

# CCPS

## CENTER FOR CHEMICAL PROCESS SAFETY

### Combined Glossary of Terms

Spring 2005

This list of glossary terms was compiled from the following CCPS Guidelines:

- o Hazard Evaluation Procedures (G1)
- o Hazard Evaluation Procedures - 2nd Edition (G1+)
- o Safe Storage & Handling of High Toxic Hazard Materials (G3)
- o Vapor Release Mitigation (G4)
- o Chemical Process Quantitative Risk Analysis (G6)
- o Process Equipment Reliability Data (G7)
- o Technical Management of Chemical Process Safety (G8)
- o Safety, Health & Loss Prevention in Chemical Processes (G17)
- o Safe Automation of Chemical Processes (G24)
- o Guidelines for Safe Warehousing of Chemicals (G33)
- o Chemical Reactivity Evaluation and Application to Process Design (G35)
- o Incident Investigation (G56)
- o Estimating the Flammable Mass of a Vapor Cloud (G60)
- o Guidelines for Process Safety in Batch Reaction Systems (G62)
- o Deflagration and Detonation Flame Arresters (G64)
- o Avoiding Static Ignition Hazards In Chemical Operations (G67)
- o Guidelines for Process Safety in Outsourced Manufacturing Operations (G68)
- o Revalidating Process Hazard Analyses (G71)
- o Wind Flow and Vapor Cloud Dispersion at Industrial and Urban Sites (G75)
- o Essential Practices for Managing Chemical Reactivity Hazards (G81)
- o Guidelines for Investigating Chemical Process Incidents Second Edition (G82)

o Guidelines for Fire Protection in Chemical, Petrochemicals and Hydrocarbon Processing Facilities (G83)

<u>Abort</u>	To terminate a procedure, such as the running of a computer program or the printing of a document while it is still in progress.  The process of halting a computer program in an orderly fashion and returning control to the operator or operating system. Abnormal termination of a computer program, caused by hardware or software malfunction or operator cancellation.	G24
<u>Absolute Application (of CPQRA)</u>	The application of CPQRA in which the results of the analysis are compared against predetermined risk targets.	G6
<u>Accelerating rate calorimetry (ARC)</u>	A technique in which a substance is heated in stages until very slow decomposition [or other reaction] is detected. The substance is then held under adiabatic conditions and the course of the decomposition [or other reaction] is monitored. (Also the name of a commercial test apparatus.) Barton and Rogers 1997	G81
<u>Accident, Accident Sequence, or Scenario</u>	An unplanned event or sequence of events that results in undesirable consequences. An incident with specific safety consequences or impacts.	G1+
<u>Accident</u>	An undesirable, unplanned combination of events or circumstances that lead to physical harm to people or damages to property. Usually the result of contact with a source of energy above the threshold limit of the body or structure.	G56
<u>Accident</u>	An event in which property damage, detrimental environmental impact, or human loss (either injury or death) occurs.	G82
<u>Accidental Chemical Release</u>	An unintended, or sudden release of chemical(s) from manufacturing, processing, handling, or on-site storage facilities to the air, water, or land.	G56 G60 G68 G82

<u>ACGIH</u>	American Conference of Governmental Industrial Hygienists; an organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs.	G17
	<b>Importance:</b> ACGIH develops and publishes recommended occupational exposure limits (see TLV) for hundreds of chemical substances and physical agents.	
<u>Action Tracking</u>	A method of logging progress when implementing a task or set of tasks.	G82
<u>Activation Energy</u>	Constant $E_a$ in the exponential part of the Arrhenius equation associated with the minimum energy difference between the reactants and an activated complex, which has a structure intermediate to those of the reactants and the products (transition state) or with the minimum collision energy between molecules that is required to enable a reaction.	G35
<u>Activation Energy</u>	The constant $E$ in the exponential part of the Arrhenius equation, associated with the minimum energy difference between the reactants and an activated complex (transition state), which has a structure intermediate to those of the reactants and the products, or with the minimum collision energy between molecules that is required to enable a reaction to occur. It is a constant that defines the effect of temperature on reaction rate. CCPS 1995a, Barton and Rogers 1997	G81
<u>Active Equipment</u>	Denotes physical motion or activity in the performance of the equipment's function, as with rotating machinery.	G7
<u>Active System</u>	A system in which failures are immediately evident during normal operation.	G24
<u>Acute Effect</u>	An adverse effect on a human or animal body, with severe symptoms developing rapidly and coming quickly to a crisis. See also, "Chronic".	G17
	<b>Importance:</b> How much and how long one is exposed to a chemical is the critical factor to how adverse the health effects will be.	
<u>Acute Exposure</u>	A short-term or rare exposure to a toxic agent in a single episode that is unlikely to recur.	G3

<u>Acute Hazard</u>	The potential for injury or damage to occur as a result of an instantaneous or short duration exposure to the effects of an undesirable event (e.g., an explosion with the potential for causing damage and injury).	G3
<u>Acute Toxicity</u>	The adverse (acute) effects resulting from a single dose or exposure to a substance.  <b>Importance:</b> Ordinarily used to denote effects in experimental animals.	G17
<u>Ad Hoc Investigation</u>	An incident investigation fashioned from the immediately available information and concerns. Typically, the ad hoc investigation is performed whenever there are no prior investigation procedures. A synonym to ad hoc is <i>unsystematic</i> .	G82
<u>Adiabatic</u>	A system condition in which no heat is exchanged between the chemical system and its environment.	G35
<u>Adiabatic</u>	No heat transfer occurs to or from the environment surrounding the sample, including the sample container. HSE 2000	G81
<u>Adiabatic decomposition temperature rise</u>	An estimation of the computed temperature which a specimen would attain if all of the enthalpy (heat) of decomposition reaction were to be absorbed by the sample itself. High values represent high hazard potential.	G81
<u>Adiabatic Induction Time</u>	Induction period to event (spontaneous ignition, explosion, etc.) ( $t_i$ ) under adiabatic conditions. When $\log(t_i)$ is plotted against $1/T$ a straight line is obtained.	G35
<u>Adiabatic Lapse Rate (ALR)</u>	See Dry Adiabatic Lapse Rate.	G6

<u>Adiabatic Temperature Rise</u>	<p>Maximum increase in temperature that can be achieved. This increase only occurs when the substance or reaction mixture decomposes completely <u>and</u> at adiabatic conditions. The adiabatic temperature rise follows from:</p> $DT_{ad} = \frac{-\Delta H_r}{\sum C_p}$ <p>In case of pure organic substances (<math>C_p \approx 2 \text{ kJ/kg K}</math>) the adiabatic temperature rise is often approximated by <math>DT_{ad} = \Delta H_r / 2</math> with <math>-\Delta H_r</math> in kJ/kg.</p>	G35
<u>Administrative Controls</u>	Procedural mechanisms, such as lockout/tagout procedures, for directing and/or checking human performance on plant tasks.	G1+
<u>Advection</u>	The transport of material by and in the wind	G60
<u>Aerosol Fraction</u>	The fraction of liquid phase, $1 - x$ , which, after flashing to the atmosphere, remains suspended as an aerosol.	G60
<u>Agency</u>	The principal object, substance, or material inflicting the physical harm or property damage in an accident.	G35
<u>Aggregation</u>	The statistical combination of several data points to form a single data point and confidence interval.	G7
<u>Air</u>	<p>Sea level concentrations of the six principal constituents of dry air are given in the following table. Dry air is often obtained by drying compressed atmospheric air using a suitable drying agent. In some cases "dry air" is made up in cylinders using 20.95 mol% oxygen with the balance being exclusively nitrogen. Care should be taken that argon is not analyzed as oxygen, as can occur in GC analysis. Dry air contains a higher concentration of oxygen than atmospheric air, which contains moisture. The absolute humidity of saturated air is found using steam tables. For example, saturated air at 100°F contains 6.46 mol% water vapor. Relative humidity at any temperature is the fraction of the water vapor concentration corresponding to saturation.</p> <p>Constituent Gas Dry Air (mol%) Sat Air @ 100°F (mol%)</p> <p>Nitrogen 78.09 73.04</p> <p>Oxygen 20.95 19.60</p> <p>Water 0.00 6.46</p> <p>Argon 0.93 0.87</p> <p>Carbon Dioxide 0.030 0.028</p> <p>Neon 0.0018 0.0017</p> <p>Helium 0.000524 0.00049</p>	G67

<u>Air Quality Control</u>	The control of the level of pollutants prescribed by regulations that may not be exceeded during a specified time in a defined area. (Association of Engineering Geologist's online dictionary)	G83
<u>Alarm Management</u>	Procedures, schematic, software, maintenance, documentation, hardware, logic, prioritization, characterization, etc., pertaining to the management of process alarm system.	G24
<u>Along-Wind Distance,x</u>	Distance in the direction the vapor cloud is traveling, i.e. the wind direction. Since the wind direction may change, the along-wind distance may change in direction and time as well.	G60
<u>Alpha Test Unit</u>	A device or system that is comprised of components that meet both the functional and form prototype requirements. The scale of test is limited, usually to a laboratory, for operational and life cycle tests. The initial preproduction device.	G24
<u>Alternating Mode</u>	Hardware operation that alternates between standby and running, e.g., a pump with an installed spare, each of which operates for a comparable amount of time.	G7
<u>Alternative Release Scenario (ARS)</u>	The basis for an off-site consequence analysis required by the EPA RMP Rule. This release scenario is less conservative, and more likely to occur than the Worst Case Scenario.	G71
<u>Amelioration</u>	Improvement of conditions immediately after an accident; treatment of injuries and conditions which endanger people and property.	G56 G82
<u>Analysis Data Base</u>	A data base that contains all input data for a CPQRA, including the System Description, as well as environmental data (e.g., land use and topography, population and demography, meteorological data).	G6
<u>Anomaly</u>	An unusual, abnormal, or irregular set of circumstances that left unrecognized or uncorrected may result in an incident.	G56 G82
<u>Antistatic</u>	Having the ability to dissipate charge at a sufficient rate to prevent hazards or nuisances under the conditions of use.	G67
<u>Apparent Activation Energy</u>	In practice, reaction rates are often determined by physical processes (e.g. mass flow, diffusion, mass transfer area) as well as by chemical processes. The activation energy observed in these cases is called the apparent activation energy.	G35

<u>Appearance and Odor</u>	The physical properties of a chemical, such as color and smell.  <b>Importance:</b> Knowing what chemicals look and smell like allows an employee to recognized unsafe working conditions.	G17
<u>Application Language</u>	A computer language which is appropriate for a specific type of application. Examples are: SLAM, ATLAS, CORAL 66, PROLOG, INQUIRE, RAMIS II, etc.	G24
<u>Application Program</u>	A generic term for a computer program written for a particular application, possibly unique to a particular installation.  Logical assembly of all the programming language ELEMENTS and constructs necessary for the intended signal processing required for the control of a MACHINE or PROCESS by a PES. See "Automated System".	G24
<u>Application Software</u>	The collection of applications programs used on a given system.	G24
<u>Approved</u>	Refers to PES equipment status following approved future equipment classification. While the PES is passing a user approved, beta site test, the PES must pass a list of generic criteria, as follows:  <ul style="list-style-type: none"> <li>o Producer approval of PES hardware.</li> <li>o Producer approval of PES hardware.</li> <li>o Timely plant access to and review of all PES problems and engineering change orders (ECOs).</li> <li>o Plant approval of PES hardware.</li> <li>o Plant approval of PES software.</li> <li>o Plant approval of PES product documentation.</li> <li>o Plant approval of PES application program documentation.</li> <li>o Plant approval of producer's training for plant maintenance.</li> <li>o Analysis of PES "watchdog timer" (WDT) diagnostics confirming a WDT exists and a WDT can be added (if required) that has no common mode faults with the PES it is monitoring.</li> </ul> If the PES testing and analysis is successful, the PES is classified "approved".	G24
<u>Approved Future</u>	Refers to PES equipment status following "preproduction". Approved Future equipment is production equipment ready or full beta-site testing.	G24

<u>Approved Independent Safety Layer (AISL)</u>	<p>Is one layer of a system or subsystem considered adequate protection, in whole or in part, against a specific hazard. An AISL:</p> <ul style="list-style-type: none"> <li>o Is generally one of a number of AISL required as protection against a specific hazards.</li> <li>o Cannot be contaminated by the failure of another AISL.</li> <li>o Is totally independent of any other AISL.</li> <li>o May be a chemical or mechanical design alternate (See Table 1).</li> <li>o Must be an "approved mature" EMR, PC, DCS, or microcomputer if electrical controls are used (See Table 2).</li> <li>o Must have EMR, PC, DCS or microcomputer with the necessary safety features.</li> <li>o Must be able to pass tests for today's process hazard analysis.</li> </ul>	G24
<u>Architecture</u>	<p>Organizational structure of a computing system referring to:</p> <ul style="list-style-type: none"> <li>o The CPU or microprocessor (board level).</li> <li>o The PES and its relationship to its I/O, MMIs and peripherals (device level).</li> <li>o Network of communication PESs (system level).</li> </ul>	G24
<u>Arrhenius Equation</u>	<p>The reaction rate constant (<math>k</math>) is a function of temperature (<math>T</math>). This function is represented by the Arrhenius equation</p> $k = k^* \cdot \exp(-E_a/RT).$ <p>The pre-exponential factor (<math>k^*</math>) and the activation energy (<math>E_a</math>) are approximately constant for a simple reaction.</p>	G35
<u>Arrhenius Equation</u>	<p><math>k = Z e^{-E/RT}</math> where <math>k</math> is the specific reaction rate constant in reciprocal minutes for first order, <math>Z</math> is the preexponential factor in reciprocal minutes, <math>E</math> is the Arrhenius activation energy in J/mol, <math>R</math> is the gas constant, 8.32 J/mol K, and <math>T</math> is the temperature in kelvin. ASTM E 1445</p>	G81
<u>Arrhenius Plot</u>	<p>Graph that shows the logarithmic rate of heat production <math>\ln(q)</math> versus the inverse temperature (<math>1/T</math>) in Kelvin. This results in a straight line with a gradient <math>-E_a/R</math> for single, non-autocatalyzed reactions. Autocatalysis results in typical deviations of the straight line. In practice, the rate of reaction is often affected by physical processes (e.g. diffusion), which results in the occurrence of an apparent activation energy.</p>	G35

<u>Asphyxiant</u>	A vapor or gas which can cause unconsciousness or death by suffocation (lack of oxygen). Most simple asphyxiants are harmful to the body only when they become so concentrated that they reduce oxygen in the air (normally about 21%) to dangerous levels (19.5% or lower).  <b>Importance:</b> Asphyxiation is one of the principal potential hazards of working in confined spaces.	G17
<u>Assignment List</u>	A list showing the correspondence between absolute or logical addresses and the symbolic addresses assigned to them.	G24
<u>Assumed Risk</u>	A risk that has been identified, analyzed, and accepted at the appropriate management level, unanalyzed or unknown risks fall under oversight and omissions <i>by default</i> .	G82
<u>Atmospheric boundary layer</u>	The layer about 1000 m deep next to the ground that is strongly affected by diurnal variations in surface conditions such as ground temperature.	G75
<u>Atmospheric Dispersion</u>	The low momentum mixing of a gas or vapor with air. The mixing is the result of turbulent energy exchange, which is a function of wind (mechanical eddy formation) and atmospheric temperature profile (thermal eddy formation).	G6
<u>Atmospheric Dispersion</u>	The low momentum mixing of a gas or vapor with air. The mixing is the result of turbulent energy exchange, which is a function of wind and atmospheric temperature profile. (CCPS, 1999)	G83
<u>Atmospheric Stability</u>	A measure of the degree of atmospheric turbulence commonly defined in terms of the vertical temperature gradient. In neutral stability the gradient is equivalent to the Adiabatic Lapse Rate (ALR). Stable atmospheric conditions refer to a gradient less than the ALR (ultimately to a temperature inversion), and unstable conditions to a gradient greater than the ALR.	G6
<u>Atmospheric Tank</u>	A storage tank that has been designed to operate at pressures from atmospheric through 0.5 psig measured at the top of the tank. (NFPA30)	G83
<u>Atmospheric transport and dispersion model</u>	A model that follows the movement and dilution of a pollutant after it is released into the atmosphere (Hanna et al., 1982).	G75

<u>Atmospheric turbulence</u>	Random and rapid fluctuations in wind components, which determine the rate of turbulent dispersion or spread of the cloud. Typically expressed by the <i>turbulent velocity</i> (averaging about 1 m/s), which is the standard deviation of rapid fluctuations in wind speed ( $\sigma_u$ refers to fluctuations in the along-wind (x) direction, $\sigma_v$ refers to fluctuations in the lateral (y) horizontal direction, and $\sigma_w$ refers to fluctuations in the vertical (z) direction).	G75
<u>Audit (Process Safety Audit)</u>	An inspection of a plant or process unit, drawings, procedures, emergency plans, and/or management systems, etc., usually by an independent, impartial team. (See "Safety Review" for contrast).	G1+
<u>Audit Trail</u>	The proof that systematic documentation of activities was performed in a way that allows an auditor to confirm compliance with required or desired organizational behavior.	G82
<u>Auto-Ignition Temperature</u>	The autoignition temperature of a substance, whether solid, liquid, or gaseous, is the minimum temperature required to initiate or cause self-sustained combustion, in air, with no other source of ignition.	G64
<u>Autoignition Temperature</u>	The minimum temperature at which combustion can be initiated without an external ignition source. (CCPS, 1996, no. 22)	G83
<u>Autocatalysis</u>	The increase of the rate of reaction due to the catalyzing effect of the reaction products. HSE 2000	G81
<u>Autocatalytic Reaction</u>	Reaction of which the rate is increased by the catalyzing effect of its reaction products.	G35
<u>Autodecomposition</u>	The sustained decomposition of a substance without introduction of any other apparent ignition source besides thermal energy and without air or other oxidants present. Autodecomposition is the result of a thermal self-decomposition reaction for given initial conditions (temperature, pressure, volume) at which the rate of heat evolution exceeds the rate of heat loss from the reacting system, thus resulting in an increasing reaction temperature and reaction rate. CCPS 1995b	G81
<u>Autodecomposition temperature</u>	The minimum temperature for a specified test method, test apparatus (including material of construction and test volume) and initial pressure required to initiate self-sustained decomposition of a solid, liquid or gaseous substance without any other apparent source of ignition and without air or other oxidants present. CCPS 1995b	G81

<u>Automated System</u>	A control system beyond the scope of this standard in which PESs are incorporated by or for the user, but which also contains other COMPONENTS including their APPLICATION PROGRAMS.	G24
<u>Autoxidation</u>	Also <i>autooxidation</i> or <i>auto-oxidation</i> . A slow, easily initiated, self-catalyzed reaction, generally by a freeradical mechanism, between a substance and atmospheric oxygen. Initiators of autoxidation include heat, light, catalysts such as metals, and freeradical generators. Davies (1961) defines autoxidation as interaction of a substance with molecular oxygen below 120°C without flame. Possible consequences of autoxidation include pressure buildup by gas evolution, autoignition by heat generation with inadequate heat dissipation, and the formation of peroxides. CCPS 1995b	G81
<u>Availability</u>	The fraction of time that the system is actually capable of performing its mission. The fraction of time a system is fully operational.	G24
<u>Average concentration</u>	The concentration averaged over time and/or space.	G75
<u>Average Individual Risk</u>	There are three Average Individual Risks.  A. <i>Average Individual Risk (exposed population)</i> is the individual risk averaged over the population which is exposed to risk from the facility. B. <i>Average Individual Risk (total population)</i> is the individual risk averaged over a predetermined population, without regard to whether or not all people in that population are actually exposed to the risk. C. <i>Average Individual Risk (Exposed hours/worked hours)</i> . The individual risk for an activity may be calculated for the duration of the activity or may be averaged over the working day.	G24
<u>Averageing Time</u>	The length of time in atmospheric dispersion testing over which concentration data are averaged to produce the concentration-time series.	G60
<u>Basic Event</u>	An event in a fault tree that represents the lowest level of resolution in the model such that no further development is necessary (e.g., equipment item failure, human failure, or external event).	G1+

<u>Batch Reactor</u>	Reactor in which all reactants and solvents are introduced prior to setting the reaction conditions (temperature, pressure). Products are only taken from the reactor upon conclusion of the reaction process. Both heat generation and concentrations in the batch reactor vary during the reaction process.	G35
<u>Batch sheet</u>	Sometimes called batch instruction. The operating procedure for making a batch product. Primarily focuses on material quantities, as well as instructions for any mixing, reaction, heating, cooling, drying required for the process.	G68
<u>Battery Limit</u>	The perimeter of a specific manufacturing process area. It is often defined by the roads around the perimeter. This area will include process equipment, and may include in-process tankage.	G83
<u>Baud</u>	Unit of modulation speed corresponding to a unit interval testing one second. (IEV 5550 20)	G24
<u>Bench Scale</u>	Technical laboratory scale (typically between 0.1 and 5 dm <sup>3</sup> ), more specifically directed to process simulation and determination of technical plant facilities (cooling/heating capacities, temperature constraints, charging requirements, etc.)	G35
<u>Benchmark</u>	A point of reference from which measurements may be made or from which other things can be measured. A program that is used to compare the operation of two or more systems is called a benchmark program.	G24
<u>Beta Test Unit</u>	A device or system that is comprised of preferably production components, but may use preproduction equipment if life cycle is satisfactory. The scale of the test is such that the equipment is installed in a real-life operating environment and its operation is monitored to determine performance against expectations.	G24
<u>Bidirectional Flame Arrester</u>	An in-line flame arrester is considered to be bidirectional if: (a) the investigation (test) shows that the flame arrester performs its intended function with a detonation or deflagration approaching from either direction, or (b) the design of the flame arrester is symmetrical and each end is considered identical when approached by a detonation or deflagration from either direction.	G64
<u>Binary Character</u>	Either of the "characters" of the "character set" consisting of two characters (e.g., a "binary digit").	G24

