller counter A radiation measuring instrument whose active element is a gas filled chamber usually consisting of a hollow cathode with a fine wire anode along its axis; in operation, the voltage between anode and cathode is high enough that the discharge caused by a primary ionising event spreads over the entire anode until stopped when the space charge reduces the electric field magnitude. Also known as "Geiger counter."

General-Purpose Interface Bus (GPIB) IEEE-488 standard bus. Used for computer interfacing to electronic instruments.

gilbert The CGS unit of magnetomotive force; the SI unit, the ampere (or ampere turn) is preferred.

gland 1. A device for preventing a pressurised fluid from leaking out of a casing at a machine joint, such as at a shaft penetration. Also known as "gland seal. " 2. A movable part that compresses the packing in a stuffing box.

globe valve 1. A valve with a linear motion closure member, one or more ports and a body distinguished by a globular shaped cavity around the port region. 2. A type of flow regulating valve consisting of a movable disc and a stationary ring seat in a generally spherical body. In the general design, the fluid enters below the valve seat and leaves from the cavity above the seat.

go/no go test A test in which one or more parameters are determined, but which can result

only in acceptance or rejection of the test object, depending on the value(s) measured.

governor A device for automatically regulating the speed or power of a prime mover

grab sampling A method of sampling bulk materials for analysis, which consists of taking one or more small portions (usually only imprecisely measured) at random from a pile, tank, hopper, railcar, truck or other point of accumulation.

graceful degradation A system attribute wherein when a piece of equipment fails, the system falls back to a degraded mode of operation rather than failing catastrophically and giving no response to its users.

graded index fiber (GRIN) An optical fiber in which the refractive index changes gradually between the core and cladding, in a way designed to refract light so it stays in the fiber core. Such fibers have lower dispersion and broader bandwidth than step index fibers.

gravitational constant A dimensionless conversion factor in English units which arises from Newton's second law ($F = ma$) when mass is expressed in pounds mass (lbm). gravitometer See "densimeter."

gravity Weight index of fuels; liquid, petroleum products expressed either as specific, Baume or API (American Petroleum Institute) gravity; weight index of gaseous fuels as specific gravity related to air under specified conditions; or weight index of solid fuels as specific gravity related to water under specified conditions.

gray Metric unit for absorbed dose.

graybody An object having the same spectral emissivity at every wavelength, or one whose spectral emissivity equals its total emissivity.

Gray code A generic name for a family of binary codes which have the property that a change from one number to the next sequential number can be accomplished by changing only one bit in a code for the original number. This type of code is commonly used in rotary shaft encoders to avoid ambiguous readings when moving from one position to the next.

grounding The act of establishing a conductive connection, whether intentional or accidental, between an electrical circuit or electrical equipment and either the earth or some other conducting body that serves in place of the earth.

ground loop Circulating current between two or more connections to electrical ground. This signal can be detected and displayed by electronic instruments. These signals are generally not associated with the variable to be measured and represent noise in the measuring system.

group Lists of materials of similar explosion hazard.

group velocity The velocity corresponding to the rate of change of average position of a wave packet as it travels through a medium.

half duplex Communications in both directions (transmit and receive), but in only one direction at a given instant in time.

half life The time span necessary for the atoms of a nuclide to disintegrate by one half.

Hall effect An electromotive force developed as a result of interaction when a steady state current flows in a steady state magnetic field; the direction of the emf is at right angles to both the direction of the current and the magnetic field vector, and the magnitude of the emf is proportional to the product of current intensity, magnetic force, and sine of the angle between current direction and magnetic field vector.

halogen Any one of the four chemical elements; chlorine, fluorine, bromine or iodine.

Hamming distance A characteristic of any given data code that indicates the ability to detect single bit errors; it equals the number of bits in any given character that must be changed to produce another legitimate character.

harmonic content The distortion in a transducer's sinusoidal output, in the form of harmonics other than the fundamental component. NOTE: (S) It is usually expressed as a percentage of rms output.

harmonic distortion 1. Distortion characterised by the appearance in the output of harmonics other than the fundamental component when the input wave is sinusoidal. 2. Distortion caused by the presence of harmonics of a desired signal. 3. Generation of unwanted harmonics by a device as expressed by the amplitude of the harmonics as a percentage or ratio (in dB) of the primary signal.

Hastelloy B An International Nickel co. alloy having a nominal composition of nickel (Ni) 66.7%; iron (Fe) 5%; molybdenum (Mo) 28%; vanadium (V) 0.3%.

Hastelloy C An International Nickel co. alloy having a nominal composition of nickel (Ni) 59%; iron (Fe) 5%; molybdenum (Mo) 16%; tungsten (W) 4%; chromium (Cr) 16%.

hazardous area An area in which explosive gas/air mixtures are, or may be expected to be, present in quantities such as to require special precautions for the construction and use of electrical apparatus.

hazardous area classifications

1. Division 1 (hazardous). Where concentrations of flammable gases or vapours exist a) continuously or periodically during normal operations; b) frequently during repair or maintenance or because of leakage; or c) due to equipment breakdown or faulty operation which could cause simultaneous failure of electrical equipment. (See "National Electrical Code, Paragraph 500 4(a)" for detailed definition.)

2. Division 2 (normally nonhazardous). Locations in which the atmosphere is normally nonhazardous and may become hazardous only through the failure of the ventilating system, opening of pipe lines, or other unusual situations. (See "National Electrical Code, Paragraph 500 4(b)" for detailed definition.)

3. Nonhazardous. Areas not classified as Division 1 or Division 2 are considered nonhazardous. NOTE: It is safe to have open flames or other continuous sources of ignition in nonhazardous areas [S12.4].

hazardous atmosphere 1. A combustible mixture of gases and/or vapours. 2. An explosive mixture of dust in air. hazardous (classified) location A location where fire or explosion hazards may exist due to flammable gases or vapours, flammable liquids, combustible dust, or easily ignitable fibers or flyings.

hazardous material Any substance that requires special handling to avoid endangering human life,

health or well being. Such substances include poisons, corrosives, and flammable, explosive or radioactive chemicals.

head loss Pressure loss in terms of a length parameter such as inches of water or millimeters of mercury.

head pressure Expression of a pressure in terms of the height of fluid. $P = \gamma p g$, where p is fluid density and y is the fluid column height.

heart cut Chromatography technique is frequently used in the analysis of trace components that are not readily separated from a large composition peak. It utilises two columns and a diverting valve, and reduces the ratio of large components to small ones.

heat Energy that flows between bodies because of a difference in temperature; same as thermal energy.

heat available The thermal energy above a fixed datum that is capable of being absorbed for useful work. In boiler practice, the heat available in a furnace is usually taken to be the higher heating value of the fuel corrected by subtracting radiation losses, unburned combustible, latent heat of the water in the fuel formed by the burning of hydrogen, and adding the sensible heat in the air for combustion, all above ambient temperatures.

heat balance An accounting of the distribution of the heat input and output.

heat content The amount of heat per unit mass that can be released when a substance undergoes a drop in temperature, a change in state or a chemical reaction.

heat exchanger A vessel in which heat is transferred from one medium to another.

heat flux The quantity of thermal energy transferred to a unit area per unit time.

heat transfer, coefficient of Heat flow per unit time across a unit area of a specified surface under the driving force of a unit temperature difference between two specified points along the direction of heat flow. Also known as "over all coefficient of heat transfer. "

heat tracing The technique of adding heat to a process or instrument measurement line by placing a steam line or electric heating element adjacent to the line.

henry Metric unit for inductance.

Henry's law A principle of physical chemistry that relates equilibrium partial pressure of a substance in the atmosphere above a liquid solution to the concentration of the same substance in the liquid; the ratio of concentration to equilibrium partial pressure equals the Henry's law constant, which is a temperature sensitive characteristic; Henry's law generally applies only at low liquid concentrations of a volatile component.

hertz Unit for frequency of a periodic phenomenon measured in cycles per second.

heuristic Pertaining to a method or problem solving in which solutions are discovered by evaluation of the progress made toward the final solution, such as a controlled trial and error method. An exploratory method of tackling a problem, or sequencing of investigation, experimentation, and trial solution in closed loops, gradually closing in on the solution. A heuristic approach usually implies or encourages further investigation, and makes use of intuitive decisions and inductive logic in the absence of direct proof known to the user. Thus, heuristic methods lead to solutions of problems or inventions through continuous analysis of results obtained thus far, permitting a determination of the next step. A stochastic method assumes a solution on the basis of intuitive conjecture or speculation and testing the solution against known evidence, observations, or measurements. The stochastic approach tends to omit intervening or intermediate steps toward a solution. Contrast with stochastic and algorithmic.

heuristic program A program that monitors its performance with the objective of improved performance.

hexadecimal (hex) A number of representation system of base 16 and the digit symbols from 0 to 9 and A to F. The hex number system is very useful in cases where computer words are composed of multiples of four bits (that is, 4 bit words, 8 bit words, 16 bit words, and so on).

high level language A programming language whose statements are translated into more than one machine language instruction. Examples of high level languages are BASIC, FORTRAN, COBOL, and PASCAL.

humidity, relative The ratio of the water vapour pressure actually present to the water vapour pressure required for saturation at a given temperature, expressed in percent.

hunting An undesirable oscillation of appreciable magnitude, prolonged after external stimuli disappear. Note: In a linear system, hunting is evidence of operation at or near the stability limit; nonlinearities may cause hunting of well defined amplitude and frequency. In automatic control, hunting is generally caused by the gain or reset of the controller being set too high.

hydrocracker A chemical reactor in which large hydrocarbon molecules are fractured in the presence of hydrogen.

hydrogen damage Any of several forms of metal failure caused by dissolved hydrogen, including blistering, internal void formation, and hydrogen induced delayed cracking.

hydrostatic test Determining the burst resistance or leak tightness of a fluid component or system by imposing internal pressure.

hygrometer An instrument for directly indicating humidity. **hygrometry** Any process for determining the amount of moisture present in air or another gas.

hygroscopic Having a tendency to absorb water. Having the ability to accelerate the condensation of water vapour.

hypergolic A term related to spontaneous ignition upon contact.

hysteresis 1. That property of an element evidenced by the dependence of the value of the output, for a given excursion of the input upon the history of prior excursions and the direction of the current traverse. NOTE: 1 It is usually determined by subtracting the value of dead band from the maximum measured separation between upscale going and downscale going indications of the measured variable (during a full range traverse, unless otherwise specified) after transients have decayed. This measurement is sometimes called "hysteresis error". NOTE 2: Some reversal of output may be expected for any small reversal of input; this distinguishes hysteresis from dead band. 4. A phenomenon demonstrated by materials which make their behavior a function of the history of the environment to which they have been subjected. 5. The tendency of an instrument to give a different output

ideal gas A hypothetical gas characterised by its obeying precisely the equation for a perfect gas, $PA = nRT$.

illuminance Luminous flux per unit area over a uniformly illuminated surface.

immersion length Of a thermometer, the distance along the thermometer body from the boundary of the medium whose temperature is being determined to the free end of the well, bulb or element, if unprotected.

impedance The complex ratio of a force-like parameter to a related velocity-like parameter - for instance, force to velocity, pressure volume velocity, electric voltage to current, temperature to heat flow, or electric field strength to magnetic field strength.

Impedance, input 1. The impedance (presented to the excitation source) measured across the excitation terminals of a transducer. 2. Impedance presented by a device to the source. 3. The impedance presented by a device or system output element to the input.

impedance, load Impedance presented to the output of a device by the load.

impedance, output 1. The impedance across the output terminals of a transducer presented by the transducer to the associated external circuitry. 2. Impedance presented by a device to the load. 3. The internal impedance of an output element which limits that element's ability to deliver power.

impedance, source Impedance presented to the input of a device by the source.

inches water gauge (wig.) Usual term for expressing a measurement of relatively low pressures or differentials by means of a U tube. One inch w.g. equals 5.2 lb per sq ft or 0.036 lb per sq in.

indined tube manometer A glass tube manometer having one leg inclined from the vertical to give more precise readings.

incomplete combustion The partial oxidation of the combustible constituents of a fuel.

incompressible Liquids are referred to as being incompressible since their change in volume due to pressure is negligible.