<u>Binary Code</u>	A code consisting of the numbers 0 and 1. Can be easily represented in a computer by a series of on/off switches, the direction of a magnetic field, etc.	G24
<u>Binary Coded Decimal (BCD)</u>	A numerical representation in which each decimal digital is represented by a group of four bits (binary digits). The bits are assigned the respective weights 8-4-2-1. If binary coded decimal, the number 14 is represented as 0001 0100.	G24
<u>Binary Digit (BIT)</u>	Either of the "digits" 0 and 1 when it is used in the "pure binary numeration system."	G24
<u>Biological Oxygen Demand</u>	The amount of dissolved oxygen in water, given in lbs. (kgs) or % that is consumed by biological oxidation of a chemical.	G33
<u>BIT</u>	<ul style="list-style-type: none"> <li>o An abbreviation for binary digit.</li> <li>o A single character in a binary number.</li> <li>o A single pulse in a group of pulses.</li> <li>o A unit of information capacity of a storage device.</li> </ul>	G24
<u>Blast</u>	A transient change in the gas density, pressure, and velocity of the air surrounding an explosion point. (CCPS, 1994)	G83
<u>Blast resistant buildings</u>	Buildings that are structurally designed to withstand an explosion generated load (pressure and impulse) while sustaining a predetermined amount of damage.	G83
<u>Blast Wave</u>	The narrow pressure pulse transmitted by an explosion.	G60
<u>Blast Wave</u>	The overpressure wave traveling outward from an explosion point. (CCPS, 1996, no. 22)	G83

<u>BLEVE (Boiling-Liquid-Expanding-Vapor Explosion)</u>	A type of rapid phase transition in which a liquid contained above its atmospheric boiling point is rapidly depressurized, causing a nearly instantaneous transition from liquid to vapor with a corresponding energy release. A BLEVE of flammable material is often accompanied by a large aerosol fireball, since an external fire impinging on the vapor space of a pressure vessel is a common cause. However, it is not necessary for the liquid to be flammable to have a BLEVE occur.	G60
<u>Boiling-Liquid-Expanding-Vapor Explosion (BLEVE)</u>	A type of rapid phase transition in which a liquid contained above its atmospheric boiling point is rapidly depressurized, causing a nearly instantaneous transition from liquid to vapor with a corresponding energy release. A BLEVE is often accompanied by a large fireball if a flammable liquid is involved, since an external fire impinging on the vapor space of a pressure vessel is a common BLEVE scenario. However, it is not necessary for the liquid to be flammable to have a BLEVE occur.	G4
<u>BLEVE</u>	A Boiling Liquid Expanding Vapor Explosion is a blast resulting from the sudden release and nearly instantaneous vaporization of a liquid under greater-than-atmospheric pressure at a temperature above its atmospheric boiling point. The material may be flammable or nonflammable. A BLEVE is often accompanied by a fireball if the contained liquid is flammable and its release results from vessel failure. (CCPS, 1996, no. 22)	G83

<u>Block flow diagram</u>	A simplified drawing representing a process. It typically shows major equipment and piping and can include major valves.	G68
<u>Blowdown drums</u>	Separators or accumulators used to separate liquids and vapors in pressure-relieving and emergency systems.	G83
<u>Boil-over</u>	A violent expulsion of contents caused by a heat wave from the surface burning at the top of the tank reaching the water stratum at the bottom of the tank. Oils subject to boilover contain components having a wide range of boiling points, including both light ends and viscous residues. These characteristics are present in most crude oils. (Draft NFPA Understanding Fire Protection for Flammable Liquids)	G83
<u>Bonding</u>	The process of connecting two or more conductive objects together by means of a conductor.	G62
<u>Bonding</u>	The process of connecting two or more conductive objects together by means of a conductor so that they are at the same potential as each other but not necessarily at the same potential as the earth. 261	G67
<u>Boolean Algebra</u>	That branch of mathematics describing the behavior of linear functions of variables which are binary in nature: on or off, open or closed, true or false. All coherent fault trees can be converted into an equivalent set of Boolean equations.	G6
<u>Bounding Group (of incidents)</u>	A small number of incidents selected to bracket the spectrum of possible incidents, which may include those catastrophic incidents sometimes referred to as the Worst Credible Incident and Worst Possible Incident.	G6
<u>BPCS</u>	(Basic Process Control System) - The control equipment which is installed to support normal production functions. (See E&I Protection Layer)	G24
<u>Branching Point</u>	[ no text given ]	G1+

<u>Breakdown Strength</u>	The minimum voltage for spark breakdown to occur across a material of given thickness held between electrodes producing a uniform electric field under specified test conditions. Expressed as volts per unit thickness. As the potential across any material is increased, Ohm's law is typically obeyed initially, followed by a region of non-Ohmic behavior; finally a potential is reached at which the current increases at an uncontrolled rate. The corresponding field is the breakdown strength, also known as breakdown field, dielectric strength, and electric strength. Insulator breakdown strengths are typically 10 <sup>6</sup> to 10 <sup>9</sup> V/m at room temperature, varying considerably with test method. High vacuum has the highest breakdown strength followed by thin homogeneous solids and then liquids.	G67
<u>Breakdown Voltage</u>	The minimum voltage for spark breakdown of a specified gas mixture between electrodes producing a uniform electric field, for specified values of the product of gas density and gap length.	G67
<u>Brownfield</u>	An industrial or commercial property that is abandoned or underused and being considered as a potential site for redevelopment. (Dictionary .com)	G83
<u>Brush Discharge</u>	A higher energy form of corona discharge characterized by low frequency bursts or streamers. The simplest type forms between charged, isolated nonconductive surfaces and grounded conductors acting as electrodes. For positive electrode, pre-onset or breakdown streamers are observed and the maximum effective energy is 5–10 mJ, while for negative electrode the maximum effective energy is a few tenths of a mJ. Brush discharges may ignite flammable gas and hybrid mixtures but not dust in air. Brush discharges may also form on nonconductive layers with grounded substrates. These include "transitional brush discharges" which have a greater effective energy than brushes from isolated nonconductors but a smaller effective energy than propagating brushes.	G67
<u>Building downwash models</u>	Models used for estimating the flow and dispersion in and near the recirculating cavity behind buildings, where plumes may "downwash" to the ground.	G75

<u>Bulking Brush Discharge</u>	A partial surface discharge created during bulking of powder in containers, appearing as a luminous, branched channel flashing radially from the wall toward the center of the container. Its maximum effective energy with respect to dust ignition is believed to be 10–20 mJ (less than the MIE of <i>Lycopodium</i> ). May ignite flammable gas, hybrid mixtures and some fine dusts in air. Owing to large size of phenomenon the effective energy cannot be measured directly but instead must be inferred from accident case histories where dust of known spark MIE was ignited with proper grounding in place.	G67
<u>Buoyant cloud</u>	The in-cloud density is less than the ambient density, due to the emissions of hot gases or materials with low molecular weight. Buoyant cloud and light cloud are synonymous.	G75
<u>Buoyant Gas</u>	See Positively Buoyant Gas.	G60
<u>Buoyant Force</u>	Mathematically, $(\rho_{cl}d - \rho_{air})gV_{cl}d$ (in Newtons), the product of the difference in density of a cloud and the surrounding medium (air), the gravitational acceleration, and the volume of the cloud.	G60
<u>Buoyant turbulence</u>	Generated by heating of the ground surface by the sun and is suppressed by cooling of the ground surface at night. Surface heating leads to the formation of buoyant thermal bubbles from the warm ground surface on sunny afternoons. The opposite effect happens during clear nights, when the surface cooling causes the suppression of turbulence.	G75
<u>Burnback Resistance</u>	The ability of a flame arrester to maintain its mechanical integrity and prevent flame breakthrough when the flame arrester is subjected to a standing flame. See also Endurance Burn(ing).	G64
Burning Velocity	Burning velocity is the speed at which a flame front propagates relative to the unburned gas. This differs from flame speed. The laminar burning velocity ( $S_L$ ) is the speed at which a laminar (planar) combustion wave propagates relative to the unburned gas mixture ahead of it. The fundamental burning velocity ( $S_u$ ) is similar, but generally not identical to, the observed laminar burning velocity. This is because $S_u$ is a characteristic parameter referring to standardized unburned gas conditions (normally 760 mm Hg and 25°C), and which has been corrected for nonidealities in the measurement. The turbulent burning velocity ( $S_t$ ) exceeds the burning velocity measured under laminar conditions to a degree depending on the scale and intensity of turbulence in the unburned gas.	G64
<u>Bus</u>	One or more conductors used for transmitting signals or power from one or more sources to one or more destinations.	G24

<u>Byte</u>	A data element of length 8 bits.	G24
<u>CALMET/CALPUFF</u>	California Meteorological and California Puff Models (Scire et al., 1998)	G75
<u>CCPS</u>	Center for Chemical Process Safety of the American Institute of Chemical Engineers	G75
<u>C or Ceiling</u>	The letter "C" or the word "ceiling" on the TLV or PEL shows the highest airborne concentration of a specific chemical that is allowed in the workplace. This concentration should never be exceeded, even for short periods of time. See also, "PEL" and "TLV".  <b>Importance:</b> Chemicals that react rapidly in the body, causing ill health effects carry this value.	G17
<u>CAS Registry Number</u>	A unique number having up to nine digits that is assigned to a chemical by the Chemical Abstracts Service of the American Chemical Society. With the exception of aqueous solutions, mixtures are not covered under this registry.	G33
<u>Calculated Adiabatic Reaction Temperature (CART)</u>	See Flame Temperature	G64
<u>Calendar Time</u>	The period between starting date and ending date.	G7
<u>Capability Assessment</u>	A systematic review of a system's ability to perform to meet system requirements under abnormal and perturbed dynamic conditions.	G24
<u>Capacitance (C).</u>	The constant of proportionality between charge and potential difference for systems of conductive bodies. The capacitance in Farads is the charge in Coulombs which must be communicated to raise the potential difference by 1 V. <b>262</b> <i>GLOSSARY</i>	G67
<u>Carcinogen</u>	A cancer-causing material.  <b>Importance:</b> If a substance is known to be cancer causing, a potential health hazard exists and special protection and precaution sections should be checked on the MSDS.	G17
<u>Car Seal</u>	A metal or plastic cable used to fix a valve in the open position (car seal open) or closed position (car seal closed). Proper authorization, controlled via administrative procedures, must be obtained before operating the valve. The physical seal should have suitable mechanical strength to prevent unauthorized valve operation.	G62

<u>Cascading</u>	See Pressure Piling	G64
<u>Catalogued Device</u>	A device that is listed in the manufacturer's catalogue of PES components.	G24
<u>Catalyst</u>	A chemical substance that accelerates the rate of a chemical reaction by lowering the energy of activation required for the chemical reaction to occur.	G33 G81
<u>Catastrophic</u>	A loss of extraordinary magnitude in physical harm to people, with damage and destruction to property, and/or to the environment.	G56
<u>Catastrophic Failure</u>	A failure which is both sudden and causes termination of one or more fundamental functions.	G7
<u>Catastrophic Incident</u>	An incident involving a major uncontrolled emission, fire or explosion that causes significant damage, injuries and/or fatalities onsite and have an outcome effect zone that extends into the surrounding community.	G62
<u>Catastrophic Incidents</u>	Incidents that have major consequences with unacceptable lasting effects, usually involving loss of human life, severe off-site impacts, and/or loss of community trust with possible loss of franchise to operate.	G82
<u>Catastrophic release</u>	Under OSHA PSM and EPA RMP, it means a major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemical substances (per OSHA) or regulated substances (per EPA) that presents serious danger to employees in the workplace (per OSHA) or imminent and substantial endangerment to public health and the environment (per EPA).	G68
<u>Category M</u>	A fluid service in which the potential for personnel exposure is judged to be significant, and in which a single exposure to a very small quantity of a toxic fluid, caused by leakage, can produce serious irreversible harm to persons upon breathing or bodily contact, even when prompt restorative measures are taken (ASME B31.3).	G3
<u>Causal Factor</u>	is a major unplanned, unintended contributor to the incident (a negative event or undesirable condition), that if eliminated would have either prevented the occurrence, or reduced its severity or frequency. (Also known as a critical causal factor or contributing cause.)	G82

<u>Cause</u>	An event, situation, or condition which results, or could result (Potential Cause), directly or indirectly in an accident or incident.	G56
<u>Cause</u>	An event, situation, condition that results, or could result, directly or indirectly in an accident or incident.(2)	G82
<u>Cause- Consequence Analysis</u> <u>[Cause-Consequence Diagrams]</u>	A method for illustrating the possible outcomes arising from the logical combination of selected input events or states. A combination of Fault Tree and Event Tree models.	G1+ [G6]
<u>cc</u>	Cubic centimeter; a volume measurement in the metric system, equal in capacity to 1 milliliter (ml). One quart is about 946 cubic centimeters.	G17
<u>Cell (in study cube)</u>	One of the 27 different categories of CPQRA, defined by a unique value for each axis of the study cube.	G6
<u>Centerline height</u>	Elevation of plume centerline above ground after plume rise is completed.	G75
<u>Central Processing Unit (CPU)</u>	The portion of a computer's or microprocessor's logic which executes the program.	G24
<u>Centroid height</u>	Mass-weighted mean height of plume, as defined by Eq. (1).	G75
<u>Certificate of Insurance</u>	A document verifying that a company maintains insurance at a specific coverage level.	G68
<u>Character</u>	Element of a finite set of different elements, called the character set, defined for representation of information, and usually represented by a letter, number or symbol.	G24
<u>Character Set</u>	A defined set of representations, called, characters, from which selections are made to denote and distinguish data. Each character differs from all others, and the total number of characters in a give set is fixed (e.g., letter A to Z, punctuation marks, and blank (space) character).	G24

<u>Characteristic velocity</u>	The typical wind speed in the obstacle array. <i>Chemical reactions</i> Removal of pollutants from the air by reactions with other chemicals. However, although one pollutant may be removed by the chemical reaction, another pollutant may be generated. Recent research has expanded this concern to heterogeneous reactions involving both gases and particles.	G75
<u>Charge (Q).</u>	An excess or deficit of electrons expressed in Coulombs. An electron carries an electric charge of $-1.6 \times 10^{-19}$ Coulombs.	G67
Charge Density (Qv).	The quantity of charge divided by the total volume that contains this charge, expressed in Coulombs per cubic meter.	G67
<u>Charge-to-Mass Ratio (Q/m).</u>	Charge density expressed per unit mass of condensed phase material. Also known as specific charge.	G67
<u>Charge Relaxation.</u>	The process by which separated charges recombine or excess charge is lost from a system.	G67
<u>Charging Current (Ic).</u>	The rate of flow of charge into a given system per unit time, expressed in Amperes.	G67
<u>Checklist</u>	A written procedure in which each item is marked off (or acknowledged on a computer screen) as its status is verified.	G1+
<u>Checksum</u>	In a computer, a summation of digits or bits summed according to an arbitrary set of rules and primarily used for checking purposes. Typically used as an error detection technique in communication and data storage.  Entry at the end of the block of data corresponding to the binary sum of all information in the block. Used to error-checking procedures.  A value which is the arithmetic sum of all bytes in a program or program segment. As the program is loaded, the loader computes the sum of all bytes and compares the result with the checksum. If the two values are equal, it is assumed that the program segment was loaded without error.	G24
<u>Chemical</u>	Any element, chemical compound or mixture of elements and/or compounds. OSHA 1994	G81

<u>Chemical Family</u>	A group of single elements or compounds with a common general name. Example: acetone, methyl ethyl ketone, and methyl isobutyl ketone are of the "ketone" family; acrolein, furfural, and acetaldehyde are of the "aldehyde" family.	G17
	<b>Importance:</b> Elements or compounds within a chemical family generally have similar physical and chemical characteristics.	
<u>Chemical Isolation</u>	The stopping of a flame by means of a chemical suppressant.	G64
<u>Chemical Process Industry</u>	The phrase is used loosely to include facilities which manufacture, handle and use chemicals.	G7
<u>Chemical Process Quantitative Risk Analysis (CPQRA)</u>	The numerical evaluation of both incident consequences and probabilities or frequencies and their combination into an overall measure of risk.	G7
<u>Chemical Process Quantitative Risk Assessment (CPQRA or QRA)</u>	The quantitative evaluation of expected risk from potential incident scenarios. It examines both consequences and frequencies, and how they combine into an overall measure of risk. The CPQRA process is always preceded by a qualitative systematic identification of process hazards. The CPQRA results may be used to make decisions, particularly when mitigation of risk is considered.	G82
<u>Chemical reactions</u>	Removal of pollutants from the air by reactions with other chemicals. However, although one pollutant may be removed by the chemical reaction, another pollutant may be generated. Recent research has expanded this concern to heterogeneous reactions involving both gases and particles	G75
<u>Chemical reactivity</u>	The tendency of substances to undergo chemical change. NOAA 2002	G81
<u>Chemical reactivity hazard</u>	A situation with the potential for an uncontrolled chemical reaction that can result directly or indirectly in serious harm to people, property or the environment. The uncontrolled chemical reaction might be accompanied by a temperature increase, pressure increase, gas evolution or other form of energy release.	G81
<u>Chemtrec</u>	Chemical Transportation Emergency Center; a national center established by the Chemical Manufacturers Association in Washington, D.C in 1970, to relay pertinent information concerning specific chemicals.	G17
	<b>Importance:</b> Chemtrec has an emergency 24-hour toll free telephone number (800-424-9300).	

<u>Chronic Effect</u>	An adverse effect on a human or animal body, with symptoms which develop slowly over a long period of time. Also, see "Acute".	G17
	<b>Importance:</b> The length of time that a worker is exposed is the critical factor. Long periods of time pass, with repeated exposure to a chemical, before any ill effects are detected in a worker.	
<u>Chronic Exposure</u>	A frequent or continuous exposure to a toxic agent over an unspecified, but generally lengthy, period of time.	G3 G4
<u>Chronic Hazard</u>	The potential for injury or damage to occur as a result of prolonged exposure to an undesirable condition (e.g., smoking, with the potential for causing lung cancer).	G3
<u>Chronic Toxicity</u>	Adverse (chronic) effects resulting from repeated doses of or exposures to a substance over a relatively prolonged period of time.	G17
	<b>Importance:</b> Ordinarily used to denote effects in experimental animals.	
<u>Class</u>	The NFPA system for flammable and combustible liquids is given in NFPA 30. Class I flammable liquids have closed-cup flash points below 100°F (37.8°C) and Reid vapor pressures not exceeding 40 psia (2068.6 mmHg) at 100°F (37.8°C). Class I flammable liquids are further classified as follows. Class 1A liquids have flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C). Class IB liquids have flash points below 73°F (22.8°C) and boiling points at or above 100°F (37.8°C). Class IC liquids have flash points at or above 73°F (22.8°C) but below 100°F (37.8°C). Combustible liquids have closed cup flash points at or above 100°F (37.8°C) and are subdivided into Class II and Class III as follows. Class II liquids have flash points at or above 100°F (37.8°C) but below 140°F (60°C). Class IIIA liquids have flash points at or above 140°F (60°C) but below 200°F (93°C). Class IIIB liquids have flash points at or above 200°F (93°C). The DOT system for flammable and combustible liquids is given in 49CFR Part 173. Disregarding special cases, flammable liquids have flash points of not more than 60.5°C (141°F) and combustible liquids have flash points above 60.5°C (141°F) and below 93°C (200°F).	G67
<u>Client</u>	The term used in this text to identify the company issuing the tolling contract to the toller. The toller's client.	G68
<u>Cloud</u>	Any type of pollutant mass moving through the atmosphere.	G75

<u>Cloud mass-weighted mean height</u>	The concentration mass-weighted mean height of a pollutant cloud.	G75
<u>CO</u>	Carbon monoxide, a colorless, odorless, flammable and very toxic gas produced by the incomplete combustion of carbon; also a byproduct of many chemical processes.	G17
<u>CO<sub>2</sub></u>	Carbon dioxide, a heavy, colorless gas, produced by the combustion and decomposition of organic substances and as a by-product of many chemical processes. CO <sub>2</sub> will not burn and is relatively non-toxic (although high concentrations, especially in confined spaces, can create hazardous oxygen-deficient environments.)  <b>Importance:</b> CO and CO <sub>2</sub> are often listed on MSDS's as hazardous decomposition products.	G17
<u>Coherent</u>	A coherent fault tree uses only "AND" and "OR" gates to represent the failure logic. Time delay gates, inhibit conditions, or "NOR" gates are not permitted.	G6
<u>Combustible</u>	Capable of burning.	G67
<u>Combustible Concentration Reduction</u>	The technique of maintaining the concentration of combustible material in a closed space below the lower flammable limit.	G64
<u>Combustible Dust.</u>	(see also "Powder"). Any finely divided solid material, 425 mm or less in diameter (i.e., material passing through a U.S. No. 40 standard sieve), that presents a fire or explosion hazard when dispersed and ignited in air or other gaseous oxidizer.	G67

<u>Combustible Liquid</u>	<p>A term used to classify certain liquids that will burn on the basis of flash points. The National Fire Protection Association (NFPA) defines a combustible liquid as any liquid that has a closed-cup flash point above 100°F (37.8°C) (NFPA 30). There are three subclasses, as follows:</p> <p><i>Class II</i> liquids have flash points at or above 100°F (37.8°C) but below 140°F (60°C)</p> <p><i>Class III</i> liquids are subdivided into two additional subclasses:</p> <p><i>Class IIIA</i>: Those having flash points at or above 140°F (60°C) but below 200°F (93.4°C).</p> <p><i>Class IIIB</i>: Those having flash points at or above 200°F (93.4°C).</p> <p>The Department of Transportation (DOT) defines “combustible liquids” as those having flash points of not more than 141°F (60.5°C) and below 200°F (93.4°C).</p>	G64
<u>Combustible Liquids</u>	<p>Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures defined in NFPA 30. Combustible liquids are classified as Class II or Class III as follows:</p> <p>Class II Liquid. Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C).</p> <p>Class IIIA. Any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C).</p> <p>Class IIIB. Any liquid that has a flash point at or above 200°F (93°C). (NFPA 30)</p>	G83
<u>Combustion</u>	<p>A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light, in the form of either a glow or flames.</p>	G64
<u>Combustion</u>	<p>Exothermic chemical reaction with oxygen as a primary reagent. (CCPS, 1996, no. 22)</p>	G83
<u>Commercial Device</u>	<p>A device that is manufactured by a consistent production method and has consistent quality. The device is complete with a part number and documentation (e.g., instructions and customer drawings).</p>	G24
<u>Common Cause Failure (CCF)</u>	<p>The failure of more than one component, item, or system due to the same cause.</p>	G6

<u>Common Mode Failure</u>	An event having a single external cause with multiple failure effects which are not consequences of each other.	G24
<u>Common Cause or Common Mode Failure</u>	Failure, which is the result of one or more events, causing coincident failures in multiple systems or on two or more separate channels in a multiple channel system, leading to system failure. The source of the common cause failure may be either internal or external to the systems affected. Common cause failure can involve the initiating event and one or more safeguards, or the interaction of several safeguards.	G82
<u>Compatibility</u>	The ability of materials to exist in contact without specified (usually hazardous) consequences under a defined scenario. ASTM E 1445	G81
<u>Component</u>	Any Device, unit , or Application Program which is a part of an Automated System. In this standard Component is limited to the manufacturer's catalogued parts of the process control system.	G24
<u>Component</u>	An equipment part.	G7
<u>Component boundary</u>	See Equipment boundary.	G7
<u>Component Technique</u>	One member of the roster of methods that collectively form the complete CPQRA procedure.	G6
<u>Computational Fluid Dynamics Models</u>	Dispersion models that treat the partial differential Navier–Stokes equations describing fluid flow by numerically solving them using a grid of nodes or finite elements.	G60
<u>Computational fluid dynamics (CFD)</u>	A class of models that can simulate very highly resolved three-dimensional time-dependent distributions of wind flows and material concentrations. These models generally solve the basic equations of motion and conservation using very small grid spacings and time steps and are computerintensive.	G75
<u>Computer</u>	Equipment composed of hardware (H/W) and software (S/W) that performs basic control functions or process control optimization.	G24
<u>Computer-Type Equipment (CTE)</u>	Includes various types of computers (e.g., mini and micro), programmable controllers, peripherals, interconnect systems, personal computers, instrument distributed control system controllers (including single and multi-loop controllers), and other associated equipment.	G24

<u>Computerized Aggregation of Reliability Parameters (CARP)</u>	A computer code developed by SAIC to: aggregate data sets into a single generic set; determine uncertainty bounds (5th and 95th percentiles); fit raw data to statistical distribution; and print reports documenting determinations made.	G7
<u>Concentration</u>	The relative amount of a substance when combined or mixed with other substances. Concentration can be expressed as mole fraction, mass fraction, or component mole or mass density. Examples: $y_i = 2$ ppm mole fraction; $w_i = 0.50$ mass fraction; $c_i = 0.03$ kmole/m <sup>3</sup> .	G60
<u>Conceptual design</u>	The initial design of a project when basic parameters are known but design details have yet to be developed.	G83
<u>Condence Limits</u>	The upper and lower endpoints of a confidence interval.	G6
<u>Condensed Phase Explosion</u>	An explosion that occurs when the material is present in the form of a liquid or solid.	G35 G6
<u>Conditional Probability</u>	Probability of occurrence given that a precursor even has occurred.	G6
<u>Conductive</u>	Having a conductivity greater than 104 pS/m or a resistivity less than 108 W-m.	G67
<u>Conductive Floor</u>	Having an average resistance between 2.5 $\times 10^3$ W and 1 $\times 10^6$ W as measured using specified electrodes placed a specified distance apart (Method: NFPA 99). GLOSSARY 263	G67
<u>Conductive Hose</u>	Having an electrical resistance less than 103 W per meter of hose length based on measurement between the end connectors. Lower resistance values are required in certain cases, for example 6 W/m for water washing hoses in ISGOTT.	G67
<u>Conductivity (k)</u>	The reciprocal of resistivity expressed as Siemens per meter or more usually in picosiemens per meter, where 1 picosiemens (pS) = 1 $\times 10^{-12}$ Siemen. Test methods: [143–146].	G67
<u>Cone Discharge Confidence</u>	See “Bulking Brush Discharge.” A statistical measure of uncertainty.	G67 G7
<u>Confidence Bounds or Limits</u>	The end points of a confidence interval.	G7
<u>Confidence Interval</u>	That portion of a distribution which is expected to contain the mean value a certain percentage of the time.	G7

<u>Confidence Level</u>	The probability that an assertion made about a statistical property of a population on the basis of a sample is true.	G24
<u>Confidentiality agreement</u>	A written agreement between a toller and their client to outline the extent of security required in the handling of the information, equipment or product. 213	G68
<u>Confidentiality disclosure agreement</u>	An agreement that allows a toller to release information to a third party that would ordinarily be considered proprietary.	G68
<u>Configuration</u>	A set of interconnected equipment forming a system.	G24
<u>Confined Explosion</u>	An explosion of fuel-oxidant mixture inside a closed system (e.g. vessel or building).	G35 G6 G60
<u>Confined Volume Deflagration</u>	A deflagration occurring in an enclosed volume such as a pipe or pressure vessel.	G64
<u>Confinement</u>	Obstacles such as walls and ceilings of a building, vessel, pipe, etc. that serve to limit the expansion of a dispersing or exploding vapor cloud.	G60
<u>Congestion</u>	Small obstacles in the path of a flame front or dispersing vapor cloud that serve to deflect the flame front or cloud and to generate turbulent mixing.	G60
<u>Connect/Disconnect</u>	Make/break a logical link (e.g., as between a MMI and a MPU, eventually through communication devices). See Plug/Unplug for physical connection/disconnection.	G24
<u>Consequence</u>	The direct result of a hazardous event, usually expressed in safety assessments in terms of the magnitude of the area over which these impacts occur.	G3
<u>Consequence</u>	The direct, undesirable result of an accident sequence usually involving a fire, explosion, or release of toxic material. Consequence descriptions may be qualitative or quantitative estimates of the effects of an accident in terms of factors such as health impacts, economic loss, and environmental damage. (CCPS, 1995, no. 17)	G83
<u>Consequence</u>	The cumulative, undesirable result of an incident, usually measured in health and safety effects, environmental impacts, loss of property, and business interruption costs.(1)	G82

<u>Consequences</u>	A measure of the expected effects of an incident outcome case.	G6
<u>Consequences</u>	The direct, undesirable result of an accident sequence usually involving a fire, explosion, or release of toxic material. Consequence descriptions may be qualitative or quantitative estimates of the effects of an accident.	G71
<u>Consequence Analysis</u>	The analysis of the expected effects of incident outcome cases independent of frequency or probability.	G56 G6 G83
<u>Consequence Analysis</u>	The analysis of the expected effects of an incident, independent of its likelihood.(1)	G82
<u>Conservation Vent Valve</u>	A device designed to maintain pressure within preset limits in a liquid-containing vessel for the purpose of emissions reduction. It also provides protection against excessive pressure or vacuum.	G64
<u>Constant stress layer</u>	The layer near the ground (about 50 m to 100 m deep) where the stress, $\hat{\sigma}$ , decreases by only about 10%, leading to the assumption of a constant $u^*$ layer near the ground	G75
<u>Containment</u>	A system condition in which under no condition reactants or products are exchanged between the chemical system and its environment.	G35
<u>Continuous Flame Test</u>	A test in which a flame arrester is subjected to flame of a continuously burning mixture (as specified in UL 525 for deflagration or detonation flame arresters) on the outlet face of the arrester for one hour (or longer at the manufacturer's request).	G64
<u>Continuous Reactors</u>	Reactors that are characterized by a continuous flow of reactants into and a continuous flow of products from the reaction system. Examples are the Plug Flow Reactor and the CSTR.	G35
<u>Continuous Release</u>	Emissions that are long in duration compared with the travel time (time for could to reach location of interest) or averaging or sampling time.	G6 G60
<u>Continuous stability categorization method</u>	Based on the Monin–Obukhov length, $L$	G75

<u>Contributing Cause</u>	Physical conditions, management practices, etc. that facilitated the occurrence of an incident.	G56
<u>Contributing Cause</u>	Factors that facilitate the occurrence of an incident such as physical conditions and management practices. (Also known as <i>contributory factors</i> .)	G82
<u>Control</u>	A mechanism used to regulate or guide the operation of a machine, apparatus, process, or system.	G24
<u>Convective scaling velocity, w</u>	A scaling velocity important during lightwind daytime conditions with strong surface heating. $w^*$ is proportional to the cube root of the product of the heat flux, $H_s$ , and the mixing depth, $z_i$ .	G75
<u>Cool-flame ignition</u>	A relatively slow, self-sustaining, barely luminous gas-phase reaction of the sample or its decomposition products with an oxidant. Cool flames are visible only in a darkened area. NFPA 325 2001	G81
<u>Corona Discharge</u>	A self-sustained low energy electrical discharge with nonthermal ionization that takes place in the vicinity of an electrode of sufficiently low radius of curvature, in a medium whose pressure is typically close to atmospheric. May be accompanied by a hissing noise that increases with current and may be observed as a pinpoint of bluish light at the electrode in darkened surroundings. The ionization region is confined to a small volume close to the electrode while in the remainder of the interelectrode space the ions accumulate and drift due to the electric field without additional ionization, creating ionic wind. Corona discharges are usually observed with electrode radii of curvature less than about 3 mm and especially at points. The effective energy depends on current; ignition of hydrocarbon vapor in air has been reported for currents exceeding 200 mA. Only unusually sensitive gas mixtures such as CS <sub>2</sub> , H <sub>2</sub> , C <sub>2</sub> H <sub>2</sub> in air, or gases in oxygen enriched atmospheres, may be ignited by typical coronas.	G67
<u>Corrosive</u>	As defined by DOT, a corrosive material is a liquid or solid that causes visible destruction or irreversible changes in human tissue at the site of contact on - the case of leakage from its packaging - a liquid that has a sever corrosion rate on steel.  <b>Importance:</b> A corrosive material requires different personal protective equipment to prevent adverse health effects.	G17

<u>Coulomb (C)</u>	The quantity of electricity on the positive plate of a capacitor of 1 Farad capacitance when the potential difference across the plates is 1 V.	G67
<u>Coulomb's Law</u>	Force between two charged bodies is proportional to the product of the two charges and inversely proportional to the square of the distance between them.	G67
<u>Coupling (for interference)</u>	The mechanism by which an interference source produces interference in a signal circuit.	G24
<u>Covered Process</u>	A process subject to regulatory requirements established under the OSHA PSM Standard or the EPA RMP Rule.	G71
<u>Covert Fault</u>	Faults that can be classified as hidden, concealed, unannounced, undetected, unrevealed, latent, etc. In the case of safety instrumented systems covert faults impair the intended safeguarding function without being apparent to the operator. Covert faults can only be detected by testing or challenging the system.	G62
<u>CPQRA</u>	The acronym for Chemical Process Quantitative Risk Analysis. It is the process of hazard identification followed by numerical evaluation of incident consequences and frequencies, and their combination into an overall measure of risk when applied to the chemical process industry. It is particularly applied to episodic events. It differs from, but is related to, a Probabilistic Risk Assessment (PRA), a quantitative tool used in the nuclear industry.	G6 G1+ G24
<u>CPU - Central Processing Unit</u>	The unit of computing system that includes the circuits controlling the interpretation of instructions and their execution. The brain of a computing machine, usually defined by arithmetic logic units plus a control section; often called a "processor".	G24
<u>Crimped Metal Ribbon</u>	A flame arrester element that is manufactured of alternate layers of thin corrugated metal ribbon and a flat metal ribbon that are wound together on a mandrel to form a cylindrical assembly of many layers to produce a range of different sized triangular cells. The height and width of the triangular cells can be varied to provide the required quenching diameter.	G64
<u>Critical</u>	Relates to major environment or safety process risks.	G24

<u>Critical Alarm</u>	An alarm having no automatic safety backup system and requiring immediate action to be taken by an operator to return the plant to a safe status (e.g., atmospheric combustible or toxic gas detection).	G24
<u>Critical Diameter</u> <u>Critical Equipment</u>	See Quenching Diameter Equipment, instrumentation, controls, or systems whose malfunction or failure would likely result in a catastrophic release of highly hazardous chemicals, or whose proper operation is required to mitigate the consequences of such release. (Examples are: most safety systems, such as area LEL monitors, fire protection systems such as deluge or underground systems, and key operational equipment usually handling high pressures or large volumes.)	G64 G68
<u>Critical Final Control Element</u>	Final control element associated with an emergency shutdown system.	G24
<u>Critical half thickness</u>	An estimation of the half thickness of a sample in an <i>unstirred container</i> , in which the heat losses to the environment are less than the retained heat. This buildup of internal temperature leads to a thermal runaway reaction. ASTM E 1445	G81
<u>Critical Load</u>	A final element whose operation has safety implications.	G24
<u>Critical mass</u>	Minimum mass that is required to enable the occurrence of an explosion.	G24
<u>Critical Process Measurement</u>	Sensor whose operation has safety implications.	G24
<u>Critical Protection Circuit</u>	Any circuit that contains critical protective devices and/or critical protective instrumentation.	G24

<u>Critical Protection Device</u>	Any protection device whose installation and performance is required in order to meet or exceed the APCI hazard rate target for an in-plant occurrence or is required from analysis of third party exposure. Also, any device whose installation is required by appropriate code bodies or insurance agents in order to satisfy minimum safety requirements for life threatening hazards. The following are examples of critical protection devices:  <ul style="list-style-type: none"> <li>o Safety Valves.</li> <li>o Rupture Discs.</li> <li>o Flame Arrestors.</li> <li>o Burner Management Systems.</li> </ul>	G24
<u>Critical Protection Instrumentation</u>	Those instruments installed as part of a protection circuit whose installation and performance is required in order to meet or exceed the APCI target for in-plant hazards or is required from analysis of third party exposure.	G24
<u>Critical Temperature</u>	Maximum cooling temperature at which all heat is generated by the mass of material can still be transferred to the coolant (either gas or liquid).	G35
<u>Cross-contamination</u>	Mixing chemicals unintentionally, typically through the use of the same process equipment or support systems for concurrent or successive tolls.	G68
<u>Cross-Reference List</u>	A list showing all the locations in a PES Program at which a selected list of data objects is operated upon.	G24
<u>Cryogenic Liquid</u>	A refrigerated liquid gas having a boiling point below –130 F (- 90 C) at atmospheric pressure. (NFPA 30)	G83
<u>CSMA/CD (Carrier Sense Multiple Access with Collision Detection)</u>	A method of controlling multiaccess computer networks in which each station on the network senses traffic and waits for it to clear before sending a message, and two devices that try to send concurrent messages must both step back and try again.	G24
<u>CSST</u>	Critical Steady-State Temperature; The highest ambient temperature at which self-heating of a material as handled (package, container, silo, vessel, etc.) still does not result in a runaway but in a stationary condition as identified by classical explosion theory (see also SADT)	G35
<u>CSTR</u>	Continuous-flow Stirred Tank Reactor; A tank reactor characterized by a continuous flow of reactants into and products from the reaction system. Composition and temperature of the reaction system is at all times identical to composition and temperature of the product stream.	G35

<u>Current (I)</u>	The rate of transfer of electricity normally expressed in Amperes (Coulombs per second).	G67
<u>Current Density (J).</u>	The current (Amperes) passing through unit area of a material (square meters).	G67
<u>Current Sinking</u>	The act of receiving current.	G24
<u>Current Sourcing</u>	The act of supplying current.	G24
<u>Damage Limiting Construction</u>	Construction of equipment (building) with weak sections to limit the damage to the equipment (building). The weak sections fail early and prevent damage to the rest of the equipment (building).	G62
<u>Data</u>	A representation of facts, concepts or instructions in a formalized manner suitable for communication, interpretation or processing by human or by "automatic" means.  Characters or continuous functions representing information due to know or supposed arrangement.	G24
<u>Data Base</u>	1) A repository for equipment reliability information categorized to facilitate data retrieval or 2) tabular lists of multiple data vectors, with little text except that needed to explain the data presentation format.	G7
<u>Data Cell</u>	A unique compartment of the taxonomy in which data is stored, defined by specific equipment, service and failure descriptions.	G7
<u>Data Communication Equipment (DCE)</u>	The equipment that provides the functions required to establish, maintain, and terminate a connection, as well as the signal conversion and coding required for communication between Data Terminal Equipment and data circuits.	G24
<u>Data Elements</u>	The basic items which form a data set or data vector, e.g. component name, size, failure mode, mean, 5% confidence level, are each a data element.	G7
<u>Data Encoding</u>	The assignment of codes and identifiers to data extracted from plant records so that failure rates may be readily calculated.	G7
<u>Data point</u>	A numerical estimate of equipment reliability as a mean or median value of a statistical distribution of the equipment's failure rate or probability.	G7

<u>Data Resource</u>	A data base, report, technical paper, journal article, or conversation which contains reliability data; subdivided into Data Bases, Data Sources, and Risk Analyses in this book.	G7
<u>Data Sets</u>	A formal or informal collection of information with a cohesive element which distinguishes this data grouping from others; e.g., data from a particular facility, data for a particular time, data for a particular component.	G7
<u>Data Source</u>	Descriptive text in a given subject area whose primary purpose is to discuss a reliability or risk topic but which also contains some useful reliability data.	G7
<u>Data Terminal Equipment (DTE)</u>	Equipment consisting of digital and instruments that convert the user information into data signals for transmission or reconvert the received data signals into user information.	G24
<u>Data Vector</u>	Only those data elements and numerical values that are used to specify failure characteristics, e.g. mean, distribution, failure modes, either as the cause or a contributing cause of the incident or as a response to the initiating event.	G7
<u>Data Window</u>	A time frame established for a given data study.	G7
<u>DCS (Distributed Control System)</u>	<p>A system which divides process control functions into specific areas interconnected by communications (normally data highways), to form a single entity. It is characterized by digital controllers and typically by central operation interfaces.</p> <p>Distributed control systems consist of subsystems that are functionally integrated but may be physically separated and remotely located from one another. Distributed control systems generally have at least one shared function within the system. This may be the controller, the communication link or the display device. All three of these functions maybe shared.</p> <p>A system of dividing plant or process control into several areas of responsibility, each managed by its own CPU, with the whole interconnected to form a single entity usually by communication buses of various kinds.</p>	G24
<u>DDA</u>	Deflagration and detonation arresters or deflagration and detonation flame arresters	G64

<u>DDC (Direct Digital Control)</u>	A mode of control wherein digital computer outputs are used to directly control a process.	G24
	A computer control technique that sets the final control-elements position directly by the computer output. Used to distinguish from analog control.	
<u>Dead-heading</u>	A blockage on the discharge side of an operating pump which results in the flow reducing to zero and an increase in the discharge pressure. The energy input from the deadheaded pump increases the temperature and pressure of the fluid in the pump.	G62
<u>Deadtime</u>	The interval of time between initiation of an input change or stimulus and the start of the resulting observable response. Dimension (Time).	G24
<u>Decomposition</u>	Breakdown of a material or substance (by heat, chemical reaction, electrolysis, decay, or other processes) into parts or element or simpler compounds.	G17 G60
	<b>Importance:</b> Decomposition products often present different hazards than the original material.	
<u>Decomposition</u>	To undergo chemical breakdown, separating into constituent parts or elements or into simpler compounds. NFPA 49 2001	G81
<u>Decomposition Energy</u>	The decomposition energy is the maximum amount of energy which can be released upon decomposition. The product decomposition energy and total mass is an important parameter for determining the effects of sudden energy release, e.g., in an explosion. The decomposition energy can be obtained for literature, calculated theoretically or determined experimentally.	G35
<u>Decomposition Energy</u>	The maximum amount of energy which can be released upon decomposition. The product of decomposition energy and total mass is an important parameter for determining the effects of a sudden energy release—for example, in an explosion. The decomposition energy can occasionally be obtained from the literature or calculated theoretically. Barton and Rogers 1997	G81

<u>Decomposition Flames</u>	Flames that are produced by exothermic decomposition of certain gases in the absence of any oxidant, provided that they are above minimum conditions of pressure, temperature, and pipe diameter. Common examples include acetylene, ethylene oxide, and ethylene.	G64
<u>Decomposition Temperature</u>	Temperature at which spontaneous decomposition occurs. In practice it is impossible to indicate the exact value of this temperature, because according to the Arrhenius law the reaction rate will only be zero at absolute zero temperature (0 K). Therefore, in measuring the decomposition temperature the sample quantity and the sensitivity of the measuring device is very important (compare e.g., DSC and AST).	G35
<u>Deductive Approach</u>	Reasoning from the general to the specific. By postulating that a system/process has failed in a certain way, an attempt is made to determine what modes of system/component/operator/organization behavior contributed to the failure.	G56
<u>Deductive Approach</u>	Reasoning from the general to the specific. By postulating that a system or process has failed in a certain way, an attempt is made to determine what modes of system, component, operator, or organizational behavior contributed to the failure.	G82
<u>Defensive Measures</u>	Measures directed to reduce the consequences of a runaway to an acceptable level.	G35
	The chemical reaction of a substance in which the reaction front advances into the unreacted substance at less than sonic velocity. Where a blast wave is produced that has the potential to cause damage, the term <i>explosive deflagration</i> may be used.	G35 G6