Inconel A series of International Nickel Co. high nickel, chromium and iron alloys characterised by inertness to certain corrosive fluids.

increased safety A type of protection by which measures are applied so as to reduce the probability of excessive temperatures and of the occurrence of arcs or sparks in the interior and on the external parts of electrical apparatus which does not produce them in normal service and which is intended for use in hazardous locations defined by the IEC as Zone 1. Referred to by IEC as type "Ex e" protection.

independent variable 1. A process or control system parameter that can change only due to external stimulus.
2. A parameter whose variations, intentional or unintentional, induce changes in other parameters according to predetermined relationships.

induced draft Airflow through a device such as a firebox or drying unit which is produced by placing a fan or suction jets in the exit duct.

inductance 1. In an electrical circuit, the property that tends to oppose changes in current magnitude or direction.
2. In electromagnetic devices, generating electromotive force in a conductor by means of relative motion between the conductor and a magnetic field such that the conductor cuts magnetic lines of force.

induction heating Raising the temperature of an electrically conductive material by electromagnetically inducing eddy currents in the material.

infrared Any electromagnetic wave whose wavelength is 0.78 to 300 μm .

infrared absorption moisture detector An instrument for determining moisture content of a material such as sheet paper; moisture content can be read directly by determining the ratio of two beam intensities, one at a wavelength within the resonant absorption band for water and the other at a wavelength just outside the band.

infrared spectroscopy A technique for determining the molecular species present in a material, and measuring their concentrations, by detecting the characteristic wavelengths at which the material absorbs infrared energy and measuring the relative drop in intensity associated with each absorption band.

inherent flow characteristic The relationship between the flow rate through a valve and the travel of the closure member as the closure member is moved from the closed position to rated travel with constant pressure drop across the valve

integer programming 1. In operations research, a class of procedures for locating the maximum or minimum of a function subject to constraints, where some or all variables must have integer values.

integral 1. This control action will cause the output signal to change according to the summation of the input signal values sampled at regular intervals up to the present time. 2. Mathematically it is the reciprocal of reset.

integral absolute error (IAE) A measure of controller error defined by the integral of the absolute value of a time dependent error function; used in tuning automatic controllers to respond properly to process transients.

integral action A type of controller function where the output (control) signal or action is a time integral of the input (sensor) signal.

integral action rate (reset rate) 1. Of proportional-plus-integral or proportional-plus-integral plus-derivative control action devices; for a step input, the ratio of the initial rate of change of output due to integral control action to the change in steady state output due to proportional control action. NOTE: Integral action rate is often expressed as the number of repeats per minute because it is equal to the number of times per minute that the proportional response to a step input is repeated by the initial integral response. 2. Of integral control action devices; for a step input, the ratio of the initial rate of change of output to the input change.

integral control Form of control action that returns the value of the controlled variable to the set point when sustained offset occurs without this action. Also called "reset control."

integral control action (reset) Control action in which the output is proportional to the time integral of the error input, i.e., the rate of change of output is proportional to the error input.

integral orifice A differential pressure measuring technique for small flow rates in which the fluid flows through a miniature orifice plate integral with a special flow fitting.

integral time absolute error (ITAE) A measure of controller error defined by the integral of the product of time and the absolute value of a time dependent error function; whereas the absolute value prevents opposite excursions in the process variable from canceling each other, the multiplication by time places a more severe penalty on sustained transients.

Integrated Systems Digital Network (ISDN) A suite of protocols being defined by CCITT to provide voice and data services over wide area networks (WANs).

interacting control Control action produced by an algorithm whose various terms are interdependent.

interaction A phenomena, characteristic of a multivariable process, in which the effect of a manipulative variable change in one control loop not only affects its own controlled variable, but also the controlled variable in another loop.

intercooler A heat exchanger in the path of fluid flow between stages of a compressor to cool the fluid and allow it to be further compressed at lower power demand.

interference, common mode A form of interference which appears between measuring circuit terminals and ground.

interference, electromagnetic Any spurious effect produced in the circuits or elements of a device by external electromagnetic fields. NOTE: A special case of interference from radio transmitters is known as "radio frequency interference (RFI)"

interference, normal-mode A form of interference which appears between measuring circuit terminals.

interference pattern The pattern of some characteristic of a stationary wave produced by superimposing one wave train on another.

interlock 1. To arrange the control of machines or devices so that their operation is interdependent in order to assure their proper coordination. 2. Instrument which will not allow one part of a process to function unless another part is functioning. 3. A device such as a switch that prevents a piece of equipment from operating when a hazard exists.

intermodulation The modulation of the components of a complex wave by each other, producing new waves whose frequencies are equal to the sums and differences of integral multiples of the component frequencies of the original complex wave.

intermodulation distortion (IMD) 1. Distortion caused by interaction of two or more signals. 2. Defined as $20 \log (\text{rms sum of the sum and difference distortion products}) / (\text{rms amplitude of the fundamental})$.

intrinsically safe circuit A circuit in which no spark nor any thermal effect produced under prescribed test conditions (which include normal operation and specified fault conditions) is capable of causing ignition of a given explosive atmosphere.

intrinsic safety 1. A type of protection in which a portion of the electrical system contains only intrinsically safe equipment (apparatus, circuits, and wiring) that is incapable of causing ignition in the surrounding atmosphere. No single device or wiring is intrinsically safe by itself (except for battery-operated self-contained apparatus such as portable pagers, transceivers, gas detectors, etc., which are specifically designed as intrinsically safe self-contained devices) but is intrinsically safe only when employed in a properly designed intrinsically safe system. This type of protection is referred to by IEC as "Ex I." see also "associated equipment (apparatus)". 2. Design methodology for a circuit or an assembly of circuits in which any spark or thermal effect produced under normal operating and specified fault conditions is not capable under prescribed test conditions of causing ignition of a given explosive atmosphere. 3. A method to provide safe operation of electric process control instrumentation where hazardous

atmospheres exist. The method keeps the available electrical energy so low that ignition of the hazardous atmosphere cannot occur. 4. A protection technique based upon the restriction of electrical energy within apparatus and of interconnecting wiring, exposed to a potentially explosive atmosphere, to a level below that which can cause ignition by either sparking or heating effects. Because of the method by which intrinsic safety is achieved, it is necessary to ensure that not only the electrical apparatus exposed to the potentially explosive atmosphere but also other electrical apparatus with which it is interconnected is suitably constructed.

intrinsic safety barrier 1. A component containing a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location, under specified fault conditions. 2. A device inserted in wire between process control instrumentation and the point where the wire passes into the hazardous area. It limits the voltage and current on the wire to safe levels.

intrinsic safety ground bus A grounding system which has a dedicated conductor separate from the power system so that ground currents will not normally flow and which is reliably connected to a ground electrode in accordance with the applicable standard.

inversion temperature In a thermocouple, the temperature of the "hot" junction when the thermoelectric emf of the circuit is equal to zero.

ion exchange A chemical process for removing unwanted dissolved ions from water by inducing an ion exchange reaction (either cation or anion) as the water passes through a bed of special resin containing the substitute ion.

ion exchange resin A synthetic organic compound (resin) that can remove unwanted ions from a dilute solution by combining with them or by exchanging them for ions that produce desirable or neutral effects.

ionisation The process of splitting a neutral molecule into positive and negative ions, or of detaching one or more electrons from a neutral atom.

isentropic Proceeding at constant entropy.

isentropic exponent A ratio defined by the specific heat at constant pressure divided by the specific heat at constant volume.

isobaric Proceeding at constant pressure.

isotope Any of two or more nuclides that have the same number of protons in their nuclei but different numbers of neutrons; such atoms are of the same element, and thus cannot be separated from each other by chemical means, but because they have different masses can be separated by physical means.

iterate To repeatedly execute a loop or series of steps. For example, a loop in a routine. iterative

jacketed valve A valve body cast with a double wall or provided with a double wall by welding material around the body so as to form a passage for a heating or cooling medium. Also refers to valves which are enclosed in split metal jackets having internal heat passageways or electric heaters. Also referred to as "steam jacketed" or "vacuum jacketed." In a vacuum jacketed valve, a vacuum is created in the space between the body and secondary outer wall to reduce the transfer of heat by convection from the atmosphere to the internal process fluid, usually cryogenic.

Kalman filter A technique for calculating the optimum estimates of process variables in the presence of noise; the technique, which generates recursion formulas suitable for computer solutions, also can be used to design an optimal controller.

Kernaugh map A tubular arrangement that facilitates the combination and elimination of logical functions by listing similar logical expressions, thereby taking advantage of the human brain's ability to recognise visual patterns to perform the minimisation.

KByte 1024(210) bytes.

kelvin Metric unit for thermodynamic temperature. The Kelvin scale is an absolute temperature scale where the zero point is defined as absolute zero and the scale divisions (called kelvins) are equal to the scale divisions in the Celsius system. $0^{\circ}\text{C} = \text{approximately } 273.16 \text{ kelvins or K.}$

Kennison nozzle A specially shaped nozzle designed for measuring flow through partially filled pipes; because of its self-scouring, nonclogging design, it is especially useful for measuring flow of liquids containing suspended solids or debris and at low flow rates or widely varying flow rates.

Keyphasor A sensing device to detect the passage of a point on the rotor. May be a magnetic, capacitive, eddy current, or photoelectric probe. The signal is used as a trigger for the external trigger input of other instruments, such as a vibration monitor.

kilogram Metric unit of mass.

kinematic viscosity Absolute viscosity of a fluid divided by its density.

kinetic energy 1. The energy of a working fluid caused by its motion. 2. Energy related to the fluid of dynamic pressure, $\frac{1}{2} \rho v^2$.

Knudsen flow Gas flow in a long tube at pressures such that the mean free path of a gas molecule is significantly greater than the tube radius.

ladder diagram Symbolic representation of a control scheme. The power lines form the two sides of a ladder like structure, with the program elements arranged to form the rungs. The basic program elements are contacts and coils as in electromechanical logic systems.

lag 1. A relative measure of the time delay between two events, states, or mechanisms. 2. In control theory, a transfer function term in the form, $\frac{1}{(Ts + 1)}$.

lambert A unit of luminance; it equals the uniform luminance of a perfectly diffusing surface emitting or reflecting light at one lumen per square centimeter.

laminar flow 1. A type of streamline flow most often observed in viscous fluids near solid boundaries, which is characterised by the tendency for fluid to remain in thin, parallel layers to maintain uniform velocity. 2. A nonturbulent flow regime in which the stream filaments glide along the pipe axially with essentially no transverse mixing. Also known as "viscous" or "streamline flow." 3. Flow under conditions in which forces due to viscosity are more significant than forces due to inertia.

Laplace transform For a function its Laplace transform is the function $F(y)$ defined as the integral over x from 0 to ∞ of the function $e^{-yx}f(x)$.

LASER Light amplification by stimulated emission of radiation. It is a source of EM radiation generally in the IR, visible, or W bands and is characterised by small divergence, coherence, and monochromaticity.

laser Doppler flowmeter An apparatus for determining flow velocity and velocity profile by measuring the Doppler shift in laser radiation scattered from particles in the moving fluid stream

latency In data processing, the time between the completion of the interpretation of an address and the start of the actual transfer from the addressed location. Latency includes the delay associated with access to storage devices such as disc drives.

latent heat Heat that does not cause a temperature change.

leakage classification Refer to ANSI B16. 104 to categorise seat leakage of control valve trim.

light-emitting diode (LED) A semiconductor diode which emits visible or infrared light. Light from an LED is incoherent spontaneous emission, as distinct from the coherent stimulated emission produced by diode lasers and other types of lasers.

limit cycle A sustained oscillation of finite amplitude.

linearity The closeness of a calibration curve to a specified straight line. Linearity is expressed as the maximum deviation of any calibration point on a specified straight line, during any one calibration cycle. It is expressed as "within + percent of full scale output".

linear programming (LP) A method of solution for problems in which a linear function of a number of variables is subject to a number of constraints in the form of linear inequalities.

linear variable differential transformer (LVDT) A position sensor consisting of a central primary coil and two secondary coils wound on the same core; a moving iron element linked to a mechanical member induces changes in self induction that are directly proportional to movement of the member.

linear variable reluctance transducer (LVRT) A position sensor consisting of a centre tapped coil and an opposing moving coil attached to a linear probe; the winding is continuous over the length of the core, instead of being segmented as in an LVDT.

liquid pressure recovery factor The ratio (F_1) of the valve flow coefficient (C_v) based on the pressure drop at the vena contracta, to the usual valve flow coefficient (C_v) which is based on the overall pressure drop across the valve in non vapourising liquid service. These coefficients compare with the orifice metering coefficients of discharge for vena contracta taps and pipe taps, respectively.

Litre Abbreviated l. The SI unit of volume; it equals 0.001 m³ or 1.057

load cell A transducer for the measurement of force or weight. Action is based on strain gauges mounted within the cell on a force beam.

load impedance The impedance presented to the output terminals of a transducer by the associated external circuitry.

longitudinal redundancy check (LRC) Error detection scheme that consists of a byte where each bit is calculated on the basis of the parity of all the bits in the block that have the same power of two.

longitudinal wave A wave in which the medium is displaced in a direction perpendicular to the wave front at all points along the wave.

loop, closed (feedback loop) A signal path which includes a forward path, a feedback path and a summing point, and forms a closed circuit.

loop gain The product of the gains of all the elements in a loop.

luminance The luminous intensity of any surface in a given direction per unit of projected area in a plane perpendicular to that direction.

luminosity Emissive power with respect to visible radiation.

luminous flux The amount of light passing a given point per unit time.

luminous intensity Luminous flux per unit solid angle.

lux Metric unit of illuminance.

or a given input, depending on whether the input resulted from an increase or decrease from the previous value.

Mach number The ratio of the fluid velocity to the velocity of sound in the fluid, at the same temperature and pressure.

manipulated variable 1. In a process that is desired to regulate some condition, a quantity or a condition that is altered by the control in order to initiate a change in the value of the regulated condition.

Manufacturing Automation Protocol (MAP) A specification for a suite of communication standards for use in manufacturing automation developed under the auspices of General Motors Corporation.

material balance 1. The procedure of accounting for the mass of material going into a process versus the mass leaving the process.

mathematical programming In operations research, a procedure for locating the maximum or minimum of a function subject to constraints. Refer also to "convex programming," "dynamic programming," "integer programming," "linear programming," "nonlinear programming," and "quadratic programming."

Maxwell The CGS unit of magnetic flux.

MByte 1,048,576(220)bytes.

mean time between failures (MTBF) The limit of the ratio of operating time of equipment to the number of observed failures as the number of failures approaches infinity. The total operating time divided by the quantity $(n + 1)$, where n is the number of failures during the time considered.

mean time to failure (MTTF) The average or mean time between initial operation and the first occurrence of a failure or malfunction, as the number of measurements of such time on many pieces of identical equipment approaches infinity.

mechanical compliance Displacement of a mechanical element per unit force; it is the mechanical equivalent of capacitance in an electrical circuit.

mechanical hygrometer A hygrometer that uses an organic material, such as a bundle of human hair, to sense changes in humidity.

meter prover A device for checking the accuracy of a flow meter.

meter run A flowmeter installed and calibrated in a section of pipe having adequate upstream and downstream length to satisfy standards of flowmeter installation.

MeV Mega electron volts; a unit of energy equivalent to the kinetic energy of a single electron accelerated through an electric potential of 1 million volts.

mho A customary unit of conductance and admittance generally defined as the reciprocal of one ohm, or the conductance of an element whose resistance is one ohm; the equivalent SI unit Siemen is preferred.

microwave Electromagnetic radiation having a wavelength of 1 to 300 mm (frequency between infrared and radio waves).

microwave amplification by the stimulated emission of radiation (MASER) The microwave equivalent and predecessor of the laser. It produces coherent microwaves.

mile A non metric unit of length; a statute mile, used for distances over land, is defined as 5280 ft.; a nautical mile, used for distances along the surface of the oceans, is defined as one minute of arc measured along the equator, which equals 6080.27 ft or 1.1516 statute miles.

millimetre 1. A unit of length equal to 0.001 meter. 2. A millimeter of mercury, abbreviated mm Hg, is a unit of pressure equivalent to the pressure exerted by a column of pure liquid mercury one mm high at 0°C under a standard gravity of 980.665 cm/s²; it is roughly equivalent to 1/760th of standard atmospheric pressure.

modulating The actions to keep a quantity or quality in proper measure or proportion.

modulation 1. The process or the result of the process by which some characteristic of one wave is varied in accordance with some characteristic of another wave (AM, amplitude modulation; PM, phase modulation; FM, frequency modulation). 2. The action of a control valve to regulate fluid flow by varying the position of the closure component.

modulus of elasticity In any solid, the slope of the stress-strain curve within the elastic region; for most materials, the value is nearly constant up to some limiting value of stress known as the elastic limit; modulus of elasticity can be measured in tension, compression, torsion or shear; the tension modulus is often referred to as "Young's modulus. "

Monel High nickel, high copper alloys used for their corrosion resistant properties to certain conditions.

Monte Carlo method A trial and error method of repeated calculations to discover the best solution of a problem. Often used when a great number of variables are present, with interrelationships so extremely complex as to forestall straightforward analytical handling.

multiplexing The transmission of a number of different messages simultaneously over a single circuit.

NAK (negative acknowledgment) This code indicates that the last block transmitted was in error and that the receiver is expecting a re-transmission.

nano A prefix which means one billionth.

nappe A sheet of liquid passing through the notch and falling over the weir crest.

natural draft Convective flow of a gas as in a boiler, stack or cooling tower-due to differences in density. Warm gas in the chamber rises toward the outlet, drawing in colder, more dense gas through inlets near the bottom of the chamber.

natural frequency See "frequency, undamped"; see also "frequency, resonant."

needle valve. Its essential design feature is a slender tapered rodlike control element which fits into a circular or conoidal seat. Operating the valve causes the rod to move into or out of the seat, gradually changing the effective cross sectional area of the gap between the rod and its seat.

NEMA standard Consensus standards for electrical equipment approved by the majority of the members of the US National Electrical Manufacturers Association.

neoprene A synthetic rubber which exhibits excellent resistance to weathering, ozone, flames, various chemicals and oils.

neper A unit of measure determined by taking the natural logarithm of the scalar ratio of two voltages or two currents.

nephelometer A general terms for instruments that measure the degree of cloudiness or turbidity.

nephelometry The application of photometry to the measurement of the concentration of - very dilute suspensions.

net positive suction head The minimum difference between the static pressure at the inlet to a pump and vapour pressure of the liquid being pumped. Below that pressure, fluid is not forced far enough into the pump inlet to be acted upon by the impeller.

network In data processing, any system consisting of an interconnection of computers and peripherals. Information is transferred between the devices in the network. LAN (Local Area Network) is a system at one location linked by cables. WAN (Wide Area Network) is a widely dispersed system usually connected by telephone lines.

neutral point Point on the titration curve where the hydrogen ion concentration equals the hydroxyl ion concentration.

neutralise To make a solution neutral (neither acidic nor basic, pH of 7) by adding a base to an acidic solution or an acid to a basic solution.

neutron A nuclear particle with a mass number of one and exhibiting zero (neutral) charge.

newton Metric unit for force.

Newtonian flow Fluid characteristics adhering to the linear relation between shear stress, viscosity and velocity distribution.

NFPA US National Fire Protection Association.

nibble A word with four bits, or one half a byte.

nipple A short piece of pipe or tube, usually with an external thread at each end.

noble metal thermocouple A thermocouple whose elements are made of platinum (Pt) or platinum rhodium (Pt-Rh alloys), and that resist oxidation and corrosion at temperatures up to about 1550°C (2800°F); three standard alloy pairs are in common use Pt vs. Pt-10%Rh, Pt vs. Pt-13%Rh, and Pt-6%Rh vs. Pt 30%Rh.

noise 1. In process instrumentation, an unwanted component of signal or. See "interference, electromagnetic". 2. Any spurious variation in the electrical output not present in the input. 3. An unwanted component of a signal or variable which obscures the information content. 4. Random variations of one or more characteristics of any entity, such as voltage, current, or data. 5. A random signal of known statistical properties of amplitude, distribution, and spectral density. 6. Loosely, any disturbance tending to interfere with the normal operation of a device or system

noise immunity 1. The maximum amount of electrical noise that a digital circuit can withstand at its input without disturbing its performance. 2. A device's ability to discern valid data in the presence of noise.

noise quantisation Inherent noise that results from the quantisation process.

noise sources, control valve Control valve noise can be caused by the following: a) turbulent flow of liquid, b) aerodynamic flow, c) liquid cavitation flow, d) mechanical vibration.

noise temperature At a pair of terminals and at a specified frequency, the temperature of a passive system exhibiting the same noise power per unit bandwidth as the actual terminals.

noninteracting control system A multi element control system designed to avoid disturbances to other controlled variables due to the process input adjustments which are made for the purpose of controlling a particular process variable.

nonlinear distortion A departure from a desired linear relationship between corresponding input and output signals of a system.

nonlinear programming 1. In operations research a procedure for locating the maximum or minimum of a function of variables which are subject to constraints, when either the function or the constraints, or both, are nonlinear

nonlinear system Any system whose operation cannot be represented by a finite set of linear differential equations.

nonreclosing pressure relief device A device for relieving internal pressure which remains open when actuated and must be replaced or reset before it can actuate again.

nonreturn to zero (NRZ) Coding of digital data for serial transmission or storage whereby a logic "1" is represented by one signal level and a logic "0" is represented by a different signal level.

normal capacity Normal capacity is 80 percent of design capacity

normality Concentration units defined as the number of gram ions of replaceable hydrogen or hydroxyl groups per liter of solution. A shorter notation of gram equivalents per liter is frequently used.

normalise 1. In programming, to adjust the exponent and fraction of a floating point quantity such that the fraction lies in a prescribed normal standard range. 2. In mathematical operations, to reduce a set of symbols or numbers to a normal or standard form; synonymous with "standardise."

normally closed (NC) 1. A switch position where the usual arrangement of contacts permits the flow of electricity in the circuit. 2. In a solenoid valve, an arrangement whereby the disk or plug is seated when the solenoid is deenergised. 3. A field contact that is closed for a normal process condition and open when the process condition is abnormal. 4. A valve with means provided to move to and/or hold in its closed position without actuator energy supply. 5. Relay contacts that are closed when the coil is not energised. See also "field contact." normally closed (NC) valve A valve with means provided to move to and/or hold in its closed position.

NOVRAM Nonvolatile random access memory (nonvolatile semiconductor computer memory).

nozzle 1. A short flanged or welded neck connection on a drum or shell for the outlet or inlet of fluids; also a projecting spout through which a fluid flows. 2. A streamlined device for accelerating and directing fluid flow into a region of lower fluid pressure. 3. A particular type of restriction used in flow system to facilitate flow measurement by pressure drop across a restriction

nozzle / flapper A fundamental part of pneumatic signal processing and pneumatic control operations. Basically, the device converts a displacement of the flapper to a pressure signal

Oersted The CGS unit of magnetic field strength; the SI unit, ampere turn per meter, is preferred.

offset 1. A sustained deviation of the controlled variable from set point. This characteristic is inherent in proportional controllers that do not incorporate reset action. 2. Offset is caused by load changes. 3. The steady state deviation when the set point is fixed. NOTE: The offset resulting from a no load to a full load change (or other specified limits) is often called "droop" of load regulation." See also "deviation, steady state". 4. A constant and steady state of deviation of the measured variable from the set point.

ohms per volt A standard rating of instrument sensitivity determined by dividing the instrument's electrical resistance by its full scale voltage.

on-off control A simple form of control whereby the control variable is switched fully on or fully off in response to the process variable rising above the set point or falling below the set point respectively. Cycling always occurs with this form of control.

opacity The reciprocal of optical transmissivity.

open-loop control 1. A control system which does not take any account of the error between the desired and actual values of the controlled variables. 2. An operation in which computer evaluated control action is applied by an operator. 3. A system in which no comparison is made between the actual value and the desired value of a process variable.

optical time domain reflectometer A device that sends a very short pulse of light down a fiber optic communication system and measures the time history of the pulse reflection. The reflection indicates fiber dispersion and discontinuities in the fiber path, such as breaks and connectors. The time it takes for the light pulse to travel to and from the discontinuity indicates how far it is from the test set.

orifice 1. The opening from the whirling chamber of a mechanical atomiser or the mixing chamber of a steam atomiser through which the liquid fuel is discharged. 2. A calibrated opening in a plate, inserted in a gas stream for measuring velocity of flow. A specially designed orifice plate holding device. orifice flange taps The 1/2 in. or 3/4

in. pipe taps in the edge of an orifice flange union. orifice flange union Two unique flanges used to hold an orifice plate primary element with specific design dimensions established by the AGA (American Gas Association).

orifice meter A general term used to describe any recording differential pressure measuring instrument.

orifice plate A disc or platelike member, with a sharp edged hole in it, used in a pipe to measure flow or reduce static pressure.

orifice run The differential pressure producing arrangement consisting of selected pipe, orifice flange union and orifice plate. An orifice run has rigid specifications defined by the AGA (American Gas Association).

orifice type variable area flowmeter A flow measurement device consisting of a tube section containing an orifice and a guided conically tapered float that rides within the orifice; flow of a fluid through the meter positions the float in relation to flow rate, with float position being determined magnetically or by other indirect means.

OSI (open system interconnection.) OSI reference model A seven layered model of communications networks defined by ISO. The seven layers are:

Layer 7 Application: provides the interface for application to access the OSI environment.

Layer 6 APresentation: provides for data conversion to preserve the meaning of the data.

Layer 5 Session: provides user to user connections.

Layer 4 Transport: provides end to end reliability.

Layer 3 Network: provides routing of data through the network.

Layer 2 Data Link: provides link access control and reliability.

Layer I Physical: provides an interface to the physical medium.

Ounce A U.S. unit of weight; one ounce (avoirdupois) equals 1/16 pound, and is used for most commercial products; one ounce (troy) equals 1/12 pound, and is used for precious metals.

Oval gear flowmeter A type of positive displacement flowmeter that operates by trapping a precise volume of fluid between an oval, toothed rotor and the meter housing as the rotor revolves in mesh with a second rotor; volume flow of an incompressible fluid is indicated directly by determining rotor speed.

overrange In process instrumentation, of a system or element, any excess value of the input signal above its upper range value or below its lower range value

overrange limit The maximum input that can be applied to a device without causing damage or permanent change in performance.

override control 1. Generally, two control loops connected to a common final control element-one control loop being nommally in control with the second being switched in by some logic element when an abnormal condition occurs so that constant control is maintained. 2. A technique in which more than one controller manipulates a final control element. The technique is used when constraint control is important.

overshoot 1. The amount of output measured beyond the final steady output value, in response to a step change in the measurand. NOTE: (S) Expressed in percent of the equivalent step change in output. 2. A transient response to a step change in an input signal which exceeds the normal or expected steady state response. 3. The maximum difference between the transient response and the steady state response.

packed column A distillation column filled with packing (commonly Raschig rings) to mix the descending liquid with the ascending vapours. Packing is often used instead of trays in columns for certain applications (such as gas adsorption) or very low pressure drop systems.

packet access device (PAD) An interface between a terminal or computer and a packet switching network.

packet switching network System where messages are broken down into smaller units called packets, each individually addressed, and are routed through the network.

packet switching system (PSS) In a wide area network, a method of sending data between computers.

packing A sealing system consisting of deformable material of one or more mating and deformable elements contained in a packing box which may have an adjustable compression means to obtain or maintain an effective pressure seal.

packing box The chamber, in the bonnet, surrounding the stem and containing packing and other stem sealing parts.

paddle wheel level detector A device for detecting the presence or absence of bulk solids at the device location; it consists of a motor that slowly rotates a paddle in the absence of material, and rotates itself against a momentary switch when material is at or above the paddle location.

PAM The process (or the results of the process) in which a series of pulses is generated having amplitudes proportional to the measured signal samples. PAM/FM Frequency modulation of a carrier by pulse amplitude modulated information. PAM/FM/FM Frequency modulation of a carrier by subcarriers that are frequency modulated by pulse amplitude modulated (PAM) information.

Pareto analysis Using a Pareto chart to identify which problems to focus upon, a cause and effect analysis can be conducted.