<u>Deflagration</u>	A combustion wave (flame) propagating in the unreacted medium at a velocity that is less than the speed of sound as measured at the flame front, and which propagates via a process of heat transfer and species diffusion across the flame front. The flame front is not coupled in time nor space with the preceding weak shock front. The pressure peak coincides with the flame front but a marked pressure rise precedes it. Typical maximum pressure ratios generated by deflagrations in confined volumes are in the range of 8-12. Maximum propagation velocities of 10-100 m/s are typical, although up to several hundred m/s may be observed.	G64
<u>Deflagration</u>	Propagation of a combustion zone at a velocity less than the speed of sound in the unreacted medium.	G67
<u>Deflagration</u>	A release of energy caused by the propagation of a chemical reaction in which the reaction front advances into the unreacted substance at less than sonic velocity in the unreacted material. Where a blast wave is produced with the potential to cause damage, the term <i>explosive deflagration</i> may be used. CCPS 1995b	G81
<u>Deflagration to Detonation Transition</u>	The transition phenomenon resulting from the acceleration of a deflagration flame to detonation via flame-generated turbulent flow and compressive heating effects. At the instant of transition a volume of precompressed, turbulent gas ahead of the flame front detonates at unusually high velocity and overpressure.	G64
<u>Deflagration Flame Arrester</u>	A flame arrester used to prevent the transmission of a deflagration.	G64
<u>Deflagration Isolation</u>	A method employing equipment and procedures that interrupts the propagation of a deflagration flame front past a point (usually in a pipe).	G64
<u>Deflagration Pressure Containment:</u>	The technique of specifying the design pressure of a vessel and its appurtenances so that they are capable of withstanding the maximum pressures resulting from an internal deflagration.	G64
<u>Deflagration Suppression</u>	The technique of detecting and arresting combustion in a confined space while the combustion is still in its incipient stage, thus preventing the development of pressures that could result in an explosion.	G64

<u>Deflagration Venting</u>	The reduction of pressure generated in a vessel by a deflagration by allowing the emergency flow of the vessel contents from the vessel by means of an opening in the vessel, thus avoiding the failure of the vessel by overpressure. The vent opening is usually closed by a pressure-relieving cover (e.g., rupture disk, explosion disk or hatch).	G64
<u>DEGADIS Degraded failure</u>	Dense Gas Dispersion Model (Havens et al., 2001) A failure which is gradual or partial; it does not cease all function but compromises that function. It may lower output below a designated point, raise output above a designated point or result in erratic output. A degraded mode might allow only one mode of operation. If left unattended, the degraded mode may result in a catastrophic failure.	G7
<u>Delay Gates</u>	A specialized logic form of an "AND" gate where all inputs to the gate must be true for a specified time period before the output from the gate can occur. Delay Gates are common when modeling the runaway reaction kinetics of a chemical reactor.	G6
<u>Delphi Method</u>	A polling of experts utilizing the following procedure: <ol style="list-style-type: none"> <li>1. Select a group of experts (usually three or more).</li> <li>2. Solicit, in isolation, their independent estimates on the value of a particular parameter and reasons for the choice.</li> <li>3. Provide initial results to all experts and all revisions to initial estimates.</li> <li>4. Use the average of the final estimates as the best estimate of the parameter. Use the standard deviation of the estimates as a measure of uncertainty.</li> </ol> The procedure is interactive, with feedback between interactions.	G6 G1+
<u>Delphi Tchnique</u>	A polling of experts. The Classical Delphi is a single estimate (for each questionnaire) of a single parameter by a single group. The Hybrid Delphi uses a single estimate of multiple parameters submitted by multiple groups. It allows the incorporation of published or recorded data during the polling process.	G7
<u>Demand</u>	A plant condition or event which requires a protective system or device to take appropriate action in order to prevent a hazard.  (1) A signal or action that should change the state of a device, or (2) an opportunity to act, and thus, to fail.	G24

<u>Demand Rate</u>	The number of demands divided by the total elapsed operating time during which the demands occur.	G24 G6
<u>Demand Spectrum</u>	The total number of demands for the data window experienced by the component population, considering test, interface, failure-related maintenance, and automatic and manual initiation demands.	G7
<u>Demand-Related Failure</u>	A failure that is primarily related to the number of times that a device or system is challenged (cycled) rather than the length of time the device or system is in service. The failure of a piece of wire after repeated bending would be considered to be a demand-related failure. Demand-related failures are sometimes called cyclic failures.	G6
<u>Dense cloud</u>	Cloud density is greater than ambient air density, due to the high molecular weight, the cold temperature, and/or the presence of aerosols in the emissions. Dense cloud and heavy cloud are synonymous.	G75
<u>Dense Gas</u>	A gas with density exceeding that of air at ambient temperature. Sometimes the expression is used loosely to apply to aerosols such as flashing liquid ammonia. See also heavy gas and negatively buoyant vapors.	G60
<u>Dependent Failure</u>	A failure of multiple devices due to some common cause, for example, the failure of all temperature sensors in a system due to miscalibration during maintenance.	G6
<u>Deposition</u>	The rate at which material accumulates on a surface	G75
<u>Depth Of Study</u>	A measure of level of review, degree of complexity, and extent of detail involved in a CPQRA.	G6
<u>DERA</u>	UK Defence and Evaluation Research Agency, developers of urban dispersion model (UDM).	G75
<u>Dermal</u>	Used on or applied to the skin.  <b>Importance:</b> Dermal exposure, as well as inhalation exposure, must be considered to prevent adverse health effects.	G17
<u>Dermal Toxicity</u>	Adverse effects resulting from skin exposure to a substance. Also referred to as "Cutaneous toxicity".  <b>Importance:</b> Ordinarily used to denote effects in experimental animals.	G17

<u>Design basis incident (DBI) (or maximum credible incident)</u>	A serious incident that has some small likelihood of occurring during the lifetime of a facility but consequences of which (resulting hazard zones) are used in siting, plant layout, and/or emergency planning decisions. (See discussions in Chapter 2.)	G3
<u>Design Institute for Emergency Relief Systems (DIERS)</u>	Institute under the auspices of the American Institute of Chemical Engineers founded to study relief requirements for reactive chemical systems and two-phase flow systems.	G62
<u>Detection Systems</u>	A mechanical, electrical, or chemical device that automatically identifies the presence of a material or a change in environmental conditions such as pressure, temperature, or composition. (Bartleby.com)	G83
<u>Detonable Limits</u>	The minimum and maximum concentrations of a combustible material, in a homogeneous mixture with a gaseous oxidizer, that will propagate a detonation	G64
<u>Detonation</u>	Propagation of a flame-driven shock wave at a velocity at or above the speed of sound in the unreacted medium as measured at the flame front. The wave is sustained by chemical energy released by shock compression and ignition of the unreacted medium. The flame front is coupled in time and space with the shock front, and there is no pressure increase significantly ahead of the shock-flame front. Propagation velocities in the range 1000–3500 m/s may be observed depending on the gas mixture, initial temperature and pressure, and type of detonation.	G64
<u>Detonation</u>	A release of energy caused by the propagation of a chemical reaction in which the reaction front advances into the unreacted substance at greater than sonic velocity in the unreacted material. CCPS 1995b	G81
<u>Detonation Flame Arrester</u>	A flame arrester used to prevent the transmission of a detonation.	G64
<u>Detonation Momentum Attenuator</u>	A mechanical device inside of a detonation flame arrester whose purpose is to reduce both the high pressure and the dynamic energy of a detonation and to split the flame front before it reaches the actual flame arrester element, thus avoiding structural damage to the element. (This device is also called a “shock absorber” device by some manufacturers.)	G64
<u>Device</u>	Part of PES.	G24

<u>Diagnostic Alarm</u>	See Pretrip Alarm.	G24
<u>Diagnostic Program (Active - On Line)</u>	A troubleshooting aid for identifying hardware malfunctions in a system or a program before they result in failure of the system to perform its desired function.	G24
<u>Diagnostic Program (Active)</u>	A troubleshooting aid for correcting hardware malfunctions in a system or a program before they become a safety hazard.	G24
<u>Diagnostic Program (Passive - Off Line)</u>	A troubleshooting side for locating hardware malfunctions in a system or a program to aid in locating coding errors in newly developed programs.	G24
<u>Diagnostic Program (Passive - On Line)</u>	A troubleshooting aid for identifying hardware malfunctions in a system or a program when they occur.	G24
<u>Diagnostic Program (Passive)</u>	A troubleshooting aid for locating hardware malfunctions in a system or a program to aid in locating coding errors in newly developed programs.	G24
<u>Diagnostic Programs</u>	Computer programs that isolate equipment malfunctions or programming errors.	G24
<u>Diagnostic Routine</u>	An electronic-computer routine designed to locate a malfunction in the computer, a mistake in coding, or both.  A routine used to locate a malfunction in a computer, or to aid in locating mistakes in a computer program. Thus, in general, any routine specifically designed to aid in debugging or troubleshooting.	G24
<u>Diagnostics</u>	H/W and S/W that is installed to analyze the cause or nature of a condition, situation, or problem and relay this information to the appropriate personnel in a preformed fashion.	G24
<u>Dielectric Constant (<math>\epsilon_r</math>).</u>	A dimensionless parameter expressing the ratio of the permittivity of a material to that of vacuum. Metals have an infinite dielectric constant while gases and vapors have a dielectric constant close to unity. 264 GLOSSARY	G67
<u>Differential scanning calorimetry (DSC)</u>	A technique in which the difference in energy inputs into a substance and a reference material is measured as a function of temperature, while the substance and the reference material are subjected to a controlled temperature program. ASTM E 1445	G81

<u>Differential thermal analysis (DTA)</u>	A technique in which the temperature difference between a substance and reference material is measured as a function of temperature while the substance and the reference material are subjected to a controlled temperature program. ASTM E 1445	G81
<u>Digital System</u>	Any programmable electronic system such as a PLC, DCS, or microcomputer.	G24
<u>Dike</u>	An embankment or wall built to act as a barrier blocking passage of liquids to surrounding areas. (Dictionary.com)	G83
<u>Dilution</u>	Reduction in concentration due to effect of wind.	G75
<u>Direct Address</u>	An address that designates the storage location of an item of data to be treated as an operand.	G24
<u>Direct Addressing</u>	A method of addressing in which the address part of an instruction contains a direct address.	G24
<u>Directional Incident Outcome</u>	An incident outcome whose consequences produce an effect zone determined by a given wind direction.	G6
<u>Directional Probability</u>	Probability in a given wind direction.	G6
<u>Disconnect</u>	See Connect.	G24
<u>Discrete</u>	Refers to individual, distinct things such as bits, characters, or circuit components. This also refers to On-Off type input/output modules.  Pertaining to distinct elements or to representation by means of distinct elements, such as characters.	G24
<u>Discrete I/O</u>	Inputs that accept on/off signals from limit switches, push buttons, and other types of switches or contact closures. On/off outputs that can operate medium power loads (e.g., solenoids, power relays, starters, lights).	G24
<u>Dispersion Coefficient</u>	The standard deviation $s$ in a specified direction of the gaussian distribution model used in atmospheric dispersion. The dispersion coefficient is normally expressed as a function of distance for a given weather stability.	G6
<u>Dispersion Coefficients</u>	$\sigma_y$ (lateral component), $\sigma_z$ (vertical component), and $\sigma_x$ (along-wind component)	G75

<u>Dispersion Models</u>	Mathematical models that characterize the transport of toxic/flammable materials released to the air and/or the water.	G1+
<u>Displacement length , d</u>	A scaling length that becomes important for describing the wind profile at elevations close to the average roughness obstacle height, <i>Hr</i> , for densely packed roughness obstacles. It describes the vertical displacement (from the ground surface) of the effective ground level and is approximately equal to 0.5 <i>Hr</i> for obstacle types such as urban centers, tall crops, and forests.	G75
<u>Displacement zones</u>	Recirculation zones adjacent to buildings or other obstacles where the flow has separated from the obstacle and reattached downwind.	G75
Disproportionation	A chemical reaction in which a single compound serves as both oxidizing and reducing agent and is thereby converted into a more oxidized and a more reduced derivative; e.g., a hypochlorite upon appropriate heating yields a chlorate and a chloride. CCPS 1995b	G81
Dissipation	See "Effective Conductivity."	G67
<u>Diversity</u>	The performance of the same overall protective function by a number of independent and different means.	G24
<u>Domino Effects</u>	The triggering of secondary events, such as toxic releases, by a primary event, such as an explosion, such that the result is an increase in consequences or area of an effect zone. Generally only considered when a significant escalation of the original incident results.	G6
<u>Dose</u>	Time-integrated concentration	G75
<u>Dow Fire and Explosion Index(F&amp;EI)</u>	A method (developed by Dow Chemical Company) for ranking the relative fire and explosion risk associated with a process. Analysts calculate various hazard and explosion indexes using material characteristics and process data.	G1+

<u>Drag force</u>	The surface stress, $\hat{o}_0$ , arises through direct viscous stress and through the pressure asymmetry around roughness elements on the surface (sometimes called form or pressure drag). In atmospheric flows the pressure asymmetry dominates over direct viscous stresses and it produces a drag force, commonly called the drag, on the roughness elements. <i>Glossary 193</i>	G75
<u>Dry Adiabatic Lapse Rate (DALR)</u>	The negative of the temperature gradient established as dry air ascending in the atmosphere. For air with a molecular weight of 29 and a specific heat ratio of 1.41 the DALR = 0.995°C/100m.	G6
<u>Dry deposition</u>	Effective downward vertical velocity of small aerosols and gases if they are chemically reactive with the ground surface. In many cases, this process is a function of the ability of a vegetative leaf to absorb the substance once the substance passes through the openings in the leaf surface. For most materials, a dry deposition velocity of about 0.01 m/s can be assumed.	G75
<u>Dry Type Flame Arrester</u>	A flame arrester that uses an element consisting of small gaps or apertures to quench and extinguish the flame, as distinguished from hydraulic flame arresters.	G64
<u>DSC</u>	Differential Scanning Calorimetry; A technique in which the difference of energy inputs into a substance and a reference material is measured as a function of temperature whilst the substance and reference material are subjected to a controlled temperature program.	G35
<u>DTA</u>	Differential Thermal Analysis; A technique in which the temperature difference between a substance and a reference material is measured as a function of temperature whilst the substance and reference material are subjected to a controlled temperature program.	G35
<u>Duration</u>	The length of time for which the event state exists. Can be the repair time. Dimension (Time).  The amount of time taken by an event or action.	G24
<u>Dust</u>	Any finely divided solid, 420 microns or 0.017 inches, or less in diameter (that is, material that can pass through a U.S. No. 40 standard sieve).	G64

## Dynamic Testing

Consists of processor routines in conjunction with external hardware under PLC control. General guidelines for dynamic testing of critical inputs and outputs are described below.

G24

### o Critical Inputs

Procedure - Disconnect inputs to Module A.

Check for zero on all inputs.

If test fails, disable inputs and generate alarm.

If test succeeds, reconnect inputs and repeat for Module B.

PES Files: Store results of tests.

### o Critical Outputs

Procedure - Check that Module B is energized.

If B is enabled, disable Module A.

Check that A outputs are deenergized (through feedback via input module).

If test fails, disable outputs and generate alarm.

If test succeeds, reenergize outputs and repeat for Module B.

PES Files: Store results of tests.

## Effect Models

Models that predict effects of incident outcomes usually with respect to human injury or fatality or property damage.

G6

## Effect Zone

For an incident that produces an incident outcome of toxic release, the area over which the airborne concentration equals or exceeds some level of concern. For a flammable release, the area over which a particular incident outcome case produces an effect based on a specified criterion. For a loss of containment incident producing thermal effects, the area over which a particular incident outcome case produces an effect based on a specified radiative heat stress limit.

G6

<u>Effective Conductivity</u>	<p>The charging process in liquids of low conductivity alters the concentration of charge carriers. In the charged state, such as downstream of microfilters, petroleum products with measured (rest) conductivities above about 2 pS/m often display a relaxation time a factor of 3–4 times longer than predicted. However, for rest conductivities less than about 2 pS/m, relaxation times become much shorter than predicted. For example, the relaxation time of jet fuel having a conductivity of 0.01 pS/m is about 30 min based on Ohmic relaxation. In practice it is found that highly charged, nonviscous liquids of such low conductivity relax charge hyperbolically rather than Ohmically. The provision of 100 s of residence time downstream of filters is found to reduce the charge to about 5% of its initial value, whereas via Ohmic relaxation this would require three relaxation times (&gt;1 hour) of residence time. In Appendix B, nonviscous liquids whose rest conductivities are usually measured at about 2 pS/m or less are not assigned a relaxation time but instead a 100 s “dissipation time.”</p>	G67
<u>Effective Energy of Static Discharge</u>	<p>The spark ignition energy (<math>J</math>) of the least easily ignitable flammable mixture known to have been ignited by the static discharge.</p>	G67
<u>Effective transport speed, <math>ue</math></u>	<p>Defined as the vertical integral of the concentration-weighted wind speed,</p> $ue = \frac{\int_0^z u C dz}{\int_0^z C dz}$ <p>where <math>z</math> is the height above ground, <math>C(z)</math> is the height-variable concentration of pollutant in the cloud, and <math>u(z)</math> is the height-variable wind speed. <math>ue</math> is also known as the cloud advective speed.</p>	G75

<u>Electric Field Intensity (E).</u>	A measure of the force exerted by one charged body on another. Imaginary “lines of force” or “electric field lines” originate (by convention) on positive charges and terminate on negative charges. They can be thought of as elastic lines which repel each other in a direction perpendicular to the line itself. The electric field intensity (volts/meter) at any location is the force (Newtons) that would be experienced by unit test charge (Coulombs) placed at the location. A uniform electric field is an ideal case in which the electric field lines are parallel with one another, for example between the plates of a large, parallel plate air capacitor. A divergent electric field is one in which the field intensity changes with distance, for example in a capacitor comprising a sphere and a plate. In practical situations electric fields are rarely uniform, particularly within solids and liquids.	G67
<u>Electromagnetic Interference</u>	Electromagnetic phenomena which, either directly or indirectly, can contribute to a degradation in performance of an electronic receiver or system. (The terms Radio Interference, Radio-Frequency Interference (RFI), noise, and EMI have been employed at various times in the same context).	G24
<u>Electrophoresis</u>	The phenomenon of particle migration in an electric field.	G67
<u>Electrophorus</u>	An early device for generating charge by induction, attributed to and named in 1775 by Volta. Comprises a nonconductive plate or “cake” which can be charged by rubbing, and an isolated metal plate which can be placed on the charged cake. After contact is made, a charge is induced on the metal plate; if the top of the metal plate is grounded momentarily, the “like” charge induced by the cake is conducted to ground while an equal and opposite charge remains on the metal plate. After the plate is lifted from the cake, it retains the opposite charge. The process may be repeated indefinitely to produce charge on metal plates without recharging the cake. Charge transfers are typically of the order 1 mC. <i>GLOSSARY</i> 265	G67
<u>Element</u>	The portion of a graphical Language corresponding to an Instruction in Textual Language. The Operation Part and the Operand Part as specified by appropriate combination of graphic and character symbols.	G24
<u>Elevated clouds or plumes</u>	Pollutant releases at elevations above about 10 or 20 m.	G75

<u>Emergency and First Aid Procedures</u>	<p>Actions that should be taken at the time of a chemical exposure before trained medical personnel arrive.</p> <p><b>Importance:</b> These procedures may lessen the severity of an injury or save a person's life if done immediately following a chemical exposure.</p>	G17
<u>Emergency Exposure Guideline Limits (EEPG)</u>	<p>Maximum concentration levels that provide guidance in advance planning for management of emergencies. Developed by the National Academy of Sciences (NAS).</p>	G3
<u>Emergency operations</u>	<p>Process changes initiated by the operations staff to place the process into a safe condition (back to normal operations or shutdown) in response to any abnormal situation that could cause a release, explosion, or other significant event.</p>	G68
<u>Emergency Relief Device</u>	<p>A device that is designed to open during emergency or abnormal conditions to prevent rise of internal fluid pressure in excess of a specified value. The device also may be designed to prevent excessive internal vacuum. The device may be a pressure relief valve, a nonreclosing pressure relief device, or a vacuum relief valve.</p>	G62
<u>Emergency response plan</u>	<p>A written plan which addresses actions to take in case of plant fire, explosion or accidental chemical release.</p>	G68
<u>Emergency Sequence</u>	<p>An automatic sequence initiated by an interlock. The sequence may consist of starting, stopping, opening, or closing equipment in order to render the process safe.</p>	G24
<u>Emergency Shutdown Device</u>	<p>A device that is designed to shutdown the system to a safe condition on command from the emergency shutdown system.</p>	G62
<u>Emergency Shutdown System</u>	<p>The safety control system that overrides the action of the basic control system and shuts down the process when predetermined conditions are violated.</p>	G62
<u>Emergency Shutdown System</u>	<p>The safety system which overrides the action of the basic control system when predetermined conditions are violated. (CCPS, 1993, no. 14)</p>	G24 G83
<u>Emergency Trip Button</u>	<p>A hard-wired push button that, when pushed, will maintain the trip position and place selected final control elements in a safety position.</p>	G24