Pareto chart A display of the number of failures of components by part number in descending order of failure rate or number of failures observed. Data may also be shown taking into account the total cost of each failure.

parity A code that is used to uncover data errors by making the sum of the " 1 " bits in a data unit either an odd or even number. parity bit A binary digit appended to a group of bits to make the sum of all the bits always odd (odd parity) or always even (even parity); used to verify data storage and transmission.

parity check A check that tests whether the number of ones or zeroes in an array of binary digits is odd or even.

parse To break a command string into its elemental components for the purpose of interpretation.

Parshall flume A venturi type device for measuring flow in an open channel at flow rates up to 6 million m³/day; it consists of a converging upstream section, a downward sloping throat and an upward sloping discharge section, and may be made of any suitable structural material, usually concrete.

partial pressure The portion of total pressure in a closed system containing a gas mixture that is due to a single element or compound.

parts per million (ppm) Represents parts per million and should be given on a weight basis. The abbreviation shall be ppm (w/w). If inconvenient to present data on a weight basis (w/w), it may be given in a volume basis; (v/v) must be stated after the term ppm

pascal Metric unit for pressure or stress.

peer to peer protocol Communication protocol between peer entities.

Peltier effect The principle in solid state physics that forms the basis of thermocouples if two dissimilar metals are brought into electrical contact at one point, the difference in electrical potential at some other point depends on the temperature difference between the two points.

period 1. The time required for one complete cycle of oscillation. 2. Of a periodic function, the smallest increment of the independent variable that can be repeated to generate the function. 3. Of an undamped instrument, the

time between two successive transits of the pointer through the rest position in the same direction following a step change in the measured quantity. **periodic duty** A type of intermittent duty involving regularly repeating load conditions. **periodic function** An oscillating quantity whose values repeatedly recur for equal increments of the independent variable.

peripheral 1. A supplementary piece of equipment that puts data into, or accepts data from the computer (printers, floppy disc memory devices, videocopiers). 2. Any device, distinct from the central processor, that can provide input or accept output from the computer.

permanent pressure drop The unrecoverable reduction in pressure that occurs when a fluid passes through a nozzle, orifice or other throttling device.

pH The symbol for the measurement of acidity or alkalinity. Solutions with a pH reading of less than 7 are acid; solutions with a pH reading of more than 7 are alkaline on the pH scale of 0 to 14, where the midpoint of 7 is neutral.

phase-locked loop (PLL) A feedback mechanism commonly used in receivers and signal generators that uses a phase detector to compare the output phase of a voltage-controlled oscillator to that of a reference signal.

phase margin The difference between 180° and the absolute value of the open loop phase angle for a stable feedback system at that frequency where the gain is unity.

phase modulation Modulation of a sinusoidal carrier wave in which the angle of the modulated wave differs from the angle of the carrier wave by an amount proportional to the instantaneous amplitude of the modulating wave.

phase shift 1. Of a transfer function, a change of phase angle with test frequency, as between points on a loop phase characteristic. 2. Of a signal a change of phase angle with transmission. 3. Difference between corresponding points on input and output signal wave shapes, disregarding any difference in magnitude. 4. The time difference between the input and output signal or between any two synchronised signals, of a control unit, system, or circuit, usually expressed in degrees or radians. 5. A change in phase angle between the sinusoidal input to an element and its resulting output.

phase shift keying (PSK) A form of PCM achieved by shifting the phase of the carrier; e.g., $+90$ degrees to represent "ones" and "zeros."

phase velocity The velocity of an equiphase surface along the normal of a traveling single frequency plane wave.

phasor A rotating vector.

pH meter An instrument for electronically measuring electrode potential of an aqueous chemical solution and directly converting the reading to pH (a measure of hydrogen ion concentration, or degree of acidity).

phon A unit of loudness level equivalent to a unit pressure level in decibels of a 1000 Hz tone.

phosphorescence Emission of radiant energy-often in the visible light range following excitation due to absorption of shorter wavelength radiation; phosphorescent emission may persist for a long time after the exciting radiation stops.

phot The CGS unit of illuminance, which equals one lumen power cm^2 ; the SI unit, lux, is preferred.

photocell A device that alters its electrical resistance in proportion to the amount of light that impinges on it.

PI control Proportional-plus-integral control, used in combination to eliminate offset. Also called "proportional-plus-reset control."

PID action A mode of controller action in which proportional integral, and derivative action are combined.

PID control Proportional-plus-integral-plus-derivative control, used in processes where the controlled variable is affected by long lag times.

piezoelectric effect The generation of an electric potential when pressure is applied to certain materials or conversely a change in shape when a voltage is applied to such materials. The changes are small, but piezoelectric devices can be used to precisely control small motions of optical components.

pig An in line scraper for removing scale and deposits from the inside surface of a pipeline; a holder containing brushes, blades, cutters, swabs, or a combination is forced through the pipe by fluid pressure.

pigtail A 270° or 360° loop in pipe or tubing to form a trap for vapour condensate. Used to prevent high temperature vapours from reaching the instrument. Used almost exclusively in static pressure measurement.

pile An assemblage of thermoelectric elements, dissimilar metal plates or fissile material components so arranged to produce electrical or thermal power as in a thermopile, storage battery or atomic reactor.

pilot circuit That portion of a control circuit or system which carries the control signal from the signal generating device to the control device.

pinch or clamp valve A valve consisting of a flexible elastomeric tubular member connected to two rigid flow path ends whereby modulation and/or shut off of flow is accomplished by squeezing the flexible member into eventual tight sealing contact.

pipe elbow meter A variable head meter used to measure flow around the bend in a pipe.

pipelining The process of increasing data processing speed by simultaneously executing a number of basic instructions.

pipng and instrumentation drawing (P&ID) 1. Show the interconnection of process equipment and the instrumentation used to control the process. In the process industry, a standard set of symbols is used to prepare drawings of processes. The instrument symbols used in these drawings are generally based on Instrument Society of America (ISA) Standard S5. 1. 2. The primary schematic drawing used for laying out a process control installation.

Pirani gauge A pressure transducer used to measure very low gas pressure based on measurement of the resistance of a heated wire filament; resistance varies in accordance with thermal conduction of the gas, which in turn is related to gas pressure. Used primarily for pressures less than one atmosphere.

piston meter A type of fluid flowmeter; it is a variable area, constant head device in which the flow rate is indicated by a pointer attached to a piston, which in turn is positioned by the buoyant force of the fluid.

piston type variable area flowmeter Any of several flowmeter designs in which fluid passing through the meter exerts force on a piston such that the piston moves against a counterbalancing force to expose a portion of an exit orifice, the amount exposed being directly related to volume flow.

pitot tube 1. An instrument for measuring stagnation pressure of a flowing liquid; it consists of an open tube pointing upstream, into the flow of fluid, and connected to a pressure indicator or recorder. 2. An instrument which will register total pressure and static pressure in a gas stream, used to determine its velocity.

pitot venturi tube A combination of a venturi device and a pitot tube.

plug meter A device for measuring flow rate in which a tapered rod extends through an orifice; when the rod is positioned so that the effective area of the annulus is just sufficient to handle the fluid flow, the rate of flow is read directly from a scale.

plug valve 1. A valve with a closure member that may be cylindrical, conical or a spherical segment in shape. It is positioned, open to closed, with rotary motion. 2. A type of shutoff valve consisting of a tapered rod with a lateral hole through it. As the rod is rotated 90° about its longitudinal axis, the hole is first aligned with the direction of flow through the valve and then aligned crosswise, interrupting the flow.

poise The CGS unit of dynamic viscosity, which equals one dyne second per cm²; the centipoise (cP) is more commonly used.

Poiseuille flow Laminar flow of gases in long tubes at pressures and velocities such that the flow can be described by Poiseuille's equation.

polar diagram A diagram showing the relative effectiveness of an antenna system for either transmitting or receiving. Principally shows directional characteristics .

positioner A position controller, which is mechanically connected to a moving part of a final control element or its actuator, and automatically adjusts its output pressure to the actuator in order to maintain a desired position that bears a predetermined relationship to the input signal. The positioner can be used to modify the action of the valve (reversing positioner), extend the stroke/controller signal (split range positioner), increase the pressure to the valve actuator (amplifying positioner) or modify the control valve flow characteristic (characterised positioner).

positioner, amplifying A pneumatic positioner in which the input control signal is amplified to a proportionately higher pressure, needed to drive the actuator, e.g., 3-15 psig input/6-30 psig output.

positioner, characterised A positioner in which the valve position feedback is modified to produce a nonlinear response.

positioner, double-acting 1. A positioner is double acting if it has two outputs, one with "direct" action and the other with "reversed" action 2. A positioner with two outputs, suited to a double-acting actuator.

positioner, electro-pneumatic A positioner which converts an electronic control signal input to a pneumatic output.

positioner, reversing A positioner which converts the input control signal into an output which is directionally opposite to the input.

positioner, single-acting 1. A positioner is single acting if it has a single output. 2. A positioner with one output, suited to a single action spring opposed actuator.

positioner, split range A positioner which drives an actuator full stroke in proportion to only a part of the input signal range.

positive draft Pressure in a furnace, gas chamber or duct that is greater than ambient atmospheric pressure.

positive feedback 1. A closed loop in which any change is reinforced until a limit is eventually reached. 2. Returning part of an output signal and using it to increase the value of an input signal.

potential energy Energy related to the position or height above a place to which fluid could possibly flow or a solid could fall or flow.

power factor The ratio of total watts to the total root-mean-square (rms) volt-amperes.

NOTE: If the voltages have the same waveform as the corresponding currents, power factor becomes the same as phasor power factor. If the voltages and currents are sinusoidal and for polyphase circuits, for symmetrical sets, $FW = \cos(\theta_v - \theta_i)$

precession The change in orientation of a rapidly spinning body, such as a gyrowheel, that occurs when its axis of spin rotates about a line perpendicular to a plane defined by the original position of the axis of spin and the axis of torque for the moment producing the change in orientation.

precipitate To separate materials from a solution by the formation of insoluble matter by chemical reaction.

predictive control 1. A type of automatic control in which the current state of a process is evaluated in terms of a model of the process and controller actions modified to anticipate and avoid undesired excursions. 2. Self tuning. 3. Artificial intelligence.

pressure Measure of applied force compared with the area over which the force is exerted.

pressure, absolute 1. The pressure measured relative to zero pressure (vacuum). 2. The pressure above the absolute zero value of pressure that is theoretically obtained in empty space or at the absolute zero for temperature, as distinguished from gauge pressure.

pressure, design The pressure used in the design of a vessel or device for the purpose of determining the minimum permissible thickness or physical characteristics of the parts for a given maximum working pressure (MWP) at a given temperature.

pressure, differential 1. The difference in pressure between two points of measurement. 2. The difference in pressure between two points of a system.

pressure drop 1. The differential pressure in pascals at a maximum linear flow measured between points four pipe diameters upstream and four pipe diameters downstream from its ends, using a specified liquid, and using pipe size matching the fittings provided [RP3 1 .1]. 2. The difference in pressure between two points in a system, caused by resistance to flow.

pressure, gauge 1. Pressure measured relative to ambient pressure. 2. The amount by which the total absolute pressure exceeds the ambient atmospheric pressure.

pressure, leak The pressure at which some discernible leakage first occurs in a device.

pressure level In acoustic measurement, $P = 1 \log (P_s/P_r)$, where P is the pressure level in bels, P_s is the sound pressure, and P_r is a reference pressure, usually taken as 0.002 dyne/cm².

pressure, maximum working (MWP) The maximum total pressure permissible in a device under any circumstances during operation, at a specified temperature. It is the highest pressure to which it will be subjected in the process. It is a designed safe limit for regular use. NOTE: MWP can be arrived at by two methods: a) designed-by adequate design analysis, with a safety factor; b) tested-by rupture testing of typical samples.

pressure rating The maximum allowable internal force per unit area of a pressure vessel, tank or piping system during normal operation.

pressure regulating valve A valve that can assume any position between fully open and fully closed, or that opens or remains closed against fluid pressure on a spring loaded valve element, to release internal pressure or hold it and allow it to build up, as desired.

pressure regulator An in line device that provides controlled venting from a high-pressure region to a lower pressure region of a closed compressed gas system to maintain a preset pressure value in the lower pressure region.

pressure relief device A mechanism that vents fluid from an internally pressurised system to counteract system overpressure; the mechanism may release all pressure and shut the system down (as does a rupture disc) or it may merely reduce the pressure in a controlled manner to return the system to a safe operating pressure (as does a spring loaded safety valve).

pressure, rupture The pressure, determined by test, at which a device will burst. NOTE: This is an alternate to the design procedure for establishing maximum working pressure (MWP). The rupture pressure test consists of causing the device to burst.

pressure, static The steady state pressure applied to a device; in the case of a differential pressure device, the process pressure applied equally to both connections.

process reaction method A method of determination of optimum controller settings when tuning a process control loop. The method is based on the reaction of the open loop to an imposed disturbance.

proof pressure The maximum pressure which may be applied to the sensing element of a transducer without changing the transducer performance beyond specified tolerances. NOTE: 1. In the case of transducers intended to

measure a property of pressurised fluid, proof pressure is applied to the portion subject to the fluid. 2. Differential pressure transducer specifications should indicate whether the specified differential proof pressure is applicable at ambient or maximum specified reference pressure, or both, and whether a reverse differential proof pressure, at ambient or maximum specified reference pressure, or both, is additionally applicable.

propeller meter An instrument for measuring the quantity of fluid flowing past a given point; the flowing stream turns a propeller like device, and the number of revolutions are related directly to the volume of fluid passed.

proportional band 1. The change in input required to produce a full range change in output due to proportional control action. NOTE 1: It is reciprocally related to proportional gain. NOTE 2: It may be stated in input units or as a percent of the input span (usually the indicated or recorded input span). The preferred term is proportional gain. 2. The amount of deviation of the controlled variable from set point required to move the final control element through the full range (expressed in % of span). 3. An expression of gain of an instrument (the wider the band, the lower the gain).