<u>EMI (Electromagnetic Interference)</u>	Any spurious effect produced in the circuits or elements of a device by external electromagnetic fields.	G24
<u>Emissivity</u>	The ratio of the radiant energy emitted by a surface to that emitted by a blackbody at the same temperature.	G6
<u>EMP (Electromagnetic Pulse)</u>	A reaction of large magnitude resulting from the detonation of nuclear weapons.  A type of disturbance that leads to noise in radio-frequency electric or electronic circuits.  A pulse of electromagnetic radiation generated by a large thermonuclear explosion.	G24
<u>Enabling Event</u>	An event that makes another event possible	G82
<u>End-of-Line Flame Arrester</u>	A deflagration flame arrester that is installed on atmospheric pressure tank vent nozzles, having only one pipe connection. It is also called a tank vent deflagration flame arrester.	G64
<u>Endothermic</u>	A physical or chemical change that requires or is accompanied by the absorption of heat.	G33 G81
<u>Endothermic Chemical Reaction</u>	A reaction involving one or more chemicals resulting in one or more new chemical species and the absorption of heat.	G33
<u>Endurance Burn(ing)</u>	Steady burning of a stabilized flame at or close to the flame arrester element	G64
<u>Endurance Burn Test</u>	A test in which a flame arrester is subjected to a stable flame on the surface of the arrester for a length of time (depends on whether UL 525 or the USCG protocol is used) until the highest obtainable temperature is reached on the ignited side or until the temperature on the protected side has a temperature rise of 100°C.	G64
<u>Energy Scaling Factor</u>	The cube root of the TNT equivalent mass, $W^{1/3}$ . [See Eq. (4.76).]	G60
<u>Entrainment</u>	The mixing of air into a vapor cloud.	G60
<u>Environmental Factor</u>	A factor used to adjust a given failure rate up or down depending upon actual service conditions to which an actual installation is exposed as compared to the given failure rate.	G24

<u>Environmental Impact Statement</u>	The analysis of the impact that a proposed development, usually industrial, will have on the natural and social environment. It includes assessment of long- and short-term effects on the physical environment, such as air, water, and noise pollution, as well as effects on employment, living standards, local services, and aesthetics. The National Environmental Policy Act of 1969 as well as many state and local laws enacted during the late 1960s and early 1970s mandate that these statements be completed before major development projects can begin. (Encyclopedia.com)	G83
<u>Environmentally Sensitive Areas (ESAs)</u>	Areas requiring special management attention to protect important scenic values, fish and wildlife resources, historical and cultural values, and other natural systems or processes. ESAs for forestry include potentially fragile, unstable soils that may deteriorate unacceptably after forest harvesting, and areas of high value to non-timber resources such as fisheries, wildlife, water, and recreation. (Province of British Columbia Ministry of Forests online dictionary)	G83
<u>EPA</u>	U.S. Environmental Protection Agency; Federal agency with environmental protection regulatory and enforcement authority.  <b>Importance:</b> EPA regulations must be met for the disposal of hazardous materials, as well as in spill situations.	G17
<u>Episodic Event</u>	An unplanned event of limited duration, usually associated with an accident.	G1+ G3
<u>Episodic Event</u>	An event of limited duration, typically an incident. For example, release of hazardous materials, a spill, or an explosion.	G82
<u>Episodic Release</u>	A release of limited duration, usually associated with an accident.	G1+ G6
<u>Equipment</u>	A piece of hardware which can be defined in terms of mechanical, electrical or instrumentation components contained within its boundaries.	G7
<u>Equipment Boundary</u>	Demarcation of the equipment defining components included and interfaces with excluded piping, electrical, and instrumentation systems.	G7

<u>Equipment Reliability</u>	The probability that, when operating under stated environment conditions, process equipment will perform its intended function adequately for a specified exposure period.	G6 G8
<u>Equivalence Ratio</u>	The ratio of fuel concentration in the actual fuel–air mixture divided by the fuel concentration in a stoichiometric mixture.	G64
<u>Equivalent Social Cost</u>	A modification of the Average Rate of Death that takes into account society's aversion of large-consequence incidents.	G6
<u>ERP</u>	Equivalent Roughness Pattern used in the Kit Fox experiments, consisting of square plywood boards with $W = Hr = 2.4$ m.	G75
<u>ERPG</u>	<p>The American Industrial Hygiene Institute defines Emergency Response Planning Guideline (ERPG) levels.</p> <ul style="list-style-type: none"> <li>• The ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.</li> <li>• The ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.</li> <li>• The ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.</li> </ul>	G83
<u>Emergency Response Planning GL's (ERPG)</u>	A system of guidelines being prepared by an industry task force of which ERPG-2 is the (ERPG) maximum airborne concentration below which, it is believed, nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible, adverse, or other serious health effects or symptoms that could impair an individual's ability to take protective action (similar to EEGLs).	G3

<u>Error Bounds</u>	See Confidence interval.	G7
<u>Error Factor</u>	The ratio of the 95th percentile value to the median value of a lognormal distribution.	G7
<u>Error Likely Situation</u>	A work situation in which the performance shaping factors are not compatible with the capabilities, limitations, or needs of the operator. This situation is likely to prevent the operator from correctly performing the task.	G1+
<u>Essential Criteria</u>	Criteria defining the required content or conduct of a PHA based upon company or regulatory requirements.	G71
<u>Evaporation Rate</u>	A number showing how fast a liquid will evaporate.  <b>Importance:</b> The higher the evaporation rate, the greater the risk of vapors collecting in the workplace. The evaporation rate can be useful in evaluating the health and fire hazards of a material.	G17
<u>Event</u>	An occurrence related to equipment performance or human action, or an occurrence external to the system that causes system upset. In this document an event is either the cause of or a contributor to an incident or accident, or is a response to an accident's initiating event.	G1+
<u>Event</u>	An occurrence involving the process caused by equipment performance, human action, or by an occurrence external to the risk control system. In Multilinear Event Sequencing (MES) an event is defined as one actor plus one action.	G82
<u>Event Sequence</u>	A specific unplanned sequence of events composed of initiating events and intermediate events that may lead to an incident.	G6 G1+
<u>Event Tree</u>	A logic model that graphically portrays the combinations of events and circumstances in an accident sequence.	G1+
<u>Event Tree (Analysis)</u>	A graphical logic model that identifies and quantifies possible outcomes following an initiating event.	G24
<u>Evidence</u>	Data on which the investigation team will rely for subsequent analysis, testing, reconstruction, corroboration, and conclusions.	G82

<u>Evidence gathering</u>	the collection of data on which the investigation team will rely for subsequent analysis, testing, reconstruction, corroboration, and conclusions.	G82
<u>Execution</u>	The process of performing the operations of a specified portion of an Application Program.	G24
<u>Exothermic</u>	A physical or chemical change accompanied by the evolution of heat.	G33
<u>Exothermic</u>	A physical or chemical change that requires or is accompanied by the absorption of heat. CCPS 1998a	G81
<u>Exothermic Chemical Reaction</u>	A reaction involving one or more chemicals resulting in one or more new chemical species and the evolution of heat.	G33
<u>Expansion Ratio, <math>r_v</math></u>	The ratio of the volume after combustion to that prior to combustion.	G60
<u>Expansive List (of incidents)</u>	The list of incidents from which the study group is selected. An Expansive List is derived from the Initial list by (1) removing incidents that are too small to be of concern; (2) combining redundant or very similar incidents; and (3) grouping similar incidents into a single equivalent incident.	G6
<u>Expected Number of Failures (ENF)</u>	The average number of occurrences of the fault event during a specified time interval.	G6
<u>Explosion</u>	The bursting or rupturing of an enclosure or container due to the development of internal pressure from a deflagration or detonation.	G64
<u>Explosion</u>	A release of energy that causes a pressure discontinuity or blast wave. (CCPS, 1999)	G83
<u>Explosion</u>	A release of energy sufficient to cause a pressure wave; a rapid or sudden release of energy that causes a pressure discontinuity or blast wave. HSE 2000; CCPS 1999a	G81
<u>Explosion Efficiency, <math>e</math></u>	The ratio of the mechanical energy released in an explosion to the heat of combustion times the flammable mass in a vapor cloud (net efficiency). Alternately, the ratio of the mechanical energy released in an explosion to the heat of combustion times the total mass of fuel in a vapor cloud (gross efficiency).	G60

<u>Explosion Overpressure</u>	Any pressure above atmospheric caused by a blast. (CCPS, 1994)	G83
<u>Explosion Vent</u>	An intentionally weakly supported panel in the wall of an enclosure designed to give way in the event of an explosion in order to reduce the explosion overpressures and thereby protect the rest of the structure.	G60
<u>Explosive</u>	A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. OSHA 1994	G81
<u>Exponential wind profile</u>	Formula proposed for vegetative canopies that is also valid for other types of surface obstacles (Cionco, 1965).	G75
<u>Exposure, Demand-related</u>	The historical number of demands experienced by the equipment population.	G7
<u>Exposure, Time-related</u>	The historical operating time of the equipment population.	G7
<u>Exposure hours</u>	An equipment's operating time in hours.	G7
<u>Exposure Period</u>	Expressed in terms of a continuous variable, such as the time equipment is operating, or as a function of a discrete variable, such as the number of demands (also called cycles in some tests) imposed on a piece of equipment.	G6
<u>External</u>	A WDT that is independent of the PES.  An electronic internal timer which will generate priority interrupt unless periodically recycled by a computer. It is used to detect program stall or hardware failure conditions.	G24
<u>External Event</u>	Event caused by (1) a natural hazard-earthquake, flood, tornado, extreme temperature, lighting, etc; or (2) man-induced events-aircraft crash, missile, nearby industrial activity, sabotage, etc., or (3) an interruption of facilities such as electric power or process air.	G6

<u>Extrinsic factor</u>	As used in this publication, a factor that is not an intrinsic property of a material being handled (see <i>intrinsic property</i> ).	G81
<u>F-N Curve</u>	A plot of cumulative frequency versus consequences (expressed as number of fatalities).	G6
<u>Facility</u>	A portion of or complete plant, unit, site, complex or any combination thereof.	G83
<u>Facility Manager</u>	On-site Engineering section or group providing service to the local facility.	G24
<u>Fail To Danger</u>	Describes an equipment fault which would inhibit or delay automatic shut-down should a demand occur. The fail-to-danger fault has a direct and detrimental effect on safety.	G24
<u>Fail-Safe</u>	<p>Design features which provide for the maintenance of safe operating conditions in the event of a malfunction of control devices or an interruption of an energy source (e.g., failure direction of a motor operated valve on loss of motive power).</p> <p>A designed property of an item which prevents its failures being critical failures.</p> <p>Describing a circuit or device which fails in such a way as to maintain circuit continuity or prevent damage. A feature of a system or device which initiates an alarm or trouble signal when the system or device either malfunctions or loses power.</p> <p>Any protection against effects of failure of the equipment, such as, fuel shut off in the event of loss of flame in a furnace.</p> <p>Describes an equipment fault which, irrespective of inputs, causes the ESD system to move nearer the shut-down point or initiate shut-down action. The fail-safe fault may lead to an undesired frequency of shut-downs which could be costly and lead to diminished confidence in the ESD system.</p> <p>The desired failed-state (e.g., closed, open for a final control element, or any control system component).</p> <p>A feature incorporated for automatically counteracting the effect of an anticipated possible source of failure. A system is fail-safe if failure of a component, signal, or utility, initiates action that return the system to a safe condition.</p>	G24

<u>Fail-Safe Circuit</u>	A circuit that has an output state which indicates that either a circuit input or the circuit itself has failed. Finds circuit application in complex systems where self-healing subsystems exist. When a subsystem failure is detected, a backup subsystem is automatically inserted.	G24
<u>Fail-Safe Control</u>	A system of remote control for preventing improper operation of the controlled function in event of circuit failure.	G24
<u>Fail-Safe Operation</u>	An electrical system so designed that the failure of any component in the system will prevent unsafe operation of the controlled equipment.	G24
<u>Fail-Safe Shutdown</u>	The ability of a Process Control System to have its outputs assume a predefined state within a specified delay after detecting the occurrence of a power supply voltage drop or an Internal Failure.	G24
<u>Failure</u>	An unacceptable difference between expected and observed performance.	G56 G64 G82
<u>Failure Frequency</u>	The number of failure events that occur divided by the total elapsed <i>calendar</i> time during which those events occur or by the total number of demands, as applicable.	G6 G24 G7
<u>Failure Mode</u>	A symptom, condition, or fashion in which hardware fails. A mode might be identified as loss of function; premature function (function without demand); an out-of-tolerance condition; or a simple physical characteristic such as a leak (incipient failure mode) observed during inspection.	G7
<u>Failure Mode and Effects Analysis</u>	A hazard identification technique in which all known failure modes of components or features of a system are considered in turn and undesired outcomes are noted.	G7 G8 G56 G6 G24 G82
<u>Failure Modes, Effects, and Criticality Analysis (FMECA)</u>	A variation of FMEA that includes a quantitative estimate of the significance of the consequence of a failure mode	G1+

<u>Failure Probability</u>	The probability - a value from 0 to 1 - that a piece of equipment will fail on demand (not to be confused with fractional dead time) or will fail in a given time interval.	G6 G7
<u>Failure Rate</u>	The number of failure events that occur divided by the total elapsed <i>operating</i> time during which these event occur or by the total number of demands, as applicable.	G6 G7 G24
<u>Failure Severity</u>	The degree of function degradation of equipment usually noted through deficient performance ; categorized by the terms "catastrophic," "degraded," and "incipient."	G6 G7
<u>Falsifiability</u>	A concept where a specific effort is made to disprove a speculated hypothesis, in addition to the efforts made to prove the hypothesis.	G82
<u>Farad</u>	A unit of capacitance equal to Coulombs per volt. See "Capacitance."	G67
<u>Faraday Pail (Cage).</u>	Grounded metal sheet or mesh enclosure that prevents external electric fields from exerting an influence inside it.	G67
<u>Far-field</u>	The area beyond the influence of local structures and plume buoyancy effects. Typically the far-field begins at about 1000 m from the source.	G75
<u>Fast-Acting Valve</u>	A valve that closes a path of deflagration propagation in a pipe or duct in response to upstream detection of a deflagration.	G64
<u>Fatal Accident Rate (FAR)</u>	The estimated number of fatalities per 10 <sup>8</sup> exposure hours (roughly 1000 employee working lifetimes).	G6
<u>Fault Avoidance</u>	Use of component selection, conservative design, testing, and burn-in to achieve high reliability. Design assurance.	G24
<u>Fault Tolerance</u>	That property of a system which permits it to carry out its assigned function even in the presence of one or more faults in the hardware or software components.  The use of redundancy to achieve a system availability approaching.	G24

<u>Fault Tolerant</u>	A system where some parts may fail but the system will still execute properly.	G24 G6
	A control system configuration that inherently provides auto selection of alternate or redundant signal paths to effect uninterrupted operations.	
<u>Fault Tree</u>	A logic model that graphically portrays the combinations of failures that can lead to a particular main failure or accident of interest (Top Event).	G1+
<u>Fault Tree</u>	A method for representing the logical combinations of various system states that lead to a particular outcome (top event).(4)	G82
<u>Fault Tree Analysis</u>	Estimation of the Hazardous incident (Top Event) frequency from a logical model of the failure mechanisms of a system.	G24 G82
<u>FDT (Fractional Dead Time)</u>	The mean fraction of time in which a component or system is unable to operate on demand.	G7
<u>Feedback Control</u>	A method by which one or more controlled variables (i.e., pressure, temperature, current, speed, power) are made to obey a common signal, whether constant or varying, according to a prescribed law, as a result of the measurement of the variable(s) in questions.	G24
<u>Final Control Element</u>	A device that manipulates a process variable normally associated with the basic process control system.	G24
	An instrument that takes action to adjust the manipulated variable in a process. This action moves the value of the controlled variable back towards the set point. The last system element that responds quantitatively to a control signal and performs the actual control action. Examples include valves, solenoids, and servometers.	
<u>Final Control Element (Critical)</u>	See Critical Final Control Element.	G24
<u>Final Control Element (for an interlock system).</u>	A field device used to drive the process to its lowest energy state, or a state away from its critical operating limit. A common final control element is a solenoid valve either directly applied to the process for control of fluid flow or to vent from or admit instrument air to an air-operated control valve. Motor control starter circuits also serve as final control elements to start or stop motors. Also, see "Output Devices".	G24

<u>Final Element (Load)</u>	A load device, such as a solenoid valve or motor starter, that is manipulated by the controller.	G24
<u>Fire</u>	A combustion reaction accompanied by the evolution of heat, light, and flame. (CCPS, 1996, no. 22)	G83
<u>Fireball</u>	The atmospheric burning of a fuel-air cloud in which the energy is mostly emitted in the form of radiant heat. The inner core of the fuel release consists of almost pure fuel whereas the outer layer in which ignition first occurs is a flammable fuel-air mixture. As buoyancy forces of the hot gases begin to dominate, the burning cloud rises and becomes more spherical in shape.	G6
<u>Fire Point</u>	The minimum temperature at which a flammable or combustible liquid, as herein defined, and some volatile combustible solids will evolve sufficient vapor to produce a mixture with air that will support sustained combustion when exposed to a source of ignition, such as a spark or flame.	G33
<u>Fire Protection</u>	Methods of providing for fire control or fire extinguishment. (NFPA 850)	G83
<u>Firmware</u>	Configurable digital programs, procedures, rules, and associated documentation contained in vendor supplied standard H/W required for the operation and/or maintenance of a digital system.	G24
<u>First Out</u>	A term usually referring to an annunciator feature that indicates which interlock caused the trip.	G24
<u>Flame</u>	A region in which chemical interaction between gases occurs, accompanied by the evolution of light and heat (see Decomposition Flames).	G64
<u>Flame Arrester</u>	A device fitted to the opening of an enclosure or to the connecting piping of a system of enclosures and whose intended function is to allow flow but prevent the transmission of flame from either a deflagration or detonation.	G64
<u>Flame Arrester Element (Matrix):</u>	That portion of a flame arrester whose principal function is to prevent flame transmission, usually by quenching the flame front.	G64
<u>Flame Arrester Housing</u>	That portion of flame arrester whose principal function is to provide a suitable enclosure for the flame arrester element, and to facilitate mechanical connection to other systems.	G64

<u>Flame Barrier</u>	A device that prevents transmission of a flame from a source to a receptor.	G64
<u>Flame Expansion Dimensions</u>	The dimensions in which a burning or exploding gas is free to expand, 1D, 2D, or 3D.	G60
<u>Flame Front</u>	That portion of the flame reaction zone moving into the unburned gas where the bulk of the reaction occurs and the medium reaches its ignition temperature	G64
<u>Flame Front Diverter</u>	A device that opens in response to the pressure wave preceding the flame front of the deflagration, venting the flame front and pressure wave.	G64
<u>Flame Propagation</u>	The movement of a flame front in piping or equipment.	G64
<u>Flame Speed</u>	The speed of a flame front relative to a fixed reference point. Flame speed is dependent on turbulence, the equipment geometry, and the fundamental burning velocity.	G64
Flame Temperature	Theoretical temperature achieved based on chemical equilibrium with the assumption of Gibbs free energy minimization	G64
<u>Flame Trap</u>	Another name for a flame arrester, commonly used in the United Kingdom.	G64
<u>Flame Velocity</u>	See Flame Speed	G64
<u>Flammable Gas (NFPA 55)</u>	A gas that is flammable in a mixture of 13 percent or less (by volume) with air, or the flammable range with air is wider than 12 percent regardless of the lower limit, at atmospheric temperature and pressure.	G33
<u>Flammable Limits</u>	The minimum and maximum concentration of fuel vapor or gas in a fuel vapor or gas/gaseous oxidant mixture (usually expressed in percent by volume) defining the concentration range (flammable or explosive range) over which propagation of flame will occur on contact with an ignition source. See also Lower Flammable Limit and Upper Flammable Limit.	G64
<u>Flammable Limits</u>	The minimum and maximum molar (or volume) concentrations of a combustible material in a homogeneous mixture with a gaseous oxidizer that will propagate a flame.	G67

<u>Flammable Liquid</u>	<p>A term used to classify certain liquids as defined by NFPA 30 as a liquid with a closed-cup flash point below 100°F (37.8°C) and Reid vapor pressures not exceeding 40 psia at 100°F (37.8°C). Flammable liquids are called Class I liquids and have three subdivisions as follows:</p> <p><i>Class IA:</i> Those having flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C).</p> <p><i>Class IB:</i> Those having flash points below 73°F (22.8°C) and boiling points at or above 100°F (37.8°C).</p> <p><i>Class IC:</i> Those having flash points at or above 73°F (22.8°C) but below 100°F (37.8°C).</p>	G64
<u>Flammable Liquids</u>	<p>Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures described in NFPA 30 and a Reid vapor pressure not exceeding 40 psia (2068.6 mm Hg) at 100°F (37.8°C), as determined by ASTM D 323, Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method). Flammable liquids are classified as Class I as follows:</p> <ul style="list-style-type: none"> <li>(a) Class IA liquids shall include those liquids that have flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C).</li> <li>(b) Class IB liquids shall include those liquids that have flash points below 73°F (22.8°C) and boiling points at or above 100°F (37.8°C).</li> <li>(c) Class IC liquids shall include those liquids that have flash points at or above 73°F (22.8°C), but below 100°F (37.8°C).</li> </ul> <p>(NFPA 30)</p>	G83
<u>Flammable Mass</u>	<p>The mass of fuel in a vapor cloud that is in the flammable range, <i>mf</i>.</p>	G60
<u>Flammable Range</u>	<p>The range of concentrations between the lower and upper flammability limits.</p>	G64
<u>Flashback</u>	<p>Undesired flame propagation opposite to the direction of flow. It is also used to describe failure of a flame arrester element.</p>	G64

<u>Flash Fire</u>	The combustion of a flammable vapor and air mixture in which flame passes through that mixture at less than sonic velocity, such that negligible damaging overpressure is generated.	G6
<u>Flash Fire</u>	The combustion of a flammable gas or vapor and air mixture in which the flame propagates through that mixture in a manner such that negligible or no damaging overpressure is generated. (CCPS, 1994)	G83
<u>Flash Point</u>	The minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid as determined by a specific test method, i.e., open-cup or closedcup	G60
<u>Flash point</u>	The lowest temperature at which vapors above a volatile combustible substance ignite in air when exposed to a source of ignition.	G68
<u>Flash point</u>	The minimum temperature at which a liquid gives off sufficient vapor to form an ignitable mixture with air within the test vessel used (Methods: ASTM 502). The flash point is less than the “fire point” at which the liquid evolves vapor at a sufficient rate for indefinite burning.	G67
<u>Flash point</u>	The temperature at which the vapor-air mixture above a liquid is capable of sustaining combustion after ignition from an external energy source. (CCPS, 1996, no. 22)	G83
<u>Flow Controlled Aperture</u>	An aperture designed to produce flow velocities which exceed the local flame speed of the flammable mixture, thus preventing flame transmission in the reverse direction.	G64
<u>Fluid model experiments</u>	Experiments carried out at small scale in wind tunnels and water channels.	G75
<u>FME (C) A</u>	Failure Mode Effect (and Criticality) Analysis; A technique in which all known failure modes of components or features of a system are considered in turn and undesired outcomes are noted. A criticality ranking of equipment may also be calculated.	G35