proportional control A control mode in which there is a continual linear relationship between the deviation computer in the controller, the signal of the controller, and the position of the final control element.

proportional control action Corrective action which is proportional to the error, that is, the change of the manipulated variable is equal to the gain of the proportional controller multiplied by the error (the activating signal).

proportional control mode 1. A controller mode in which the controller output is directly proportional to the controlled variable error. 2. Produces an output signal proportional to the magnitude of the input signal. 3. In a control system proportional action produces a value correction proportional to the deviation of the controlled variable from set point.

proportional, integral and derivative 1. Three-mode controller. 2. Refers to a control method in which the controller output is proportional to the error, its time history, and the rate at which it is changing. The error is the difference between the observed and desired values of the variable that is under control action. 3. Proportional-plus-integral-plus-derivative control, used in processes where the controlled variable is affected by long lag times.

proportional-integral-derivative (PID) control A combination of proportional, integral and derivative control actions. Refers to a control method in which the controller output is proportional to the error, its time history, and the rate at which it is changing. The error is the difference between the observed and desired values of the variable that is under control action. Also called "three mode control."

proportional-plus-reset control A mode of control in which there is a continuous linear relation between the value of the controlled variable and the position of the final control element (proportional) plus an additional change in the position of the final control element based on both the amount and duration of the change in the controlled variable (reset). Same as "PI control."

pseudo random The property of satisfying one or more of the standard criteria for statistical randomness but being produced by a definite calculation process. Related to "uniformly distributed random numbers."

pseudo random number sequence A sequence of numbers, determined by some defined arithmetic process, that is satisfactorily random for a given purpose, such as by satisfying one or more of the standard statistical tests for randomness. Such a sequence may approximate any one of several statistical distributions, such as uniform distribution or normal (Gaussian) distribution.

psychrometer A device consisting of two thermometers, one of which is covered with a water saturated wick, used for determining relative humidity; for a given set of wet bulb and dry bulb temperature readings, relative humidity is read from a chart. Also known as "wet and dry bulb thermometer."

purge meter A device designed to measure small flow rates of liquids and gases used for purging measurement piping.

purging 1. The addition of air or inert gas (such as nitrogen) into the enclosure around the electrical equipment at sufficient flow to remove any hazardous vapours present and sufficient pressure to prevent their re entry. 2.

Elimination of an undesirable gas or material from an enclosure by means of displacing the undesirable material with an acceptable gas or material.

pycnometer A container of precisely known volume that is used to determine density of a liquid by weighting the filled container and dividing the weight by the known volume. Also spelled "pyknometer."

pyroelectric detectors Detectors of visible, infrared, and ultraviolet radiation which rely on the absorption of radiation by pyroelectric materials. Heating of such materials by the absorbed radiation produces electric charges on opposite sides of the crystal, which can be measured to determine changes in the amount of radiation incident on the detector. These detectors usually also exhibit piezoelectric properties and may require isolation from acoustic or acceleration phenomena.

pyrometer Any of a broad class of temperature measuring instruments or devices. Some typical pyrometers include thermocouples, radiation pyrometers, resistance pyrometers and thermistors, but usually not thermometers. It is a temperature transducer that measures temperatures by the EM radiation emitted by an object, which is a function of the temperature.

Q The ratio of reactance to resistance in a reactive component or resonant circuit.

quadrant edged orifice An orifice having a rounded contour at the inlet edge to yield more constant and predictable discharge coefficient at low flow velocity (Reynolds number less than 10,000).

quadratic programming In operations research, a particular case of nonlinear programming in which the function to be maximised or minimised and the constraints are quadratic functions of the controllable variables.

quantisation The subdivision of the range of values of a variable into a finite number of overlapping, and not necessarily equal, subranges or intervals, each of which is represented by an assigned value within the subrange. For example, a person's age is quantised for most purposes with the quantum of one year.

quantisation distortion Inherent distortion introduced when a range of values for a wave attribute is divided into a series of smaller subranges.

quantum noise Noise due to the discrete nature of light-i.e., its quantisation into photons.

quarter amplitude A process control tuning criterion where the amplitude of the deviation (error) of the controlled variable, following a disturbance, is cyclic so that the amplitude of each peak is one quarter of the previous peak.

queuing theory A form of probability theory useful in studying delays or line ups at servicing points.

Quevenne scale A specific gravity scale used in determining the density of milk; a difference of 1° Quevenne is equivalent to a difference of 0.001 in specific gravity, and therefore 20° Quevenne expresses a specific gravity of 1.020.

quick-opening valve Control valve with trim characteristic designed to produce large flow capacity with small amount of valve opening.

radian Metric unit for a plane angle.

radiance The rates of flow of radiant energy with respect to time. Expressed in watts.

Rankine An absolute temperature scale where the zero point is defined as absolute zero (the point where all spontaneous molecular motion ceases) and the scale divisions are equal to the scale divisions in the Celsius system; 0°F equals approximately 459.69°R.

rate action Another name for the derivative control mode.

rated capacity The manufacturers stated capacity rating for mechanical equipment, for instance, the maximum continuous capacity in pounds of steam per hour for which a boiler is designed.

rated flow 1. Design flow rate for a piping system or process vessel. 2. Normal operating flow rate for a fluid passing through a piping system.

rated horsepower The maximum or allowable power output of an engine, turbine or other prime mover under normal, continuous operating conditions.

rated load The maximum design load for a machine, structure or vehicle.

rated supply voltage The supply voltage, or range of voltages, for which the manufacturer has designed the equipment.

ratio controller 1. A controller that maintains a predetermined ratio between two or more variables. 2. Maintains the magnitude of a controlled variable at a fixed ratio to another variable.

ratio of specific heats Specific heat at constant pressure divided by specific heat at constant volume.

reactance A component in an electrical circuit which is due to the presence of capacitive or inductive elements and not resistive elements, and which opposes the flow of electric current.

reactance drop The voltage drop 90° out of phase with the current.

reboiler The heat exchanger at the bottom of a distillation column. The reboiler generates the vapours that ascend through the column from liquid which comes down the column.

receiver gauge A gauge, calibrated in engineering units, which receives the output of a pneumatic transmitter.

rectifying section The section of trays in a distillation column above the feed plate. In this section the vapour is enriched in the light components that are taken overhead.

recursion The property which allows a callable program to call itself.

redox potential The electrochemical potential prevailing in a chemical reaction involving an exchange of electrons (reduction oxidation potential).

reducing atmosphere An atmosphere which tends to: a) promote the removal of oxygen from a chemical compound; b) promote the reduction of immersed materials.

reduction 1. Gain of electrons by a constituent of a chemical reaction. 2. Removal of oxygen from a chemical compound.

redundancy check An automatic or programmed check based on the systematic insertion of components or characters used especially for checking purposes.

redundant Duplication or repetition of elements in electronic or mechanical equipment to provide alternative functional channels in case of failure.

Redwood scale A time based viscosity scale used predominantly in Great Britain; it is similar in concept to the Saybolt scale used in the United States.

reenetrancy The property which allows a callable program to be called and executed before it has completed the execution from a previous call. The results of the previous call are not affected.

reflash (multiple input) 1. An auxiliary logic circuit that allows two or more abnormal process conditions to initiate or initiate the alarm state of one alarm point at any time. The alarm point cannot return to normal until all related process conditions return to normal. 2. One type of auxiliary output.

reflectance The fraction of incident light which is reflected by the surface.

reflux The recycle stream that is returned to the top of the column. This stream supplies a liquid flow for the rectifying section that enriches the vapour stream moving up the column. Material in the stream is condensate from the overhead condenser. Reflux closes the energy balance by removing heat introduced at the reboiler.

reflux ratio A quantity usually expressed as the ratio of the reflux flow to the distillate flow. The ratio is used primarily in column design.

refractive index The ratio of phase velocity of a wave in free space to phase velocity of the same wave in the specific medium.

refractometer An instrument for measuring the index of refraction of a transparent substance; measurement can be accomplished in any of several ways, including measuring the critical angle, measuring refraction produced by a prism, observing interference patterns in transmitted light, and measuring the substance's dielectric constant.

Regime I Control valve regime of noise generation in which flow is subsonic and the gas pressure is partially recovered or recompressed.

Regime II Control valve regime of noise generation in which sonic flow exists, with interaction between shock cells and with turbulent choked flow mixing. Pressure recovery is less as the limit of Regime II is approached.

Regime III Control valve regime of noise generation in which no isentropic pressure recovery takes place.

Regime IV Control valve regime of noise generation in which the shock cell structure diminishes as a "Mach disk" is formed.

Regime V Control valve regime of noise generation in which there is a constant acoustic efficiency.

relative flow coefficient The ratio of the flow coefficient (C_v) at a stated travel to the flow coefficient (C_v) at rated travel.

relative gain An open loop gain determined with all other manipulated variables constant, divided by the same gain determined with all other controlled variables constant.

relative humidity 1. The ratio of the amount of water vapour contained in the air at a given temperature and pressure to the maximum amount it could contain at the same temperature and pressure under saturated conditions. 2. The ratio of the weight of water vapour present in a unit volume of gas to the maximum possible weight of water vapour in unit volume of the same gas at the same temperature and pressure.

reliability 1. The probability that a device will perform its objective adequately, for the period of time specified, under the operating conditions specified. 2. The probability that a component, piece of equipment or system will perform its intended function for a specified period of time, usually operating hours, without requiring corrective maintenance.

relief valve A device used to protect piping and components from overpressure.

relief valve (safety) An automatic pressure relieving device actuated by the pressure upstream of the valve and characterised by opening pop action with further increase in lift with an increase in pressure over popping pressure.

repeatability The ability of a transducer to reproduce output readings when the same measurand value is applied to it consecutively under the same conditions, and in the same direction. NOTE(S): Repeatability is expressed as the maximum difference between output readings; it is expressed as "within percent of full-scale output." Two calibration cycles are used to determine repeatability unless otherwise specified.

repeater 1. Device used to extend the range over which signals can be correctly transmitted and received for a given medium. 2. A device that amplifies or regenerates data signals in order to extend the distance between data stations.

reproducibility 1. In process instrumentation, the closeness of agreement among repeated measurements of the output for the same value of input made under the same operating conditions over a period of time, approaching from both directions. 2. The ability of an instrument to duplicate, with exactness, measurements of a given value. Usually expressed as a percent of span of the instrument.

resealing pressure The inlet pressure at which fluid no longer leaks past a relief valve after it is closed.

reset control action See "control action, integral (reset)."

reset rate See "integral action rate."

reset windup Saturation of the integral mode of a controller developing during times when control cannot be achieved, which causes the controlled variable to overshoot its set point when the obstacle to control is removed.

resonant frequency The wave frequency at which mechanical or electronic resonance is achieved. See also "frequency, resonant." resonant frequency amplification factor The ratio of the maximum sensitivity of a transducer at its lowest resonant frequency to its nominal sensitivity.

response 1. The change in output of a device in relation to a change of input. 2. Defined output for a given input under explicitly stated conditions.

response, dynamic The behavior of the output of a device as a function of the input, both with respect to time.

response, ramp The total (transient plus steady state) time response resulting from a sudden increase in the rate of change from zero to some finite value of the input stimulus.

response, step The total (transient plus steady state) time response resulting from a sudden change from one constant level of input to another.

response time 1. The length of time required for the output of a transducer to rise to a specified percentage of its final value as a result of a step change of measurand.

Reynolds number A dimensionless criterion of the nature of flow in pipes. It is proportional to the ratio of dynamic forces to viscous forces: the product of diameter, velocity and density, divided by absolute viscosity.

rheoplectic substance A fluid whose apparent viscosity increases with time at any constant shear rate.

Roentgen A quantity of x ray or gamma ray radiation that produces, in air, ions carrying one electrostatic unit of electrical charge of either sign per 0.001293 gram of air.

roentgen equivalent man (rem) The unit of dose in radiation dosimetry; it equals the amount of radiation of any type that produces the same amount of biological damage in human beings as a dose of 1 roentgen of 200 kV x rays.

roentgen equivalent physical (rep) A unit of radiation equal to the amount of radiation of any type that results in energy absorption of 93 ergs/g in soft tissue.

Roentgen rays An alternative term for x rays.

room conditions Ambient environmental conditions, under which transducers must commonly operate, which have been established as follows:

a) temperature: $25 \pm 10^{\circ}\text{C}$ ($77 \pm 18^{\circ}\text{F}$)

b) relative humidity: 90 percent or less

c) barometric pressure: 26 to 32 inches Hg.

NOTE: Tolerances closer than shown above are frequently specified for transducer calibration and test environments.

root mean square value (rms) 1. A statistical averaging technique where all data are individually squared, the average of those squares taken and the square root of that average taken. 2. Equal to 0.707 times the peak.

root valve The first valve located in a sample line after it taps off the process. It is typically located in close proximity to the sample tap.

rotameter A variable area, constant head, indicating-type rate of flow volume meter in which fluid flows upward through a tapered tube, lifting a shaped plummet to a position where upward fluid force just balances the weight of the plummet.

rupture disc A diaphragm designed to burst at a predetermined pressure differential. Symbol rupture disc device A nonreclosing pressure relief device that relieves excessive static inlet pressure via a rupture disc.

Sabin A unit of measure for sound absorption equivalent to one square foot of a perfectly absorptive surface.

safe area 1. Nonhazardous (unclassified) location. 2. An area in which explosive gas/air mixture are not expected to be present so that special precautions for the construction and use of electrical apparatus are not required.

safety ground 1. A connection between metal structures, cabinets, cases, etc. which is required to prevent electrical shock hazard to personnel. 2. Safety ground is not a signal reference point.

safety relief valve An automatic pressure relieving device actuated by the pressure upstream of the valve and characterised by opening pop action with further increase in lift with an increase in pressure over popping pressure.

sample and hold A device which senses and stores the value of an analog signal units subsequently updated.

sampled data control That branch of automatic control theory concerned with the control of variables whose current values are not continuously available for comparison with the setpoint but instead are sampled only at given intervals.

sample vessel An integrally valved, portable sample container designed to obtain pressurised samples at process pressure.

sampling rate For a given measurement, the number of times that it is sampled per second in a time division multiplexed system. Typically, it is at least five times the highest data frequency of the measurement.

sampling theorem Nyquist's result that equispaced data, with two or more points per cycle of highest frequency, allow reconstruction of band limited functions; the theorem states: "If the rms spectrum/G(t), is identically zero at all frequencies above W cycles per second, then g(t) is uniquely determined by giving its ordinates at a series of points spaced 1/2Wseconds apart, the series extending through the time domain.

saturation A device characteristic exhibited when a further change in the input signal produces no significant additional change in the output.

Saybolt color scale A standardised color scale used primarily in the petroleum and pharmaceutical industries to grade the yellowness of pale products; it is based on matching the color of a column of the sample liquid with one of a set of color controlled glass disks, as described in ASTM standard D156.

Saybolt Furol viscosimeter An instrument similar to a Saybolt Universal viscosimeter, but with a larger diameter tube for measuring the viscosity of very thick oils.

Saybolt Universal viscosimeter An instrument for determining viscosity by measuring the time it takes an oil or other fluid to flow through a calibrated tube.

scalar quantity Any quantity that can be described by magnitude alone, as opposed to a vector quantity which can only be described by both magnitude and direction.

schedule A term used to define the wall thickness of pipe (schedule 40, 80, 160 and others).

Scientific Apparatus Makers Association (SAMA) A former industrial association in the United States. Reorganised and is now called "Measurement Control & Automation Association (MCAA)". No longer writes or supports SAMA standards.

seal chambers Enlarged pipe sections in measurement impulse lines to provide a) a high area to volume displacement ratio to minimise error from hydrostatic head difference when using large volume displacement measuring elements, and b) to prevent loss of seal fluid by displacement into the process. Also known as Seal Pots

sealed reference differential pressure transducer A transducer which measures the pressure difference between an unknown pressure and the pressure of a gas in an integral sealed reference chamber.

seal leg The piping from the instrument to the top elevation of the seal fluid in the impulse line. seal on disk A seal ring located in a groove in the disk circumference. The body is unlined in this case [S75.05].

seat The fixed area of a valve into which the moving part of a valve rests when the valve is closed to retain pressure and prevent flow.

segmented ball A closure member that is a segment of a spherical surface which may have one edge contoured to yield a desired flow characteristic.

selective ion electrode A type of oxidation reduction potential electrode that involves use of a metal-metal-salt combination as the measuring electrode, which makes the electrode particularly sensitive to solution activities of the anion in the metal salt.

separable flanges Nonintegral loose flanges held to the vessel/valve by mechanical means such as retaining rings or swaged rims.

set point 1. An input variable which sets the desired value of the controlled variable. It is expressed in the same units as the controlled variable.

set point control A control technique in which the computer supplies as calculated set point to a conventional analog instrumentation control loop.

set pressure The inlet pressure at which a safety relief valve opens; usually a pressure established by specification or code.

shrinkage A decrease (shrinkage) in drum level due to a decrease in steam bubble volume. This condition is due to a decrease in load (steam flow), with a resulting increase in drum pressure and decrease in heat input.

shutoff head The pressure developed by a centrifugal or axial flow pump at its discharge when the discharge flow is zero.

siemens Metric unit of conductance.

sight glass A glass tube, or a glass faced section of a process line, used for sighting liquid levels or taking manometer readings.

signal common 1. The signal common shall refer to a point in the signal loop which may be connected to the corresponding points of other signal loops. It may or may not be connected to earth ground [S50.1]. 2. The

reference point for all voltage signals in a system. Current flow into signal common is minimized to prevent IR drops which induce inaccuracy in the signal common reference.

signal isolation Signal isolation refers to the absence of a connection between the signal loop and all other terminals and earth ground.

signature The unique vibration characteristics of a machine. This signature changes as physical conditions or force events change within the machine or on its support system.

signature analysis A process can be identified as having a particular signature when operating correctly. This can be noise spectrum or vibration spectrum. Signature analysis involves identifying departures from the reference signature and recognising the source of the departure.

sign bit A single bit, usually the most significant bit in a word, which is used to designate the algebraic sign of the information contained in the remainder of the word.

simmer Detectable leakage from a safety relief valve at a pressure below the popping pressure.

simple apparatus A device which will neither generate nor store more than 1.2 V, 0.1 A, 25 mW, or 20 ZJ. Examples are: switches, thermocouples, light emitting diodes, and resistance temperature devices (RTDs).

sine wave A signal varying with time which can be obtained through projection of a rotating vector of constant magnitude with constant angular velocity on a linear scale.

single element feedwater control A control system whereby one process variable, drum level, is used as the input to the control loop that regulates feedwater flow to the drum to maintain the drum level at set point.

sling psychrometer A device for determining relative humidity that consists of a wet and dry bulb thermometer mounted in a frame that can be whirled about, usually by means of a handle and short piece of chain or wire rope attached to the upper end of the frame.

slip A term commonly used to express leakage in positive displacement flowmeters.

snubber 1. A device which is used to damp the motion of the valve stem. This is usually accomplished by an oil filled cylinder/piston assembly. The valve stem is attached to the piston and the flow of hydraulic fluid from one side of the piston to the other is restricted. 2. A mechanical or hydraulic device for restraining motion. 3. A device installed between an instrument and the process used to protect the instrument from rapid pressure fluctuations.

soft water Water which contains little or no calcium or magnesium salts, or water from which scale forming impurities have been removed or reduced.

solar blind A detector which contains filters to block sunlight, so the detector becomes essentially "blind" to the sun.

solenoid A type of electromechanical operator in which reciprocal axial motion of a ferromagnetic core within an electromagnetic coil performs some mechanical function; common applications include opening or closing valves or electrical contacts.

solenoid valve A shutoff valve whose position is determined by whether or not electric current is flowing through a coil surrounding a moving iron valve stem.

sonic opacity A characteristic of a medium such as one containing a large quantity of particles or small bubbles that results in sound or ultrasound being reflected randomly from the discontinuities rather than being transmitted through the medium.

soot blower A mechanical device for discharging steam or air to clean heat absorbing surfaces.

sound pressure level (SPL) The intensity of a sound wave which, in decibels, equals $20 \log (P_s/P_r)$, where P_s is the pressure produced by the sound and P_r is a stated reference pressure.

sour crude Crude oil containing excessive amounts of sulfur, which liberate corrosive sulfur compounds during refining. Contrast with "sweet crude."

sour gas Natural gas that contains corrosive sulfur bearing compounds such as H_2S or mercaptans.

span The algebraic difference between the upper and lower range values.

sparger Liquid distribution device consisting of a length of piping or tubing with holes at spaced intervals along the length; used in spray columns, liquid- vapour contactors, and spray dryers.

special protection A protection technique other than those that have been standardised. This type of protection is referred to by IEC as "Type s".

specific gravity (SG) The ratio of the density of a material to the density of the water at the same conditions. Specific gravity: G_f = liquid at flowing condition referred to water at $60^\circ F$; G_g = gas referred to air, both at STP.

specific gravity bottle A small flask used to determine density; its precise weight is determined when empty, when filled with a reference liquid such as water, and when filled with a liquid of unknown density.

specific gravity, gas The density of a gas compared to the density of air.

specific gravity, liquid The density of a liquid compared to the density of water.

specific heat (sp ht) 1. The quantity of heat, expressed in Btu, required to raise the temperature of 1 lb of a substance $1^\circ F$. 2. The ratio of the thermal capacity of a substance to that of water. The specific heat at constant pressure of a gas is designated c_p . The specific heat at constant volume of a gas is designated c_v . The ratio of the two (c_p/c_v), is called the ratio of specific heats, k .

specific humidity The weight of water vapour in a gas water vapour mixture per unit weight of dry gas.

spectrofluorometer An instrument for determining chemical concentration by fluorometric analysis using two monochromators-one to analyze the wavelength of strongest emission and the other to select the wavelength of best excitation in the sample.

spectrometer A spectroscope which includes an angular scale for measurement of the angular deviation and wavelengths of the components of the spectrum.

spectrophotometric titration Instrumented titration in which the end point is determined by measuring a change in absorbed radiation with a spectrophotometer.

spectroscopic analysis Identification of chemical elements by characteristic emission and absorption of light rays.

stability 1. The ability of a transducer to retain its performance characteristics for a relatively long period of time. 2. The state of a system if the magnitude of the response produced by an input variable, either constant or varied in time, is limited and related to the magnitude of the input variable.

stability of a linear system A linear system is stable if, having been displaced from its steady state by an external disturbance, it returns to that steady state when the disturbance has ceased.

standard atmospheric pressure A reference pressure approximately equal to the mean atmospheric pressure at sea level, because atmospheric pressure varies with elevation and is not constant with time, standard atmospheric pressure is defined arbitrarily as an absolute pressure of 14.695 psi, 30.0 in. of mercury or 760 mm Hg (using mercury of density 13.595 g/cm³).

standard cell A primary cell Whose voltage is accurately known and remains sufficiently constant for instrument calibration purposes; the Weston standard cell has a voltage of 1.018636 volts in 20°C.

standard condition 1. A temperature of 0°C and a pressure of 1 atmospheres (760 torr). Also known as "normal temperature and pressure (NTP)"; "standard temperature and pressure (STP)." 2. According to the American Gas Association (AGA), a temperature of 60°F (15.5/9°C) and a pressure of 30 inches of mercury (762 mm). 3. According to the Compressed Gas Institute (CGI), a temperature of 20° C (68°F) and a pressure of 1 atmosphere.

standard deviation The positive square root of the expected value of the square of the difference between a random variable and its mean.

standard electrode potential The reversible or equilibrium potential of an electrode in an environment where reactants and products are at unit activity.

standard noise temperature The standard reference temperature used for noise measurements, 290 K.

standard potential The potential of an electrode composed of a substance in its standard state, in equilibrium with ions in their standard states compared to a hydrogen electrode.

standard pressure 1. The arbitrarily selected atmospheric pressure of 1000 millibars to which adiabatic processes are referred for definitions of potential temperature, equivalent potential temperature, etc. 2. A pressure of 1 atmosphere (101.325 Newtons per square meter), to which measurements of quantities dependent on pressure, such as the volume of a gas, are often referred. Also known as "normal pressure."

standard volume The volume of 1 mole of a gas at a pressure of 1 atmosphere and a temperature of 0°C.

standing wave A wave in which, for any of the dependent wave functions, the ratio of its instantaneous value at one point on the wave to its instantaneous value at any other point does not vary with time.

standpipe A vertical tube filled with a liquid such as water.

static head liquid level meter A pressure sensing device, such as a gauge, so connected in the piping system that any dynamic pressures in the system cancel each other and only the pressure difference due to liquid head above the gauge position is registered.

static pressure 1. The pressure of a fluid that is independent of the kinetic energy of the fluid. 2. Pressure exerted by a gas at rest, or pressure measured when the relative velocity between a moving stream and a pressure measuring device is zero.

static RAM Random access memory which requires continuous power but does not need to be refreshed as with dynamic RAM.

static tube A device used to measure static pressure in a stream of fluid. Normally, a static tube consists of a perforated, tapered tube with a branch tube for connecting it to a manometer; a related device called a static pressure tube consists of a smooth tube with a rounded nose that has radial holes in the tube behind the nose.

stationary wave A standing wave in which the energy flux is zero at all points on the wave.

statistically significant number of readings A statistically significant number of readings is a sample whose statistics closely approximate the true statistics of the parameter under consideration. That is, increasing the number of readings or repeatedly performing the data collection procedure will not result in substantially different calculated statistical parameters such as the mean and deviation.

statistical process control (SPC) The use of statistical techniques as a means of controlling the quality of a product or process.

statistical quality control (SQC) Any method for controlling the attributes of a product or controlling the characteristics of a process that is based on statistical methods of inspection.

steady state A characteristic of a condition, such as value, rate, periodicity, or amplitude, exhibiting only negligible change over an arbitrary long period of time.

steady state deviation The system deviation after transients have expired.

steady state model A mathematical model that represents the process at equilibrium (infinite time) conditions.

steady state optimisation A method of optimising some criterion function of a process usually using a steady state model of the process. Linear programming is frequently the optimisation method used and a function approximating the profit of the process is a typical optimising criterion.

steam attenuation Reducing the temperature of superheated steam by injecting water into the flow or passing the steam through a submerged pipe.

steam tracing An arrangement for heating a process line or instrument air line to keep liquids from freezing or condensing-often, a piece of pipe or tubing carrying live steam is simply run alongside or coiled around the line to be heated.

steam trap A device that automatically collects condensate in a steam line and drains it away.

step response Of a system or a component, the time required for an output to go through a specified percentage of the total excursion either before, or (in the absence of overshoot) as a result of a step change to the input
NOTE: This is usually stated for 90, 95, or 99 percent change.

stiffness In process instrumentation, the ratio of change of force (or torque) to the resulting change in deflection of a spring like element. NOTE: Stiffness is the opposite of compliance [S51.1].