<u>Force majeure</u>	An event or effect that cannot reasonably be anticipated or controlled.	G68
<u>Forensic Engineering</u>	The art and science of professional practice of those qualified to serve as engineering experts in matters before the courts of law or in arbitration proceedings.	G56 G82
<u>Form Prototype</u>	A device that is of the correct physical size and general appearance, and can be mechanically installed or interconnected with other devices or components that constitute a system. A form prototype is not necessarily functional electrically or optically. A "mock-up".	G24
<u>Formula</u>	The conventional scientific designation for a material (water is H <sub>2</sub> O, sulfuric acid is H <sub>2</sub> SO <sub>4</sub> Sulfur dioxide is SO <sub>2</sub> , etc.)  <b>Importance:</b> Chemical formulas identify specific materials.	G17
<u>Fractional Dead Time (FDT)</u>	A probability representing the mean proportion of the total relevant time that a component, equipment, or system, is incapable of providing protection. Also called average unavailability or average probability of being in a failed state. Dimensionless.  The mean fraction of time in which a component or system is unable to operate on demand. (Also know as Unavailability.)  The measure of the fractional time that the system is likely to be in a non-working state.	G24
<u>Fractional Dead Time (FDT)</u>	The mean fraction of time in which a component or system is unable to operate on demand.	G7
<u>Free stream or geostrophic wind speed</u>	G Wind speed at the top of the boundary layer.	G75
<u>Frequency</u>	The number of occurrences per unit time at which observed events occur or are predicted to occur.	G1+
<u>Frequency</u>	The number of occurrences of an event per unit of time.	G83 G82

<u>friction velocity, <math>u^*</math></u>	The fundamental scaling velocity, equal to the square root of the surface stress, $\hat{\sigma}_o$ , divided by the air density. The surface stress can be observed by special instruments that directly observe the drag at the surface, or by fast response turbulence instruments using the definition: $\hat{\sigma}_o = \bar{\tau} = \overline{u' w'}$ where $u'$ is the longitudinal wind speed fluctuation, $w'$ is the vertical wind speed fluctuation, and the average is over about a one-hour time period. The variable $u^*$ can also be estimated from wind observations. A rough rule of thumb is that the ratio $u^*/u$ is about 0.05 to 0.1, where $u$ is the wind speed at a height of about 10 m, which is the standard measurement height at airports around the world. $u^*$ has typical values ranging from about 0.05 m/s in light winds to about 1 m/s in strong winds.	G75
<u>Froth-over</u>	When water is present or enters a tank containing hot viscous oil, the sudden conversion of water to steam causes a portion of the tank contents to overflow.	G62
<u>Fuel gas</u>	Gaseous fuels consisting of natural gas and various manufactured or by-product gases.	G83
<u>Fugitive Emissions</u>	Emissions of material from process equipment due to leakage.	G62
<u>Full-scale field experiments</u>	Field experiments of flow and dispersion around full sized obstacles (e.g., buildings, storage tanks, nuclear reactor structures, street canyons, isolated hills).	G75
<u>Full Volume Deflagration (FVD)</u>	A deflagration explosion developed from a flammable cloud of gas, aerosol, or dust that occupies the entire volume in a confined space.	G60
Fully developed flow	Flow in a long, constant area pipe in which the mean velocity profiles are independent of position along the pipe. In the pipe the surface shear stress is balanced by the longitudinal gradient of static pressure in the pipe (the "pressure gradient").	G75
<u>Functional Deficiencies</u>	Failures from a system that works as designed but are inadequate for the task at hand.	G24
<u>Functional Design</u>	A phase in the development of computerized systems which produces detailed descriptions of the system that are independent of particular hardware and software. This includes all flows of information, timing diagrams, and state transition diagrams.	G24

<u>Functional Prototype</u>	A device that is electrically and optically workable, used to demonstrate the operating function of the device or interconnected system. It may not have a size or shape that is considered usable in an operating environment. A "breadboarded" device.	G24
<u>Functional Requirements</u>	A phase in the development of computerized systems in which all inputs to and outputs from the system and transfer functions that produce the outputs from the inputs are identified and described in detail.	G24
<u>Fundamental Burning Velocity (Su).</u>	The burning velocity is the rate of flame propagation relative to unburned gas ahead of the flame front. The fundamental burning velocity is the burning velocity of a laminar flame under stated conditions of composition, temperature and pressure in the unburned gas. The reported Su is usually the maximum value measured for the fastest burning composition at 25°C and 760 mmHg.	G67
<u>g</u>	Gram: a metric unit of weight. One U.S. ounce is about 28.4 grams.	G17
<u>g/kg</u>	Grams per kilogram; an expression of dose used in oral dermal toxicology testing to indicate the grams of substance dosed per kilogram of animal body weight. See also, "kg."  <b>Importance:</b> A measure of the toxicity of a substance.	G17
<u>Gallon</u>	US Liquid Measure equal to 3.785 × 10 <sup>-3</sup> m <sup>3</sup> .	G67
<u>Galloping Detonation</u>	A detonation that periodically fails and reinitiates during propagation. This type of detonation is typically observed in near-limit mixtures. Since it reinitiates via DDT, a galloping detonation is periodically overdriven and results in large overpressures at periodic distances along a pipe.	G64
<u>Gas</u>	The state of matter characterized by complete molecular mobility and unlimited expansion at standard temperature and pressure	G64
Gas Enrichment	The addition of another flammable gas to a gas–air mixture to raise the concentration above the upper flammable limit.	G64

<u>Gaussian Model</u>	A dispersion model based on the concept that atmospheric diffusion is a random mixing process driven by turbulence in the atmosphere. The concentration at any point downwind of a release source is approximated by a Gaussian concentration profile in both the horizontal and vertical dimensions.	G6
<u>Gaussian models</u>	A class of transport and dispersion model which assumes that the distribution of pollutant concentration has a Gaussian or normal shape [e.g., $\exp(-y^2/2\sigma_y^2)$ , where $y$ is the lateral crosswind distance from the center of the plume or puff and $\sigma_y$ is the lateral dispersion component].	G75
<u>General Exhaust</u>	A system for exhausting air containing contaminants from a general work area. See also, "Local Exhaust".  <b>Importance:</b> Adequate ventilation is necessary to prevent adverse health effects from exposures to hazardous materials and vapor accumulations that can be a fire hazard.	G17
<u>Generic Data</u>	Data which is typical for a system. Such data will not have been collected for the particular system but will have been collected, estimated or aggregated from many generally similar systems.	G7
<u>Geotechnical</u>	Relating to the engineering field which combines geology and engineering. (Merriam Webster's Collegiate online dictionary)	G83
<u>Go-Devil</u>	See "Surface Streamer."	G67
<u>Graceful Degradation</u>	A computer program technique the purpose of which is to prevent catastrophic system failure by permitting the machine to operate, although in a degraded mode, in spite of failures of malfunctions in several integral units or subsystems.	G24
<u>Gradient transport or K theory</u>	The eddy diffusivity coefficient $K$ is used to solve the mass conservation equation for the pollutant. The solution can be obtained analytically for some simple cases but must be solved numerically for more general cases. This model is most useful when the size of the cloud is greater than the dominant turbulent length scales.	G75
<u>Grassroots</u>	Totally new facility that may be built upon a greenfield or brownfield site.	G83

<u>Gravitational settling velocities</u>	Downward velocity of particles due to gravity (about 10 cm/s for an aerosol diameter of about 50 µm and about 100 cm/s for an aerosol diameter of about 200 µm, assuming an aerosol density approximately equal to the density of water, or about 1000 kg/m <sup>3</sup> ).	G75
<u>Gravity Slumping</u>	The decrease in cloud height of a flowing dense gas due to the effects of gravity (negative buoyancy).	G60
<u>Greenfield</u>	Undeveloped property that is being considered as a site for construction. (Dictionary.com)	G83
<u>Grooved and Shouldered Joint</u>	Type of pipe connection that might result in electrical isolation by gasket and which may require jumper cable across joint.	G67
<u>Ground Indicator</u>	Commercially available device which automatically senses the presence of ground continuity and which may be equipped with alarms or interlocks to prevent operations such as flammable liquid transfers unless equipment is grounded.	G67
<u>Ground-level releases</u>	Source emissions from near ground level.	G75
<u>Grounding</u>	Grounding is a conducting connection between a piece of equipment or electrical circuit and the earth.	G62
<u>Grounding (Earthing).</u>	Ideally the process of connecting one or more conductive objects to ground so that each is at the same potential as the earth. By convention the earth has zero potential. In practice, grounding is the process of providing a sufficiently small resistance to ground so that a static hazard cannot be created at the maximum credible charging current to a system. <b>266 GLOSSARY</b>	G67
<u>Hard Failures</u>	[ no text given ]	G24
<u>Hard Wired Interlock</u>	An interlock accomplished by electro-relays and/or wires. An interlock not accomplished through a PES (see software interlock).	G24
<u>Hardware</u>	Physical equipment directly involved in performing industrial process measuring and controlling functions, as opposed to computer programs, procedures, rules, and associated documentation.	G24
<u>Hardwired</u>	That portion of the logic which is executed by electrical circuits comprised exclusively of H/W.  That portion of the logic which is executed by electrical circuits devoid of S/W or firmware.	G24

<u>Hazard</u>	An inherent chemical or physical characteristic that has the potential for causing damage to people, property, or the environment. In this document it is the combination of a hazardous material, an operating environment, and certain unplanned events that could result in an accident.	G1+ G64
<u>Hazard</u>	An inherent physical or chemical characteristic that has the potential for causing harm to people, property, or the environment.	G71
<u>Hazard</u>	A chemical or physical condition that has the potential for causing damage to people, property, or the environment. (CCPS, 1999)	G83 G81
<u>Hazard</u>	A chemical, physical, or changing condition that has the potential for causing damage to human life, property, or the environment.(1)	G82
<u>Hazard Analysis</u>	The identification of undesired events that lead to the materialization of a hazard, the analysis of the mechanisms by which these undesired events could occur and usually the estimation of the consequences.	G7
<u>Hazard and Operability Study (HAZOP)</u>	A systematic qualitative technique to identify process hazards and potential operating problems using a series of guide words to study process deviations. A HAZOP is used to question every part of a process to discover what deviations from the intention of the design can occur and what their causes and consequences may be. This is done systematically by applying suitable guidewords. This is a systematic detailed review technique, for both batch and continuous plants, which can be applied to new or existing processes to identify hazards.	G62
<u>Hazard and Operability Study (HAZOP)</u>	A systematic qualitative technique to identify and evaluate process hazards and potential operating problems, using a series of guidewords to examine deviations from normal process conditions.(4)	G82
<u>Hazard Classifications</u>	Broken into three categories, "Safety and Environmental", "High Business Risk", and "Low Business Risk."	G24

<u>Hazard Evaluation</u>	The analysis of the significance of hazardous situations associated with a process or activity. Uses qualitative techniques to pinpoint weaknesses in the design and operation of facilities that could lead to accidents.	G1+ G71 G82
<u>Hazard Evaluation</u>	The analysis of hazardous situations associated with a process or activity, using techniques to identify weaknesses in design and operation. (CCPS, 1993, no. 15)	G83
<u>Hazard Frequency of Potential Hazards</u>	(i.e., Demand Rate) times the Fractional Deadtime of Safety Systems describes the relationship between hazard rate and demand rate.	G24
<u>Hazardous material</u>	In a broad sense, any substance or mixture of substances having properties capable of producing adverse effects on people, property, or the environment. Such materials may be flammable, combustible, toxic, reactive, unstable or corrosive. (CCPS, 1988)	G83
<u>Hazard Rate</u>	The frequency with which hazards occur. Dimension (Time - 1).  The frequency at which failures lead to hazardous events.  Also know as the Time-Related Equipment Failure Rate, is an Instantaneous Failure Rate function of time.	G24
<u>Hazard Warning Structure</u>	A modified form of fault tree highlighting event mitigating feature pairs. These are often pairings of incident precursors and protective devices or event terminating features which are combined through an AND gate.	G6
<u>Hazard Zone</u>	The zone or region where hazard impact has the potential to occur.	G3
<u>Hazard</u>	A chemical or physical condition that has the potential for causing damage to people, property or the environment. CCPS 1999b	G81
<u>Hazardous Chemical Reactivity</u>	Any chemical reaction with the potential to exhibit rates of increase in temperature and/or pressure too high to be absorbed by the environment surrounding the system. Included are reactive materials and unstable materials.	G35

<u>Hazardous Material</u>	In a broad sense, any substance or mixture of substances having properties capable of producing adverse effects to the health or safety of human beings or the environment. Material presenting dangers beyond the fire problems relating to flash point and boiling point. These dangers may arise from, but are not limited to, toxicity, reactivity, instability, or corrosivity.	G64
<u>Hazardous Waste (40 CFR 261)</u>	<p>Hazardous waste can be classified as follows:</p> <ul style="list-style-type: none"> <li>• <i>Ignitable</i>—Based upon the flash point of a liquid waste; for a solid, the capability to cause fire through friction or absorption of moisture, and to burn vigorously and persistently; solids that meet the 49 CFR definition of oxidizer; and, compressed gases that are ignitable under the DOT definition.</li> <li>• <i>Corrosive</i>—Liquid wastes that have a pH of <i>plain</i> 2 or 12.5, or that corrode steel at a rate of greater than 0.25 inch per year.</li> <li>• <i>Reactive</i>—Wastes that are unstable and readily undergo violent change; that react violently with water or when mixed with water generate toxic vapors or fumes; that are cyanide or sulfide bearing and can generate toxic gases, vapors, or fumes at pH conditions between 2 and 12.5; that are readily capable of detonation or explosion at standard temperature and pressure if subjected to a strong initiating force or if heated under confinement; or DOT forbidden explosives.</li> <li>• <i>Toxic</i>—Liquid wastes or extract from waste solids that fail the Toxicity Characteristic Leaching Procedure (TCLP) analytical test because they contain certain designated metals, pesticides, or organic chemicals at concentrations equal to or, in excess of, specified regulatory limits.</li> </ul>	G33
<u>Hazardous Material</u>	A solid waste, or combination of solid waste, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. (RCRA )	G83
<u>Health Hazard</u>	A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. OSHA 1994	G81

<u>Heat of Combustion, <math>H_{ci}</math></u>	The heat of reaction obtained by burning a unit mass of a substance at the stoichiometric concentration in air to produce fully oxygenated products. If water is a product, then the "gross" heat of combustion includes the heat of condensation of water, so that liquid water is a product. Correspondingly, the "net" heat of combustion does not include the heat of condensation of water, and vapor water is a product. Unless otherwise stated, we refer here to "net" heat of combustion.	G60
<u>Heat of Reaction</u>	The net difference in heat of formation of all reactants and of all products in an adiabatic system. The reaction is exothermic if heat is released (heat of reaction is negative), and endothermic if heat is absorbed by the reaction.	G60
<u>Heat of Reaction</u>	The total quantity of thermal energy liberated or absorbed during a chemical reaction. HSE 2000	G81
<u>Heavy Gas</u>	A gas with density exceeding that of air at ambient temperature. See also dense gas and negatively buoyant vapors.	G60
<u>Heavy Gas</u>	A gas whose density is greater than that of the ambient air. Synonymous with dense gas.	G75
<u>HEGADAS</u>	Heavy Gas Dispersion Model	G75
<u>Hexadecimal</u>	Pertaining to the numeration system with a radix of sixteen.	G24
<u>HGSYSTEM</u>	Heavy Gas System Model (Witlox and McFarlane, 1985)	G75
<u>High Potential Incident</u>	An event that, under different circumstances, might easily have resulted in a catastrophic loss	G82
<u>High Velocity Vent Valve</u>	A device to prevent the passage of flame in the reverse direction, consisting of a mechanical valve which adjusts the opening available for flow in accordance with the pressure at the inlet of the valve in such a way that the efflux (exiting) velocity cannot be less than 30 m/s.	G64
<u>Historical Data</u>	Data recorded from actual past experience.	G7
<u>Historical Error</u>	Actions by designers, operators, or managers that may contribute to or result in accidents.	G8
<u>Historical Incident Data</u>	Data collected and recorded from past incidents.	G6 G8 G82

<u>Hot-flame ignition</u>	A rapid, self-sustaining, sometimes audible gasphase reaction of the sample or its decomposition products with an oxidant. A readily visible yellow or blue flame usually accompanies the reaction. NFPA 325 2001	G81
<u>HPDM</u>	Hybrid Plume Dispersion Model	G75
<u>HRA Event Tree</u>	A graphical representation of sequential events in which the tree limbs designate human actions and other events as well as different conditions or influences upon these events. The values assigned to all tree limbs (except those in the first branching) are conditional probabilities. At any branch point in the tree, the sum of the probability values assigned to all of the limbs emanating from that point is 1.0. Typically the HRA event tree is drawn as a binary tree (i.e., only two limbs at each branch point).	G1+
<u>HTHM</u>	High toxic hazard material.	G3
<u>Human Error</u>	Any human action (or lack thereof) that exceed some limit of acceptability (i.e., an out-of-tolerance action) where the limits of human performance are deined by the system. Includes actions by designers, operators, or managers that may contribute to or result in accidents.	G1+ G82
<u>Human Error Probability</u>	The ratio between the number of human errors and the number of opportunities for human error. Synonyms: human failure probability and task failure probability.	G6
<u>Human Factors</u>	A discipline concerned with designing machines, operations, and work environments so that they match human capabilities, limitations, and needs. Includes any technical work (engineering, procedure writing, worker training, worker selection, etc.) related to the human factor in operator-machine systems.	G56 G82
<u>Human Factors</u>	A discipline concerned with designing machines, operations, and work environments to match human capabilities, limitations, and needs.	G71

<u>Human Reliability Analysis (HRA)</u>	A method used to evaluate whether system-required human-actions, tasks, or jobs will be completed successfully within a required time period. Also used to determine the probability that no extraneous human actions detrimental to the system will be performed.	G1+
<u>Human Reliability Analysis (HRA)</u>	A method by which the probability of a person successfully performing a task is estimated.	G82
<u>Hybrid Mixture</u>	A mixture of a combustible gas with either a combustible dust or combustible mist.	G64
<u>Hybrid Mixture</u>	A mixture of a flammable gas with either a combustible dust or combustible mist.	G67
<u>Hydration</u>	The incorporation of molecular water into a complex molecule with the molecules or units of another species. The complex may be held together by relatively weak forces or may exist as a definite compound. Parker 1997	G81
<u>Hydraulic Diameter</u>	An equivalent diameter for noncircular apertures which is equal to $4 \times \text{aperture area} / \text{aperture perimeter}$ .	G64
Hydraulic Flame Arrester	A flame arrester consisting of a vessel filled with a seal fluid (often water) and a distributor which breaks up the incoming gas into discrete bubbles, thus facilitating quenching of the flame and preventing flame transmission.	G64
Hypergolic	Hypergolic behavior is characterized by immediate, spontaneous ignition of an oxidation reaction upon mixing of two or more substances. CCPS 1995b	G81
<u>IEEE</u>	Acronym for Institute of Electrical and Electronics Engineers.	G24

<u>Ignitable Mixture</u>	A flammable gas, mist, or dust mixture or any combination of these that can be ignited by a specified ignition source such as a static spark.	G67
<u>Ignition</u>	Self-sustained flame propagation caused by a static discharge in a flammable mixture.	G67
<u>Ignition Energy</u>	Energy in Joules stored in a capacitor which upon discharge is just sufficient to effect ignition of a given fuel mixture under specified test conditions (Methods: ASTM 582 for Gas Mixtures	G67
<u>Ignition Sensitive</u>	“Easily ignitable” gases or dusts meeting the following criteria: a gas whose LMIE in air is small compared with the 0.2 mJ value typical of common fuel and solvent vapors, or a dust whose MIE in air is small compared with that of <i>Lycopodium</i> . In practice, ignition sensitive gases have LMIEs $\leq 0.1$ mJ and ignition sensitive dusts have MIEs $\leq 10$ mJ. Examples of ignition sensitive gases are acetylene and hydrogen. Ignition sensitive dusts include finely divided bisphenol-A (BPA) and butylated hydroxy toluene (BHT).	G67
<u>Ignition Source Density</u>	The number of ignition sources per unit area (of plant).	G60
<u>Image (I/O Image, Image Register)</u>	A portion of memory where I/O status (the image) is maintained.	G24
<u>Immediately Dangerous To Life And Health (IDLH)</u>	Maximum airborne contaminant concentrations from which one could escape with 30 minutes without any escape impairing symptoms or any irreversible health effects. Developed by the National Institute for Occupational Safety and Health (NIOSH).	G4 G3
<u>Impact</u>	The ultimate potential result of a hazardous event, expressed, depending on the particular application, in terms of injuries, fatalities, environmental or property damage, business interruption, etc.	G3
<u>Impact</u>	The ultimate potential result of a hazardous event. Impact may be expressed in terms of numbers of injuries or fatalities, environmental or property damage, or business interruption.	G82
<u>Impedance</u>	Frequency-dependent counterpart of resistance in AC circuits, comprising both inductive and resistive components.	G67