stilling basin An area ahead of the weir plate large enough to pond the liquid so that it approaches the weir plate at low velocity, also called "weir pond."

stochastic Pertaining to direct solution by trial and error, usually without a step by step approach, and involving analysis and evaluation of progress made, as in a heuristic approach to trial and error methods. In a stochastic approach to a problem solution, intuitive conjecture or speculation is used to select a possible solution, which is then tested against known evidence, observations or measurements. Intervening or intermediate steps toward a solution are omitted. Contrast with "algorithmic" and "heuristic. "

stoichiometric conditions In chemical reactions, the point at which equilibrium is reached, as calculated from the atomic weights of the elements taking part in the reaction; stoichiometric equilibrium is rarely achieved in real chemical systems but, rather, empirically reproducible equivalence points are used to closely approximate stoichiometric conditions.

stoke A unit of kinematic viscosity (dynamic viscosity divided by sample density); the centistoke is more commonly used.

straightening vanes Horizontal vanes inside a fluid conduit or pipe to reduce turbulent flow ahead of a flow meter.

stress corrosion cracking Deep cracking in a metal part due to the synergistic action of tensile stress and a corrosive environment, causing failure in less time than could be predicted by simply adding the effects of stress and the corrosive environment together.

stripper A distillation column that has no rectifying section. In such a column, the feed enters at the top, and there is no other reflux.

stripping section That section of a distillation column below the feed. This section strips the light components from the liquid moving down the column.

supercompressibility The extent to which behavior of a gas departs from Boyle's law.

superheat To raise the temperature of steam above its saturation temperature. The temperature in excess of its saturation temperature.

superheated steam Steam at a higher temperature than its saturation temperature.

superheater A nest of tubes in the upper part of a steam boiler whose function is to raise the steam temperature above saturation temperature.

supervisory control A term used to imply that a controller output or computer program output is used as an input to other controllers.

supervisory control and data acquisition (SCADA) Operator interface and monitoring of (usually remote) control devices by computer.

suppressed range A suppressed range is an instrument range which does not include zero. The degree of suppression is expressed by the ratio of the value at the lower end of the scale to the span.

suppressed weir A rectangular weir in which the width of the approach channel is equal to the crest width, i.e., there are no end contractions.

suppressed zero instrument Any indicating or recording instrument whose zero (no load) indicator position is offscale, below the lower limit of travel for the pointer or marking device.

susceptibility, electric A dimensionless parameter measuring the ease of polarisation of a dielectric. Also known as "dielectric susceptibility."

susceptibility, magnetic The ratio of the magnetisation of a material to the magnetic field strength. Also known as "susceptibility."

sweet crude Crude petroleum containing very little sulfur.

sweet gas Natural gas containing no hydrogen sulfide or mercaptans.

swell 1. An increase (swell) in drum level due to an increase in steam bubble volume. This condition is due to an increase in load (steam flow), with a resulting decrease in drum pressure and an increase in heat input. Swelling also occurs during a cold start up as the specific volume of the water increases. 2. The sudden increase in the volume of steam in the water steam mixture below the water level.

synergism An action where the total effect of two components or agents is greater than the individual effects of the components when simply added together.

syntax In data processing, grammatical rules for software programming that specify how instructions can be written.

Système Internationale d'Unités (SI) The current International System of Units.

system, linear One of which the time response to several simultaneous inputs is the sum of their independent time responses. It is represented by a linear differential equation and has a transfer function which is constant for any value of input within a specified range. A system not meeting these conditions is described as nonlinear

tapered tube rotameter A type of variable area flowmeter in which a float that has greater density than the fluid rides inside a tapered tube in such a manner that fluid flowing upward through the tapered section carries the float with it until the upward force exerted by the flowing fluid just balances the downward force due to float weight, as the float rides upward, the annular area around it becomes larger and force on the float decreases; if the tube is made of glass, it can be graduated so that flow rate is read directly by observing float position; otherwise flow rate must be determined from an indirect indication of float position.

tape type liquid level gauge A liquid level gauge consisting of a tape wound around a drum which is attached to a pointer or other level indicator, with one end of the tape attached to a float and the other counterweighted to keep the tape taut.

tare weight In any weighing operation, the residual weight of any containers, scale components or residue that is included in total indicated weight and must be subtracted to determine weight of the live load.

target flowmeter A device for measuring fluid flow rates by means of the drag force exerted on a sharp edged disk centered in a circular flow path due to differential pressure created by fluid flowing through the annulus; usually, the disk is mounted on a bar whose axis coincides with the tube axis, and drag force is measured by a secondary device attached to the bar.

tesla Metric unit for magnetic flux density.

thermal bulb A device for measuring temperature in which the liquid in a bulb expands and contracts with changes in temperature, causing a Bourdon tube element to elastically deform, thereby moving a pointer in direct relation to the temperature at the bulb.

thermal coefficient of resistance The relative change in resistance of a conductor or semiconductor per unit change in temperature over a stated range of temperature. Expressed in ohms per ohm per degree C or F.

thermal conductivity Heat flow per unit cross section per unit temperature gradient.

thermal diffusion Spontaneous movement of solvent atoms or molecules to establish a concentration gradient as a direct result of the influence of a temperature gradient.

thermal electromotive force The electromotive force developed across the free ends of a bimetallic couple when heat is applied to a physical junction between the opposite ends of the couple.

thermal type flowmeter An apparatus in which heat is injected into a flowing fluid stream and flow rate is determined from the rate of heat dissipation; either the rise in temperature or some point downstream of the heater or the amount of thermal or electrical energy required to maintain the heater at a constant temperature is measured.

thermistor A temperature transducer constructed from semiconductor material and for which the temperature is converted into a resistance, usually with negative slope and highly nonlinear.

thermoammeter A device used chiefly to measure radio frequency currents where the current is run through a wire of appropriate size; on this wire is mounted a thermocouple whose output is proportional to the temperature of the wire, which is a function of the R.F. current passing through the wire. Also called a "hot wire ammeter."

thermocouple Two dissimilar wires joined together that generate a voltage proportional to temperature when their junction is heated.

thermocouple extension wire A matched pair of wires having specific temperature EMF properties that make the pair suitable for use with a thermocouple to extend the location of its reference junction (cold junction) to some remote location.

thermoelectric cooling A method of cooling a chamber based on the Peltier effect, in which an electric current is circulated in a thermocouple whose cold junction is coupled to the chamber; the hot junction dissipates heat to the environment.

thermoelectric heating A method of heating involving a device similar to one used for thermoelectric cooling, except that the direction of current is reversed in the circuit.

thermojunction Either of the two locations where the conductors of a thermocouple are in electrical contact; one, the measuring junction, is in thermal contact with the body whose temperature is being determined, and the other, the reference junction, is generally held at some known or controlled temperature.

thermowell A thermowell is a pressure tight receptacle adapted to receive a temperature sensing element and provided with external threads, flanges or other means for pressure tight attachment to a vessel.

three element feedwater control A control system whereby three process variables (steam flow, feedwater flow and drum level) are used as inputs to the control loop that regulates feedwater flow to the drum to maintain the drum level at set point. This is a cascaded feedforward loop with drum level as the primary variable steam flow as the feedforward input, and feedwater flow (feedback) as the secondary variable.

three mode controller Another name for a "PID controller. "

three term control Proportional-integral-derivative control.

throttling The actions to regulate fluid flow through a valve by restricting its orifice opening. See also "modulating".

time constant 1. The value t in an exponential response term. For the output of a first order system forced by a step or an impulse, t is the time required to complete 63.2% of the total rise or decay; at any instant during the process, t is the quotient of the instantaneous ratio of change divided into the change still to be completed. In higher order systems, there is a time constant for each of the first order components of the process. 2. In process instrumentation, the value T in an exponential response term $A \exp(-t/T)$ or in one of the transform factors $1 + sT$, $1 + joT$, $1/(1 + sT)$, $1/(1 + jeT)$, where: s = complex variable; t = time, seconds; T = time constant; j = square root of -1; $@$ = angular velocity, radians per second. NOTE: For the output of a first order system forced by a step or an impulse, T is the time required to complete 63.2% of the total rise or decay; at any instant during the process, T is the quotient of the instantaneous rate of change divided into the change still to be completed. In higher order systems, there is a time constant for each of the first order components of the process. In a Bode diagram, break points occur at $\omega = 1/T$. 3. The length of time required for the output of a transducer to rise to 63% of its final value as a result of a step change of measurand.

time constant, derivative action Of proportional-plus-derivative control action, a parameter the value of which is equal to $1/\omega_d$ whereby ω_d is the frequency (in hertz) on a Bode diagram of the lowest frequency gain corner resulting from derivative control action.

time constant, integral action 1. Of proportional-plus-integral control action, a parameter whose value is equal to $1/\omega_i$ whereby ω_i is the frequency (in hertz) on a Bode diagram of the highest frequency gain corner resulting from integral control action. 2. It is the reciprocal of integral action rate. NOTE: The use of integral action rate is preferred.

time, derivative action In proportional-plus-derivative control action, for a unit ramp signal input, the advance in time of the output signal (after transients have subsided) caused by derivative control action, as compared to the output signal due to proportional control action only.

titration curve A plot with pH as the ordinate and units of reagent added per unit of sample as the abscissa.

ton 1. A weight measurement equal to 2,000 lb (avoirdupois), short ton; 2,240 lb (avoirdupois), long ton; or 1,000 kg, metric ton. 2. A unit of measurement for refrigerating capacity equal to 200 Btu/min, or about 3517 W; derived from the capacity equal to the rate of heat extraction needed to produce a short ton of ice having a latent heat of fusion of 144 Btu/lb from water at the same temperature in 24 hr.

topworks A nonstandard term for control valve actuator.

torque tube flowmeter A device for measuring liquid flow through a pipe in which differential pressure due to the flow operates a bellows, whose motion is transmitted to a recorder arm by means of a flexible torque tube.

torque type viscometer An instrument that can measure viscosity of Newtonian fluids, non Newtonian fluids, and suspensions by determining the torque needed to rotate a vertical paddle or cylinder submerged in the fluid.

torr Also spelled tor. A unit of pressure equal to the pressure exerted by a column of mercury 1 mm high at 0°C.

total absorption spectrometer An instrument that measures the total amount of x rays absorbed by a sample and compares it to the amount absorbed by a reference sample; the sample may be solid, liquid or gas.

total pressure The sum of the static and velocity pressures.

tracer A colored thread or filament visible in the insulation on an electrical wire so that the wire can be easily identified or traced between connections.

tracer gas A gas used in connection with a leak detecting instrument to find minute openings in a sealed vacuum system.

transfer function A mathematical expression frequently used by control engineers, which expresses the relationship between the outgoing and the incoming signals of a process, or control element. The transfer function is useful in studies of control problems. Transfer functions are generally presented in terms of the Laplace transform.

transient response The response of a transducer to a step change in measurand. NOTE: Transient response, as such, is not shown in a specification except as a general heading, but is defined by such characteristics as time constant, response time, ringing period, etc.

transitional flow Flow between laminar and turbulent flow; generally between a pipe Reynolds number 2000 and 7000.

transverse electromagnetic wave A type of electromagnetic wave having both its electric field vector and its magnetic field vector everywhere perpendicular to the direction of propagation in a homogeneous isotropic medium.

tray A horizontal plate in a distillation column that temporarily holds a pool of descending liquid until it flows into a vertical "downcomer" and onto the next tray. Each tray has openings to permit passage of ascending vapours.

trim The internal parts of a valve which are in flowing contact with the controlled fluid.

trim, anti cavitation A combination of control valve trim that by its geometry reduces the tendency of the controlled liquid to cavitate.

trim, anti noise A combination of control valve trim that by its geometry reduces the noise generated by fluid flowing through the valve.

trim, balanced Control valve trim designed to minimize the net static and dynamic fluid flow forces acting on the trim.

trim, restricted Control valve trim which has a flow area less than the full flow area for that valve.

trim, reduced Control valve trim which has a flow area smaller than the full flow area for that valve.

trim, soft-seated Valve trim with an elastomeric, plastic or other readily deformable material used either in the closure component or seat ring to provide shutoff with minimal actuator forces.

triple point A temperature at which all three phases of a pure substance solid, liquid and gas-are in equilibrium.

tundish A pouring basin (typically for molten metal).

tuning The adjustment of control constants in algorithms or analog controllers to produce the desired control effect.

turbidity The optical obstruction to the passing of a ray of light through a body of water, caused by finely divided suspended matter.

turbine meter A volumetric flow measuring device using the rotation of a turbine type element to determine flow rate.

turbulent flow A flow regime characterised by random motion of the fluid particles in the transverse direction as well as motion in the axial direction. This occurs at high Reynolds numbers and is the type of flow most common in industrial fluid systems.

turndown The ratio of the maximum plant design flow rate to the minimum plant design flow rate.

Twaddle scale A specific gravity scale that attempts to simplify measurement of liquid densities heavier than water, such as industrial liquors; the range of density from 1.000 to 2.000 is divided into 200 equal parts, so that one degree Twaddle equals a difference in specific gravity of 0.005; on this scale, 40° Twaddle indicates a specific gravity of 1.200.

twisted pair Two insulated wires (signal and return) which are twisted around each other. Since both wires have nearly equal exposure to any electrostatic or electromagnetic interference, the differential noise is slight.

two-element feedwater control A control system whereby two process variables (steam flow and drum level) are used as inputs to the control loop that regulates feedwater flow to the drum to maintain the drum level at set point. The feedforward input is steam flow, with the output of the drum level controller as the primary control signal.

two out of three logic circuit (2/3 logic circuit) A logic circuit with three independent inputs. The output of the logic circuit is the same state as any two matching input states.

two phase A fluid state comprising a mixture of liquid with gas or vapours.

two-wire transmitter Electronic transmitter which uses the power wires (typically 24vdc) for signal transmission, usually by manipulating the current flow (typically 4-20mA) to represent the desired signal.