<u>Implementation Design</u>	A phase in the development of computerized systems in which hardware and software components are selected and implementation, operation, and maintenance procedures are developed.	G24
<u>Importance</u>	The contribution from a subsystem or a component to the complete system.	G6
<u>Impulse</u>	The area under the overpressure-time curve for explosions. The area can be calculated for the positive phase or negative phase of the blast.	G6
<u>Incendive</u>	Ability of an energy source, such as a static discharge, to cause ignition in a given system.	G67
<u>Incestuous Data</u>	Data in two or more data sets which is derived from a common origin and may be inadvertently "double-counted" when aggregated.	G7
<u>Incident</u>	An unplanned event or series of events and circumstances that may result in an undersirable consequence.	G56
<u>Incident</u>	An unplanned event with the potential for undesirable consequences. (CCPS, 1993, no. 15)	G83
<u>Incident</u>	An unusual or unexpected event, which either resulted in, or had the potential to result in serious injury to personnel, significant damage to property, adverse environmental impact, or a major interruption of process operations.	G82
<u>Incident Enumeration</u>	The identification and tabulation of incidents without regard to significance or other biases.	G6
<u>Incident Investigation</u>	The management process by which underlying causes of undesirabe events are uncovered and steps are taken to prevent similar occurrences.	G56 G68 G71 G82
<u>Incident Investigation Management System</u>	A written document that defines the roles, responsibilities, protocols, and specific activities to be carried out by personnel performing an incident investigation.	G82

<u>Incident Investigation Team</u>	A group of qualified people that examine an incident in a manner that is timely, objective, systematic, and technically sound to determine that factual information pertaining to the event is documented, probable cause(s) are ascertained, and complete technical understanding of such an event is achieved.	G56 G82
<u>Incident Outcome</u>	The physical manifestation of an incident.	G1+ G6
<u>Incident Outcome Case</u>	The quantitative definition of a single result of an incident outcome through specification of sufficient parameters to allow distinction of this case from all others for the same incident outcome.	G6
<u>Incident Stereotype</u>	A fixed or general pattern of incident causation. From a review of historical incident data it can be possible to identify "classes of incidents," each with certain features (or typical, repeated patterns) in common; i.e., incident stereotypes are defined.	G56 G82
<u>Incipient failure</u>	An imperfection in the state or condition of hardware such that a degraded or catastrophic failure can be expected to result if corrective action is not taken.	G7
<u>Incompatible</u>	Materials which could cause dangerous reactions from direct contact with one another are described as incompatible.  <b>Importance:</b> On a MSDS, incompatible materials are listed to prevent dangerous reaction in the handling and storage of the material.	G17
<u>Incompatible</u>	The term can refer to any undesired results occurring when substances are combined. In the context of this publication, it refers to incompatible substances giving an undesired chemical reaction when combined, posing a chemical reactivity hazard under a defined scenario.	G81
<u>Independent</u>	Give events A and B, A is independent of B if, and only if, the probability of A is unchanged by the occurrence of B. Also, if A is independent of B, B is likewise independent of A.	G24
<u>Individual Hazard Index (IHI)</u>	The Fatal Accident Rate (FAR) for a particular hazard, with the exposure time defined as the actual time that a person is exposed to a hazard of concern.	G6

<u>Individual Risk</u>	The risk to a person in the vicinity of a hazard. This includes the nature of the injury to the individual, the likelihood of the injury occurring, and the time period over which the injury might occur.	G6
<u>Induction Charging</u>	This is the process of momentarily grounding a conductor which has been polarized by an electric field, then removing the conductor from the electric field so that it gains a net charge.	G67
<u>Induction Period/Time</u>	Time interval (starting at operating conditions) after which a runaway shows its maximum effects.	G35
<u>Inductive Approach</u>	Reasoning from individual cases to a general conclusion by postulating that a system element has failed in a certain way. An attempt is then made to find out what happens to the whole system or process.	G56 G82
<u>Inert</u>	A chemical that does not react chemically with other substances. (Cambridge online)	G83
<u>Inert Gas</u>	A nonflammable, nonreactive gas that can be used to render the combustible material in a system incapable of supporting combustion.	G64 G67
<u>Inerting</u>	A technique by which a combustible mixture is rendered nonignitable by addition of an inert gas or a noncombustible dust.	G64
<u>Infrastructure</u>	The basic facilities, services, and installations needed for the functioning of a site such as transportation and communications systems, water and power lines, and public institutions including emergency response organizations. (Dictionary.com)	G83
<u>Ingestion</u>	The taking of a substance through the mouth.  <b>Importance:</b> A route of exposure to a hazardous material.	G17
<u>Ingredients</u>	A listing of chemicals that are in a mixture.  <b>Importance:</b> Knowing exactly what chemicals and how much of each is in a mixture helps you to understand the potential hazard a mixture represents.	G17

<u>Inhalation</u>	The breathing in of a substance in the form of gas, vapor, fume, mist, or dust.	G17
	<b>Importance:</b> A route of exposure to a hazardous material.	
<u>Inherently Safer</u>	A system is inherently safer if it relies on the chemistry and physics (the quantity, properties and conditions of use of the process materials) rather than on control systems, interlocks, alarms and procedures to prevent incidents.	G62
<u>Inherently Safer</u>	A condition in which the hazards associated with the materials and operations used in the process have been reduced or eliminated, and this reduction or elimination is permanent and inseparable. (CCPS, 1996, no. 23)	G83
<u>Inhibitor</u>	A chemical which is added to another substance to prevent an unwanted chemical change from occurring.	G17
	<b>Importance:</b> Inhibitors are sometimes listed on a MSDS, along with the expected time period before the inhibitor is used up and will no longer prevent unwanted chemical reaction.	
<u>Inhibitor</u>	A chemical substance used to prevent or stop a chemical reaction, such as polymerization, from occurring. CCPS 1998a	G81
<u>Initial List (of incidents)</u>	A list containing all the incidents identified by the enumeration methods chosen.	G6
<u>Initial Pressure</u>	The maximum normal operating pressure that exists at a point in the system prior to initiation of a flame event.	G64
<u>Initialization</u>	Originating or establishing basic conditions or start-up state.	G24
<u>Initiating Event</u>	The first event in an event sequence. Can result in an accident unless engineered protection systems or human actions intervene to prevent or mitigate the accident.	G1+
<u>Initiating Event</u>	The event that initiates the scenario leading to the undesired consequence.	G82

<u>Injury</u>	Physical harm or damage to a person resulting from traumatic contact between the body and an outside agency or exposure to environmental factors.	G56 G82
<u>In-Line Flame Arrester</u>	A flame arrester which is fitted with two pipe connections, one on each side of the flame arrester element. An in-line flame arrester may be either a deflagration or a detonation flame arrester. An in-line arrester that is installed on a vessel vent nozzle with a short length of pipe attached to the discharge (atmospheric) side is sometimes also called a "pipe-away" flame arrester.	G64
<u>Input</u>	<p>The current, voltage, power, or driving force applied to a circuit or device. Also called input value of input data.</p> <p>The terminals or other places where current, voltage, power, or device. Also called input terminal.</p> <p>Data which can be ready by the application program from an interface between the user program execution function and another functional unit of the PES. Also called program input.</p>	G24
<u>Input Device</u>	<p>The device or set of devices through which data is brought into another device.</p> <p>A device that reads input quantities (i.e., thermocouple, level switch).</p> <p>Devices such as limit switches, pressure switches, push buttons, etc., that supply data to a PES. These discrete inputs have a common return or an individual return (referred to as isolated inputs). Other inputs (may) include analog devices and digital encoders.</p> <p>Pneumatic, hydraulic, or electronic switches for common input devices such as pressure switches, flow switches, level switches, temperature switches, selector switches, and push buttons. Also see "sensor".</p>	G24
<u>Insolation</u>	Solar radiation heat loading (Watts/m <sup>2</sup> ).	G60
<u>Instability</u>	The degree of intrinsic susceptibility of a material to release energy through self-reaction (polymerizing, decomposing or rearranging).	G81
<u>Instantaneous Release</u>	Emissions that are <i>short</i> in duration compared with the travel time (time for cloud to reach location of interest) or sampling (or averaging) time.	G6

<u>Instruction</u>	A programming language Element that specifies an operation and the values or location of its operands.	G24
<u>Insulating</u>	See “nonconductive.”	G67
<u>Insulating Flange</u>	A flange or spool piece inserted into an otherwise conductive pipe–hose system. These are not truly insulating but have typical resistances of about 10 kW, which is high enough to prevent hazardous stray currents but low enough to prevent hazardous static accumulation. Used particularly in liquid or vapor lines subject to stray current arcs (breaksparks) when hoses are disconnected. <b>GLOSSARY 267</b>	G67
<u>Intentional chemistry</u>	Processing of substances such that a chemical reaction is intended to take place.	G81
<u>Integral Model</u>	A dispersion model which averages or “integrates” the concentration in a given dimension or time so that concentrations can be described by solving an ordinary differential equation instead of a partial differential equation.	G60
<u>Interlock</u>	<p>A protective response which is initiated by an out-of-limit process condition.</p> <p>Instrument which will not allow one part of a process to function unless another part is functioning.</p> <p>A device such as a switch that prevents a piece of equipment from operating when a hazard exists.</p> <p>To join two parts together in such a way that they remain rigidly attached to each other solely by physical interference.</p> <p>A device to prove the physical state of a required condition, and to furnish that proof to the primary safety control circuit.</p>	G24
<u>Interlock System</u>	A system that detects out-of-limits or abnormal conditions or improper sequences and either halts further action or starts corrective action.	G64
<u>Intermediates</u>	Materials from a process that are not yet completely finished product. They may be a mixture or compound.	G68
<u>Intermediate Event</u>	An event that propagates or mitigates an initiating (basic) event during the accident sequence (e.g., improper operation actions, failure to stop an ammonia leak but an emergency plant mitigates the consequences).	G24

<u>Intermittency</u>	The fraction of the time that a measured value is zero in a timeseries of measurements.	G60
<u>Internal</u>	A WDT is not independent of the PES it checks.	G24
<u>Internal boundary layer</u>	A transition layer rising downwind of a change of surface roughness, which separates the air below, which has <b>Glossary 195</b> adjusted to the new surface, from the air above, which is still influenced by the old upwind surface. The internal boundary layer has an average slope of about 1/100 to 1/10.	G75
<u>Internal Failure</u>	A failure involving either the hardware or the software of the Process Control System, excluding the Application Program.	G24
<u>Interrupt</u>	A break in the normal flow of a system or program occurring in such a way that the flow can be resumed from that point at a later time.	G24
<u>Interview</u>	A cooperative informal meeting with a witness where questions are answered voluntarily.	G56
<u>Intrinsic property</u>	In relation to materials, a property of the material itself, regardless of use or environmental conditions.	G81
<u>Intrinsically Safe</u>	Equipment and wiring which is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture or hazardous layer.  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.	G24

<u>Inversion</u>	In the air quality literature, the term inversion refers to a situation when the actual temperature gradient is positive (i.e., the temperature increases with height).	G75
<u>Inversion, capping</u>	A type of inversion that occurs aloft, at an elevation of about 1000 m, and marks the top of the layer of air subjected to strong vertical mixing during the day. The height of this layer is often referred to as the <i>mixing depth</i> , <i>zi</i> .	G75
<u>Inversion, ground-based</u>	During calm and clear nights, the inversion can be as much as 100 or 200 m deep, causing inhibition of vertical growth of pollutant clouds.	G75
<u>Inversion, synoptic</u>	A persistent elevated inversion caused by subsiding air associated with a large-scale weather system such as a stagnant high pressure system.	G75
<u>Ionic Wind</u>	In a corona discharge the interelectrode space contains slow moving ions of a single polarity corresponding to the polarity of the sharp electrode. These make frequent collisions with neutral molecules of similar size to the ions resulting in momentum transfer and bulk gas movement in the direction of the electric field. The bulk gas movement, having a velocity of the order 1 m/s, is known as the ionic wind.	G67
<u>Irritant</u>	A substance which, by contact in sufficient concentration for a sufficient period of time, will cause an inflammatory response or reaction of the eye, skin, or respiratory system. The contact may be a single exposure or multiple exposures. Some primary irritant: chronic acid, nitric acid, sodium hydroxide, calcium chloride, amines, chlorinated hydrocarbons, ketones, alcohols.  <b>Importance:</b> Knowing that a substance is an irritant allows you to be aware of the signs and symptoms of overexposure.	G17
<u>ISA</u>	Acronym for Instrument Society of America, a U.S. society of instrument and controls professionals.	G24
<u>ISC3</u>	Industrial Source Complex—Version 3 model recommended by the EPA (1995) for many types of industrial sources.	G75
<u>ISO 14000 / ISO 9000</u>	Standards published by the International Organization for Standardization. ISO 14000 standards are for companies establishing an environmental management system. ISO 9000 standards are for companies establishing a quality management system.. 214 GLOSSARY	G68
<u>Isolated (Devices, Circuits)</u>	Devices, Circuits are said to be isolated where there is not galvanic connection between them.	G24

<u>Isolation</u>	A means of preventing certain stream properties (deflagration, mass flow, ignition capability) from being conveyed past a predefined point.	G64
<u>Isomerization</u>	The conversion of a chemical with a given molecular formula to another compound with the same molecular formula but a different molecular structure, such as from a straight-chain to a branched-chain hydrocarbon or an alicyclic to an aromatic hydrocarbon. Examples include the isomerization of ethylene oxide to acetaldehyde (both C <sub>2</sub> H <sub>4</sub> O) and butane to isobutane (both C <sub>4</sub> H <sub>10</sub> ). CCPS 1995b	G81
<u>Isoperibolic System</u>	A system in which the controlling jacket temperature is kept constant.	G35
<u>Isoperibolic System</u>	A system in which the controlling external temperature is kept constant. CCPS 1995a	G81
<u>Isopleth</u>	A plot of specific locations (in the three spatial coordinates: x, y, z) downwind from the release source that is corresponding to a concentration of interest (e.g., fixed by toxic load or flammable concentration).	G6
<u>Isothermal</u>	A system condition in which the temperature remains constant. This implies that temperature increases and decreases are compensated by sufficient heat exchange with the environment of the system.	G35
<u>IUPAC Name</u>	A chemical name derived from a formal system of nomenclature employing a fundamental principle that each specific compound will have a different name. The system was developed 10.3. Design and Construction <b>163</b> and is maintained by the International Union of Pure and Applied Chemistry.	G33
<u>Jet Discharge</u>	A release of vapor or aerosol at sufficient pressure that the momentum of the release provides the dominating mechanism for air entrainment and for the centerline trajectory of the release.	G60

<u>Jet Fire</u>	Fire type resulting from fires from pressurized release of gas and/or liquid.	G6
<u>Jet Fire</u>	A fire type resulting from the discharge of liquid, vapor, or gas into free space from an orifice, the momentum of which induces the surrounding atmosphere to mix with the discharged material. (CCPS, 1999 and CCPS, 1994)	G83
<u>Job Safety Analysis (JSA)</u>	A procedure that systematically identifies: (1) job steps, (2) specific hazards associated with each job step, and (3) safe job procedures associated with each step to minimize accident potential. Also called job hazard analysis	G82
<u>Judgement Data</u>	Equipment failure rate data derived from expert opinion or judgement.	G6
<u>Jump (Conditional)</u>	A jump that takes place only when the instruction that specifies it is executed and specified conditions are satisfied.	G24
<u>Jump (Unconditional)</u>	In the execution of a computer program, a departure from the implied or declared order in which instructions are being executed.	G24
<u>Kaizan</u>	A quality system using lessons learned.	G82
<u>kg</u>	Kilogram, a metric unit of weight, about 2.2 U.S. pounds. See also, "g/kg", "g", and "mg".	G17
<u>Kinetic Tree Theory (KTT)</u>	An approximation method that allows the analyst to estimate fault tree Top Event reliability characteristics through use of minimal cut sets, and failure data for the basic events in the fault tree.	G6
<u>Kinetical Data</u>	Data associated with the conversion rate of a reaction such as the activation energy, pre-exponential factor and order of reaction.	G35
<u>Kit Fox</u>	Field experiments at the Nevada Test Site involved groundlevel area source releases of CO <sub>2</sub> gas within a large array of roughness obstacles (Hanna and Steinberg 2001 and Hanna and Chang 2001).	G75
<u>Knockout Pot</u>	A vessel used to separate liquids from vapors.	G83
<u>Known Demands</u>	Where the demand is equally likely to occur at any time, the main concern is with the proportion of the total time that the system is likely to be in the failed state.	G24

<u>L</u>	Liter, a metric unit of capacity. A U.S. quart is about 9/10 of a liter.	G17
<u>Lacustrine Flood</u>	A flood resulting from an overflow of a lake or pond.	G33
<u>Ladder Diagram (Relay Ladder Diagram)</u>	One or more Networks of contacts, coils, graphically represented functions, functions, function blocks, data elements, labels, and connective elements, delimited on the left and (optionally) on the right by Power Rails.	G24
<u>Laminar Burning Velocity</u>	See Burning Velocity	G64
<u>Language, Function Block Diagram (FBD)</u>	A programming language using function block diagrams for representing the Application Program for a PES.	G24
<u>Language, Graphical</u>	A programming language based upon graphical representation.	G24
<u>Language, Instruction List (IL)</u>	A Textual programming language using Instructions for representing the Application Program for PES.	G24
<u>Language, Ladder Diagram (LD)</u>	A programming language using Ladder Diagrams for representing the Application Program for PES.	G24
<u>Language, Structured Text (ST)</u>	A Textual programming language using assignment, sub-program control, selection and instruction Statements to represent the Application Program for a PES.	G24
<u>Language, Textual</u>	A system consisting of a well-defined, usually finite, set of characters; rules for combining characters with one another to form works or other expressions; a specific assignment of meanings to some of the works or expressions.	G24
<u>Lap Joint</u>	See "Slip Flange."	G67
<u>Laplace Equation</u>	Partial differential equation applying to potential distribution for any system of conductors whose intervening space contains no free charges. Has unique solution for given boundary conditions.	G67
<u>Latent Failure</u>	Failure in a component as a result of a hidden flaw.	G56 G82
<u>Law of "conservation of energy"</u>	Second law of thermodynamics that states that energy can only change in form, but can never be "lost" or "created".	G35

<u>Law of the wall</u>	Formula describing the profile of mean velocity close to the surface, given by a mathematically derived (using a classical asymptote matching approach) and experimentally confirmed relation. This has two forms depending upon whether the surface is aerodynamically (or hydraulically if you are a civil engineer) smooth or rough.	G75
<u>Layer of Protection Analysis (LOPA)</u>	A process (method, system) of evaluating the effectiveness of independent protection layer(s) in reducing the likelihood or severity of an undesirable event.	G82
<u>Layers</u>	See "Safety Layer".	G24
<u>Layout</u>	The relative location of equipment or buildings within a given site. (CCPS, 1996, no. 22)	G83
<u>LC</u>	Lethal Concentration: A concentration of a substance being tested which will kill a test animal.	G17
<u>LC<sub>50</sub></u>	Lethal Concentration 50: The concentration of a material in air which, on the basis of laboratory tests, is expected to kill 50% of a group of test animals when administered as a single exposure (usually 1 or 4 hours). The LC <sub>50</sub> is expressed as parts of material per million parts of air, by volume (ppm) for gases and vapors, or as micrograms of material per liter of air ( $\mu\text{g/L}$ ) or milligrams of material per cubic meter of air ( $\text{mg/m}^3$ ) for dusts and mists, as well as for gases and vapors.  <b>Importance:</b> Both are measures of the toxicity of a substance.	G17
<u>LD</u>	Lethal Dose: A concentration of a substance being tested which will kill a test animal.	G17
<u>LD<sub>50</sub></u>	Lethal Dose 50: A single dose of a material which on the basis of laboratory tests is expected to kill 50% of a group of test animals. The LD <sub>50</sub> dose is usually expressed as milligrams or grams of material per kilogram of animal body weight ( $\text{mg/kg}$ or $\text{g/kg}$ ).  <b>Importance:</b> Both are measures of the toxicity of a substance.	G17

<u>LEL or LFL</u>	Lower Explosive Limit or Lower Flammable Limit of a vapor or gas; the lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. See also, "UEL".	G17
	<b>Importance:</b> At concentrations lower than the LEL/LFL, the mixture is too "lean" to burn.	
<u>Lessons Learned</u>	Applying knowledge gained from past incidents in current practices.	G82
<u>Lethal Service</u>	Service utilizing poisonous gases or liquids of such a nature that a very small amount of the gas or the vapor of the liquid, mixed or unmixed with air, is dangerous to life when inhaled...this class includes substances of this nature that are stored under pressure, or may generate a pressure if stored in a closed vessel (ASME Boiler and Pressure Vessel Code, Section VIII, Div. I).	G3
<u>Level of Concern</u>	The concentration of an airborne chemical above which there may be adverse human health effects experience as a result of a short-term exposure during an episodic release.	G6
<u>LFG (Liquefied Flammable Gas)</u>	Any flammable gaseous material or mixture of materials that is in liquid form under pressure.	G83
<u>Light cloud</u>	A cloud with density less than that of the ambient air. Synonymous with buoyant cloud.	G75
<u>Lightning-like Discharge</u>	Hypothetical discharge in large volumes containing clouds of charged, suspended material (such as silos being loaded with powder and supertanker tanks being water washed). Is observed in nature during dust storms, tornadoes and volcanic eruptions. Owing to limited size and/or charge density in practical containers, such discharges are highly improbable and have not been reported.	G67