Tyndall effect A physical phenomenon in which particles suspended in a fluid can be seen readily if illuminated by strong light and viewed from the side, although they cannot be seen when viewed from the front in the same light beam; forms the basis for nephelometry, which involves measurement of the intensity of side reflected light. Used in such applications as analysing for trace amounts of silver in solution, determining the concentration of small amounts of calcium in titanium alloys, measuring bacterial growth rates, and controlling the clarity of beverages, potable water and effluent discharges.

ultrasonic Using sound at frequencies above the audio frequency range, i.e., above 15 kHz.

ultrasonic density sensor A device for determining density from the attenuation of ultrasound beams passing through a liquid or semisolid; a typical application involves immersing an ultrasonic transducer in fully agitated lime slurry, thus avoiding coating and clogging which occurs with other devices.

ultrasonic flowmeter A device for measuring flow rates across fluid streams by either Doppler effect measurements or time of transit determination; in both types of flow measurement, displacement of the portion of the flowing stream carrying the sound waves is determined and flow rate calculated from the effect on soundwave characteristics.

ultraviolet erasable read only memory (UVROM) A type of computer memory that can be erased or changed only by exposure to ultraviolet light.

ultraviolet radiation Electromagnetic radiation having wavelengths shorter than visible light and longer than low frequency x rays-that is, wavelengths of about 14 to 400 nanometers.

Underwriters Laboratories (UL) An independent US testing and certifying organization.

unfired pressure vessel A vessel designed to withstand internal pressure, neither subjected to heat from products of combustion nor an integral part of a fired pressure vessel system.

unified screw thread A US system of standard 60° V threads that are classified coarse, fine and extra fine (UNC, UNF and UNEF) to provide different levels of strength and clamping power.

universal asynchronous receiver transmitter (UART) A semiconductor chip that performs asynchronous communications functions.

USASCII (ASCII) U.S. Standard Code for Information Exchange. The standard code, using a coded character set consisting of 7 bit coded characters (8 bits including parity check), used for information exchange among data processing systems, communications systems, and associated equipment. The USASCII set consists of control characters and graphic characters.

U tube manometer A device for measuring gauge pressure or differential pressure by means of a U shaped transparent tube partly filled with a liquid, commonly water; a small pressure above or below atmospheric is measured by connecting one leg of the U to the pressurised space and observing the height of liquid while the other leg is open to the atmosphere; a small differential pressure may be measured by connecting both legs to pressurised space for example, high and low pressure regions across an orifice or venturi.

UV erasable PROM (EPROM) Memory whose contents can be erased by a period of intense exposure to UV radiation. See UVROM

vacuum breaker A device used in a water supply line to relieve a vacuum and prevent backflow Also known as "backflow preventer. "

valence A positive number that characterises the combining power of an element for other elements, as measured by the number of bonds to other atoms which one atom of the given element forms upon chemical combination; hydrogen is assigned valence 1, and the valence is the number of hydrogen atoms, or their equivalent, with which an atom of the given element combines.

value, rms (root mean square value) The square root of the average of the square of the instantaneous values.

valve, ball A valve with a rotary motion closure component consisting of a full ball or a segmented ball.

valve body assembly An assembly of a body, bonnet assembly, bottom flange and trim elements. The trim includes a valve plug which opens, shuts or partially obstructs one or more ports.

valve, diaphragm A flexible member which is moved into the fluid flow passageway of a body to modify the rate of flow through the valve.

valve, diaphragm-type A valve with a flexible linear motion closure component which is moved into the fluid flow passageway of the body to modify the rate of flow through the valve by the actuator.

valve, floating ball A valve with a full ball positioned within the valve that contacts either of two seat rings and is free to move toward the seat ring opposite the pressure source when in the closed position to effect shutoff.

valve flow coefficient (Cv) The number of US gallons per minute of 60°F water that will flow through a valve with a one pound per square inch pressure drop.

valve, globe A valve with a linear motion closure component, one or more ports and a body distinguished by a globular shaped cavity around the port region.

valve hand A valve with a manual actuator.

Van Stone nipples (flanges) A pipe nipple made with one enlarged integral end held against another face with a loose flange around the nipple.

vapour filled thermometer A type of filled system thermometer in which temperature is determined from the vapour pressure developed from partial vapourisation of a volatile liquid contained within the system.

vapour pressure 1. The pressure of a vapour corresponding to a given temperature at which the liquid and vapour are in equilibrium. vapour pressure increases with temperature. 2. The pressure (for a given temperature)

at which a liquid is in equilibrium with its vapour. As a liquid is heated, its vapour pressure will increase until it equals the pressure above the liquid; at this point the liquid will begin to vapourise.

vapour pressure, Reid The vapour pressure of a liquid at 100°F (311 K) as determined by ASTM Designation D 323 58, "Standard Method of Test for vapour Pressure of Petroleum Products (Reid Method)".

vapour pressure thermometer A temperature transducer for which the pressure of vapour in a closed system of gas and liquid is a function of temperature.

var A unit of measure for reactive power; it is calculated by taking the product of voltage, current, and the sine of the phase angle.

variable inductance pickup A transducer that converts mechanical oscillations into audio frequency electrical signals by varying the inductance of an internal coil.

variable reluctance pickup A transducer that converts mechanical oscillations into audio frequency electrical signals by varying the reluctance of an internal magnetic circuit.

variable reluctance proximity sensor A device that senses the position (presence) of an actuating object by means of the voltage generated across the terminals of a coil surrounding a pole piece that extends from one end of a permanent magnet; coil voltage is proportional to the rate of change of magnetic flux as the object passes through the field near the pole piece.

variance The square of the standard deviation.

vector 1. A quantity having magnitude and direction, as contrasted with a scalar which has quantity only. 2. A one-dimensional matrix.

vee orifice "V"-shaped flow control orifice which allows a characterised flow control as the gate moves in relation to the fixed Vee opening.

velocity head The pressure, measured in height of fluid column, needed to create a fluid velocity. Numerically, velocity head is the square of the velocity divided by twice the acceleration of gravity ($V^2 / 2g$) [S5 1 .1].

Venn diagram A graphical representation in which sets are represented by closed areas. The closed regions may bear all kinds of relations to one another, such as be partially overlapped, be completely separated from one another, or be contained totally one within another. All members of a set are considered to lie within or be contained within the closed region representing the set. The diagram is used to facilitate the determination of whether several sets include or exclude the same members.

venturi A constriction in a pipe, tube or flume consisting of a tapered inlet, a short straight constricted throat and a gradually tapered outlet; fluid velocity is greater and pressure is lower in the throat area than in the main conduit upstream or downstream of the venturi; it can be used to measure flow rate, or to draw another fluid from a branch into the main fluid stream.

venturi meter A type of flowmeter that measures flow rate by determining the pressure drop through a venturi constriction.

venturi tube A primary differential pressure-producing device having a cone section approach to a throat and a longer cone discharge section. Used for high volume flow at low pressure loss.

vertical orifice installation, vertical orifice run, vertical meter run An orifice plate used in a vertical pipeline.

V/F (boilup to feed ratio) A quantity used to analyze the operation of a distillation column.

vibrating density sensor Any of several devices in which a change in natural oscillating frequency of a device element-cylinder, single tube, twin tube, U tube or vane is detected and related to density of process fluid flowing through the system.

vibrating quartz crystal moisture sensor A device for detecting the presence of moisture in a sample gas stream by dividing the stream into two portions, one of which is dried, then alternately passing the two streams across the face of a hygroscopically sensitised quartz crystal whose wet and dry vibrational frequencies are continuously monitored and compared to the frequency of an uncoated sealed reference crystal.

viscometer An instrument that measures the viscosity of a fluid.

viscosity Measure of the internal friction of a fluid or its resistance to flow.

viscosity, absolute The property by which a fluid in motion offers resistance to shear. Usually expressed as newton seconds/meter².

viscosity, kinematic The ratio of absolute viscosity to density. The SI unit is the meter²/s.

viscous drag type density meter A type of meter for determining gas density by comparing the drag force on linked impellers driven by flow of a standard gas and the test gas; the balance point is a function of gas density, and the instrument can be calibrated to read directly in density units.

Viton A A fluorocarbon rubber by E.I. du Pont de Nemours co.

volt A unit of electromotive force which when steadily applied to a conductor whose resistance is one ohm will produce a current of one ampere.

voltage, common mode (CMV) That amount of voltage of the same polarity and phase common to both input lines. Common mode voltage can be caused by magnetic induction, capacitive coupling, and resistive coupling.

vortex shedding A phenomenon that occurs when fluid flows past an obstruction; the shear layer near the obstruction has a high velocity gradient, which makes it inherently unstable; at some point downstream of the immediate vicinity of the obstruction, the shear layer breaks down into well defined vortices, which are captured by the flowing stream and carried further downstream.

vortex flowmeter A device that measures flow by sensing the movement of vortices in a pipe or conduit. The instrument usually is constructed with a bluff body (vortex shedder) inserted perpendicular to the flow to allow formation of vortices, and sensor(s) to detect the passing vortices. The vortices are shed from one side of the shedder and then the other side as the fluid flows around the shedder. The shedding frequency (f), flow velocity (v) and the shedder width (d) can be expressed with the formula:

$$f = St_x V d$$

St_x is a dimensionless constant called the Strouhal number. If the frequency of vortices generation is known, and the sensor can count the number of vortices generated per unit of time, then the velocity of the fluid can be calculated.

wafer body A body whose end surfaces mate with the pipeline flanges. It is located and clamped between the piping flanges by long bolts extending from flange to flange. A wafer body is also called a flangeless body.

watt (W) Metric unit of power. The rate of doing work or the power expended equal to 107 ergs/second, 3.4192 Btu/hour or 44.27 foot-pounds/minute.

weber (Wb) Metric unit for magnetic flux.

weight (wt) The force with which a body is attracted by gravity. The newton is the unit force in this Standard.

weighting Artificial adjustment of a measurement to account for factors peculiar to conditions prevailing at the time the measurement was taken.

weir An open channel flow measurement device analogous to the orifice plate flow constriction.

weir-type valve A body having a raised contour contacted by a diaphragm to shut off fluid flow.

wet bulb temperature The lowest temperature which a water wetted body will attain when exposed to an air current. This is the temperature of adiabatic saturation.

wet bulb thermometer A thermometer whose bulb is covered with a piece of fabric such as muslin or cambric that is saturated with water; it is most often used as an element in a psychrometer.

wet leg The liquid filled low side impulse line in a differential pressure level measuring system.

white noise 1. Random noise that has a constant energy per unit bandwidth at every frequency in the range of interest. 2. A noise whose power is distributed uniformly over all frequencies and has a mean noise power per unit bandwidth; since idealistic white noise is an impossibility, bandwidth restrictions have to be applied.

Whitworth screw thread A British standard screw threaded characterised by a 55° V form with rounded crests and roots.

windup Saturation of the integral mode of a controller developing during times when control cannot be achieved, which causes the controlled variable to overshoot its set point when the obstacle to control is removed.

Wobbe index The ratio of the heat of combustion of a gas to its specific gravity. For light hydrocarbon gases the Wobbe index is almost a linear function of the gas' specific gravity.

Xrays Short wavelength electromagnetic radiation, having a wavelength shorter than about 15 nanometers, usually produced by bombarding a metal target with a stream of high energy electrons; wavelengths are in the same range as gamma rays, longer than cosmic rays but shorter than ultraviolet; like gamma rays, Xrays are very penetrating and can damage human tissues, induce ionisation, and expose photographic films.

Xray thickness gauge A device used to continually measure the thickness of moving cold rolled sheet or strip during the rolling process; it consists of an Xray source on one side of the strip and a detector on the other thickness is proportional to the loss in intensity as the Xray beam passes through the moving material.

No Entries for the letter "Y".

zap In data processing, meaning to erase or wipe out data.

zero bias A positive or negative adjustment to instrument zero to cause the measurement to read as desired.

zero shift 1. In process instrumentation, any parallel shift of the input-output curve [S51.1]. 2. A change in the zero measurand output over a specified period of time and at room conditions.. NOTE: This error is characterised by a parallel displacement of the entire calibration curve [S37. 1]. 3. A shift in the instrument calibrated span evidenced by a change in the zero value. Usually caused by temperature changes, overrange, or vibration of the instrument.

zero suppression 1. For a suppressed zero range, the amount the measured variable zero is below the lower range value. It may be expressed either in units of the measured variable or in percent of span [S5 1 .1]. 2. The elimination of nonsignificant zeros in a numeral. 3. Biasing the zero output signal to produce the desired measurement. Used in level measurement to counteract the zero elevation caused by a wet leg.

Ziegler-Nichols method A method of determination of optimum controller settings when tuning a process control loop (also called the "ultimate cycle method"). It is based on finding the proportional gain which causes instability in a closed loop.

zone The international method of specifying the probability that a location is made hazardous by the presence, or potential presence, of flammable concentrations of gases and vapours. NOTE: Zone classification has not not yet been defined for dusts and flyings.

Zone 0: Classification of a location in which an explosive concentration of a flammable gas or vapour mixture is continuously present or is present for long periods.

Zone 1: Classification of a location in which an explosive concentration of a flammable or explosive gas or vapour mixture is likely to occur in normal operation.

Zone 2: Classification of a location in which an explosive concentration of a flammable or explosive gas or vapour mixture is unlikely to occur in normal operation and, if it does occur, will exist only for a short time.