<u>Likelihood</u>	A measure of the expected frequency with which an event occurs. This may be expressed as a frequency (e.g., events per year), a probability of occurrence during a time interval (e.g., annual probability), or a conditional probability (e.g., probability of occurrence, given that a precursor event has occurred).	G3
<u>Likelihood</u>	A measure of the expected probability or frequency of an event's occurrence.	G71
<u>Likelihood</u>	A measure of the expected probability or frequency of occurrence of an event. This may be expressed as a frequency, a probability of occurrence during some time interval or a conditional probability. (CCPS, 2000)	G83
<u>Likelihood</u>	An estimate of the expected frequency or probability of the occurrence of an event.(4)	G82
<u>Limited impact incidents</u>	Incidents deemed to be controllable with local resources and which have no lasting effects.	G82
<u>Limiting Oxidant Concentration (LOC):</u>	The limiting oxidant concentration (LOC) is that concentration of oxidant, below which a deflagration (flame propagation in the gas, mist, suspended dust, or hybrid mixture) cannot occur. For most hydrocarbons where oxygen is the oxidant and nitrogen is the diluent the LOC is approximately 9 to 11 vol% oxygen. The LOC for dusts is dependent on the composition and particle size distribution of the solid. Values of LOC for most organic chemical dusts lie in the range of 10 to 16 vol% oxygen, again where nitrogen is the diluent.	G62
<u>Limiting Oxidant (Oxygen) Concentration (LOC)</u>	The lowest molar (or volume) gas-phase concentration of oxidant (usually oxygen) at which a specified fuel can propagate a flame.	G67
<u>Liquid Seal</u>	A device for preventing the passage of flame by passing the gas mixture through a suitable liquid. See Hydraulic Flame Arrester.	G64
<u>LNG (Liquefied Natural Gas)</u>	A fluid in the liquid state composed predominantly of methane and that can contain minor quantities of ethane, propane, nitrogen, or other components normally found in natural gas. (NFPA 59A)	G83

<u>Local Exhaust</u>	A system for capturing and exhausting contaminants from the air at the point where the contaminants are produced (welding, grinding, sanding, dispersion operations). See also, "General Exhaust".	G17
	<b>Importance:</b> Adequate ventilation is necessary to prevent adverse health effects from exposures to hazardous materials and prevent vapor accumulations that can be a fire hazard.	
<u>Local friction velocity, <math>u^*_{local}</math></u>	Friction velocity measured at a local position (height) based on the local wind shear at some height, $z$ , or the local square root of the average of $\langle u^2 \rangle_w$ .	G75
<u>Localized Incident</u>	An incident whose effect zone is limited to a plant area (e.g., pump fire, small toxic release), and does not extend into the off-site surrounding community.	G6
<u>Lockout/Tagout</u>	A safe work practice in which energy sources are positively blocked away from a segment of a process with a locking mechanism and visibly tagged as such to help ensure worker safety during maintenance and some operations tasks.	G82
<u>Logic Control System</u>	A control system in which definite output signal states are functions of the states of the Input signals in keeping with the rules of Boolean algebra.	G24
<u>Logic Gate</u>	A logical relationship between input (lower) events and the single output (higher) event. These logical relationships are normally represented as AND or OR gates. AND gates combine input events, all of which must occur simultaneously for the output to occur. OR gates combine input events, any one of which is sufficient to cause the output. Other gate types which are variants of these are occasionally used.	G24
<u>Logic System</u>	A group of interconnected logic elements that act in combination to perform a relatively complex logic function. Programming-recording system constructed of solid-state modules based on a series of binary logic (go/no go) components.	G24
	A pneumatic or electronic system composed of relays, solid-state electronic logic modules, fluidic logic elements, PLCs or DCSs which solves complex problems of interlocking or sequencing through the repeated use of simple functions that define basic concepts such as OR and AND gates.	

<u>Loop Reactors</u>	Continuous flow reactors that are characterized by the fact that part of the effluent stream is re-supplied to the reactor, either directly or mixed with a reactant supply stream.	G35
<u>Low Pressure Tank</u>	A storage tank designed to withstand an internal pressure above 0.5 psig but not more than 15 psig measured at the top of the tank.	G83
<u>Lower Flammable Limit (LFL):</u>	That concentration of a combustible material in air below which ignition will not occur. It is often, interchangeably, called Lower Explosive Limit (LEL). Mixtures below this limit are said to be "too lean."	G64
<u>Lower Flammable Limit (LFL).</u>	The lowest molar (or volume) concentration of a combustible substance in an oxidizing medium that will propagate a flame.	G67
<u>LPDM (Lagrangian Particle Dispersion Model)</u>	A model in which the individual trajectories of thousands of "particles" are tracked by the computer and the particle's motion is determined by a mean flow velocity plus a correlated turbulent velocity and a random turbulent velocity.	G75
<u>LPG (Liquefied Petroleum Gas)</u>	Any material having a vapor pressure not exceeding that allowed for commercial propane composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes. (NFPA 58)	G83
<u>LSI (Large-Scale Integration)</u>	A computer chip containing a large number of digital circuits in a small area.	G24
<u>Lycopodium</u>	Any of about 200 varieties of club moss. The commonest is the staghorn moss <i>Lycopodium clavatum</i> from which a resinous, reticulate-shaped pollen is obtained. This is commercially available and is characterized by a relatively spherical, uniformly sized particle (surface average diameter 29 mm, typically with 80 wt% contained within 25–35 mm) suitable for calibration purposes. When tested by noninductive sparks in various dust ignition energy apparatus under the auspices of ASTM, its minimum ignition energy has been found to be about 20 mJ. This is believed to correspond to, or exceed, the maximum effective energy of bulking brush discharges.	G67
<u>m<sup>3</sup></u>	Cubic meter; a metric measure of volume, about 35.3 cubic feet or 1.3 cubic yards.	G17
<u>Mach Number, <i>M</i><sub>w</sub></u>	The ratio of the speed of a flame or blast wave to the speed of sound at ambient temperature and pressure.	G60

<u>Macro-Assembler</u>	An assembler that brings high-level language features to assembly language programming. It translates a single multi-argument source line of code into a sequence of machine instructions.	G24
<u>Main Processing Unit (MPU)</u>	The portion of the PES which interprets or executes the (main part of the) Application Program. The MPU may include power supply, memory, and I/Os. See Appendix B of this part and also Part 2 sub-clauses 3.1 and 3.6.	G24
<u>Maintenance</u>	Probability that a system survives a fault without erroneous output.	G24
<u>Major Incident</u>	An incident whose effect zone, while significant, is still limited to site boundaries (e.g., major fire, spill).	G1+ G6
<u>Management of change</u>	A system to identify, review and approve all modifications to equipment, procedures, raw materials and processing conditions, other than "replacement in kind," prior to implementation.	G68
<u>Man Machine System</u>	A system in which the functions of the worker and the machine are interrelated and necessary for the operation of the system.	G24
<u>Man-Machine Interface (MMI)</u>	A manufacturer's Catalogued Peripheral equipped with push buttons, lamps, keyboards, displays, or equivalent, intended as operator interface, such as AXIS or LOOP control/monitor panel, general purpose operator interface etc. MMIs may be part of the Permanent installation (e.g., mounted on front panels, doors, boards) or not.	G24
<u>Management of Change</u>	A system to identify, review and approve all modifications to equipment, procedures, raw materials and processing conditions, other than "replacement in kind," prior to implementation.	G71
<u>Management of Change</u>	A mechanism to require safety analysis of a proposed change.	G82
<u>Management System</u>	An administrative system that governs essential business activities.	G82
<u>Master/Slave</u>	Device setting action (in control)/device carrying out action.  A mode of operation where one data station (the master) controls the network access of one or more data stations (the slaves).	G24

<u>Master/Slave Mode</u>	The feature ensuring the protection of each program when more than one program resides in memory.	G24
<u>Master/Slave System</u>	A system of interlinked computers under the control of one computer (master computer).	G24
<u>Material Choke</u>	A mass of bulk solids or powders in a rotary valve or screw feeder that prevents a flame from being transmitted.	G64
<u>Material Identification</u>	The name of a chemical. It may be a trade name, chemical name or any other name a chemical is known by. On a MSDS this section also includes the name, address, and emergency telephone number of the distributing chemical company.  <b>Importance:</b> Proper identification of a chemical allows an employee to get additional health hazard and safety information.	G17
<u>Maurer Discharge</u>	See "Bulking Brush Discharge."	G67
<u>Maximum Allowable Concentration (MAC)</u>	The maximum concentration in air of a toxic material that the facility and the public authorities having jurisdiction are willing to tolerate at a populated downwind location in the event of a major accident.	G3
<u>Maximum Experimental Safe Gap (MESG):</u>	The maximum gap of the joint between the two parts of the interior chamber of a test apparatus which, when the internal gas mixture is ignited and under specified conditions, prevents ignition of the internal gas mixture through a 25- mm-long joint, for all concentrations of the tested gas or vapor in air. The MESG is a property of the respective gas mixture, but can vary depending on the test apparatus.	G64
<u>Maximum Individual Risk</u>	The individual risk to the person(s) exposed to the highest risk in an exposed population.	G6
<u>Maximum Potential Quantity</u>	The maximum amount of a chemical that can be released from a process containment system. Such a system may be an isolated pressure vessel and associated piping or two or more interconnected and communicating vessels without isolation capability. This quantity is different from and often much greater than both the typical chemical inventory and design maximum inventory for a containment system.	G6
<u>Maximum Pressure After Decomposition</u>	The maximum pressure which is obtained in a closed vessel. This pressure depends on the adiabatic temperature rise and the specific gas production.	G35

<u>Mean</u>	The measure of central tendency of a distribution, often referred to as its arithmetic average.	G7
<u>Mean Time Between Failure (MTBF)</u>	For a stated period in the life of a functional unit, the mean value of the length of time between consecutive failures under stated conditions.	G24
<u>Mean Time To Failure (MTTF)</u>	$1/\lambda$ , where $\lambda$ is the instantaneous failure rate. Dimension (Time).	G24
<u>Mean Time To Repair (MTTR)</u>	The statistical average of time taken to identify and repair a fault. Normally expressed as $t_r$ . Dimension (Time).	G24
<u>Mechanical integrity</u>	An element of process safety focused on ensuring that equipment is designed, installed, and maintained to perform the desired function.	G68
<u>Mechanical turbulence</u>	Turbulence caused by the wind speed variations and the surface roughness elements, and can be thought of as simple mechanical mixing or stirring of the air.	G75
<u>Median</u>	Midpoint of the failure data distribution.	G7
<u>Median Lethal Concentration/Dose</u>	Concentration or dose levels, respectively, that kill 50% of exposed laboratory animals in controlled experiments.	G6
<u>Medical Treatment</u>	As defined by OSHA, treatment (other than first aid) administered by a physician or by registered professional personnel under the standing orders of a physician.	G56 G82
<u>Melting Point</u>	The temperature at which a solid substance changes to a liquid state. For mixtures, the melting range may be given.  <b>Importance:</b> The physical state of a substance is critical in assessing its hazard potential, route of exposure and method of control.	G17
<u>Memory</u>	That portion of the programmable controller used for storage of data and program information.	G24
<u>Memory Utilization</u>	The amount of memory required for a specified part of a program.	G24

<u>Mesoscale</u>	The distance scales ranging from about 1 to 100 km.	G75
<u>Mesoscale puff models</u>	Used for estimating transport and dispersion at distances ranging from a few kilometers to 100 km, intermediatescale. The pollutant release is modeled as a series of puffs, which are allowed to have curved trajectories to account for space and time variations in meteorology.	G75
<u>Methodology</u>	The use of a combination of two or more incident investigation tools to analyze the evidence and determine the root causes of the incident.	G82
<u>mg</u>	Milligram; a metric unit of weight. There are 1,000 milligrams in 1 gram (g) of a substance.	G17
<u>mg/kg</u>	Milligrams per kilogram; an expression of toxicological dose. See also, "g/kg".  <b>Importance:</b> A measure of the toxicity of a substance.	G17
<u>mg/m<sup>3</sup></u>	Milligrams per cubic meter; a unit of measuring concentrations of dusts, gases, or mists in air.  <b>Importance:</b> The effects of overexposure depend on the concentration or dose of a hazardous substance.	G17
<u>Microcalorimetry</u>	Isothermal techniques of high sensitivity in which heat fluxes from the converting sample material are measured very accurately. Differential Microcalorimetry is performed if the heat fluxes from the sample are compared with those of a reference material.	G35
<u>Microprocessor</u>	The control and processing portion of a computer or microcomputer, that can be built with large scale integration (LSI) circuitry usually on one chip.  A large scale integrated circuit that has all the function of a computer, except memory and input/output systems. The IC thus includes the instruction set, ALU, registers and control functions.  Usually a monolithic, Large-Scale Integrated (LSI) Central Processing Unit (CPU) on a single chip or semiconductor material; memory, input/output circuits, power supply, etc. are needed to turn a microprocessor into a microcomputer.	G24
<u>Mil</u>	One thousandth part of one inch, equal to 25.4 mm.	G67

<u>Minimal Cut Set</u>	The smallest combination of component and human failures which, if they all occur, will cause the top event to occur. The failures all correspond to Basic or Undeveloped Events.	G24
<u>Minimal Cut Set Approach</u>	A term used in Fault Tree Analysis to describe the smallest combination of component and human failures which, if they all occur, will cause the top event to occur. The failures all correspond to Basic or Undeveloped Events.	G6
<u>Minimum Explosible Concentration (MEC):</u>	The lowest concentration of combustible dust necessary to produce an explosion.	G62
<u>Minimum Explosible Concentration (MEC)</u>	The lowest concentration of a combustible dust in air, expressed in grams per cubic meter, that will propagate a flame. <b>268 GLOSSARY</b>	G67
<u>Minimum Flammable Mass</u>	The lowest mass of fuel in the flammable range that will cause a defined level of damage.	G60
<u>Minimum Igniting Current (MIC) Ratio</u>	The ratio of the minimum current required from an inductive spark discharge to ignite the most easily ignitable mixture of a gas or vapor, divided by the minimum current required from an inductive spark discharge to ignite methane under the same test conditions.	G64
<u>Minimum Ignition Energy</u>	The lowest energy of an electrical spark discharge that will ignite a flammable mixture of fuel and air under defined test conditions.	G60
<u>Minimum Ignition Energy (MIE)</u>	Initiation of flame propagation in a combustible mixture requires an ignition source of adequate energy and duration to overcome heat losses to the cooler surrounding material. Dust and vapor clouds may be readily ignited if exposed to electric discharges that exceed the minimum ignition energy (MIE) for the combustible mixture.	G62
<u>Minimum Ignition Energy (MIE)</u>	The minimum amount of energy released at a point in a combustible mixture that caused flame propagation away from the point, under specified test conditions. The lowest value of the minimum ignition energy is found at a certain optimum mixture. The lowest value is usually quoted as the minimum ignition energy.	G64
<u>Minimum ignition Energy (MIE)</u>	Electrical energy discharged from a capacitor, which is just sufficient to effect ignition of the most ignitable mixture of a given fuel-mixture under specific test conditions. ASTM E 1445	G81

<u>Minimum Ignition Voltage</u>	Voltage across capacitor of specified capacitance which upon discharge is just sufficient to effect ignition of the most easily ignitable composition of a given fuel–oxidant mixture	G67
<u>Minor incidents</u>	Infrequent occurrence of these accidents or near misses have acceptable consequences but recurring events of this magnitude may warrant an investigation.	G82
<u>Mist</u>	A dispersion of fine liquid droplets in a gaseous medium.	G64 G67
<u>Mitigation</u>	Reducing the risk of an accident event sequence by taking protective measures to reduce the likelihood of occurrence of the event, and/or reduce the magnitude of the event and/or minimize the exposure of people or property to the event.	G62
<u>Mitigation</u>	Lessening the risk of an accident event sequence by acting on the source in a preventive way by reducing the likelihood of occurrence of the event, or in a protective way by reducing the magnitude of the event and/or the exposure of local persons or property.	G64
<u>Mitigation</u>	An act that causes a consequence to be less hazardous (CCPS, 2001)	G83
<u>Mitigation</u>	The act of causing a consequence to be less severe.	G82
<u>Mitigation Event</u>	Equipment and/or procedures designed to respond to an accident event sequence by hindering accident propagation and/or reducing the accident consequences.	G4
<u>Mitigation Factors</u>	Systems or procedures, such as water sprays, foam systems, and sheltering and evacuation, which tend to reduce the magnitude of potential effects due to a release. (CCPS, 1999)	G83
<u>Mitigation System</u>	Equipment and/or procedures designed to respond to an accident event sequence by interfering with accident propagation and/or reducing the accident consequences.	G1 G24
<u>Mixing depth, zi</u>	Maximum elevation of mixing in a typical daytime boundary layer.	G75

<u>mL</u>	Milliliter; a metric unit of capacity, equal in volume to 1 cubic centimeter (cc), or about 1/16 of a cubic inch. There are 1,000 milliliters in 1 liter (L).	G17
<u>mm Hg</u>	Millimeters (mm) of Mercury (Hg); a unit of measurement for low pressures or partial vacuums.	G17
	<b>Importance:</b> Vapor pressures are expressed in mm Hg.	
<u>MMI (Man Machine Interface)</u>	The means by which human interaction with the control system is accomplished.	G24
<u>Momentum Flux</u>	Mathematically, $\rho u^2$ (in Newtons/m <sup>2</sup> ), the product of the cloud density and speed squared.	G60
<u>Momentum Force</u>	Mathematically, $\rho u^2 A$ (in Newtons), the product of the cloud density, speed squared, and cross-sectional area.	G60
<u>Monin–Obukhov length, <math>L</math></u>	Accounts for the effects of stability and is proportional to $u^{*3}$ divided by the surface turbulent heat flux, $H_s$ , to or from the ground surface: $L = \frac{u^{*3}}{g H_s / (\rho c_p T)}$ where $g = 9.8 \text{ m/s}^2$ is the acceleration of gravity, $c_p = 1005 \text{ J/kg-K}$ is the specific heat of air at constant pressure, and $T$ is the air temperature (in K). The friction velocity, $u^*$ , in this formula is based on the surface stress, $\tau_0$ . $H_s$ (in Watts/m <sup>2</sup> ) is positive during the day and negative at night.	G75
<u>Monin–Obukhov similarity theory</u>	Used in many boundary layer and transport and dispersion models to estimate winds, temperatures, and turbulence in the atmospheric boundary layer. This theory states that the mean wind and temperature profiles and turbulent velocities in the boundary layer are completely determined by three scaling lengths ( $z_0$ , $d$ , and $L$ ) and a scaling velocity ( $u^*$ ).	G75
<u>Monomer</u>	A simple molecule that is capable of combining with a number of other molecules to form a polymer. NFPA 49	G81
<u>Mortality Index</u>	An index based on the observed average ratio of casualties to the mass of material or energy released, as derived from the historical record. It is used to characterize the potential hazard of toxic material storage.	G6
<u>Morphological Approach</u>	A structured analysis of an incident directed by insights from historic case studies but not as rigorous as a formal hazard analysis.	G56 G82

<u>Multiplexer</u>	<p>A device for accomplishing simultaneous transmission of two or more signals over a common transmission medium.</p> <p>A device or circuit that samples many data lines in a time-ordered sequence, one at a time, and puts all sampled data onto a single bus.</p> <p>A device which combines two or more separate signals for transmission through a single fiber. Optical multiplexers combine signals at different wavelengths. Electronic multiplexers combine signals electronically before they are converted into optical form.</p> <p>A device that allows selection of one of many input channels of analog data under computer control.</p>	G24
<u>Mutagen</u>	<p>A substance or agent capable of altering the genetic material in a living cell.</p> <p><b>Importance:</b> If a substance is known to be a mutagen, a potential health hazard exists, and special protection and precaution sections should be checked on the MSDS.</p>	G17
<u>NAAQS</u>	<p>National Ambient Air Quality Standards</p> <p><b>Glossary 197</b></p>	G75
<u>Near-field</u>	<p>The area within a few hundred meters downwind of the source where there is possible influence of local structures, source geometry, and initial plume momentum and buoyancy effects.</p>	G75
<u>Near-Miss</u>	<p>An extraordinary event that could have reasonably, but actually did not, resulted in a negative consequence (accident or incident) under slightly different circumstances.</p>	G56
<u>Near-Miss</u>	<p>An unplanned sequence of events that could have caused harm or loss if conditions were different or were allowed to progress, but actually did not. CCPS 1989</p>	G81
<u>Near Miss</u>	<p>An event in which an accident (that is, property damage, environmental impact, or human loss) or an operational interruption could have plausibly resulted if circumstances had been slightly different. <b>Glossary 437</b></p>	G82

<u>Negatively Buoyant Vapors</u>	Vapors or aerosol with a specific gravity greater than ambient air so the vapors tend to sink to low spots and to spread along the ground by “gravity spreading.”	G60
<u>Net Positive Suction Head (NPSH):</u>	The net static liquid head that must be provided on the suction side of the pump to prevent cavitation.	G62
<u>Network</u>	A maximal interconnected group of graphical Elements of a Ladder Diagram Program, excluding the left and right Power Rails.	G24
<u>Neutral Buoyant Gas</u>	A gas with density approximately equal to that of air at ambient temperature.	G6
<u>Neutral cloud</u>	The in-cloud density is equal to the ambient density. Neutral cloud and passive cloud are synonymous.	G75
<u>Neutral stability</u>	The ambient boundary layer is well-mixed, with Pasquill stability class D, $Ri = 0$ , and $1/L = 0$ . Usually occurs with high winds and/or small surface heat fluxes.	G75
<u>NFPA</u>	Acronym for National Fire Protection Association.	G24
<u>NIOSH</u>	National Institute for Occupational Safety and Health of the Public Health Service, U.S. Department of Health and Human Services (DHHS).  <b>Importance:</b> Federal agency which - among other activities - tests and certifies respiratory protective devices, recommends occupational exposure limits for various substances and assists in occupational safety and health investigations and research.	G17
<u>Node</u>	Sections of equipment with definite boundaries (e.g., a line between two vessels) within which process parameters are investigated for deviations. The locations on P&IDs at which the process parameters are investigated for deviations (e.g., a reactor). The concept of dividing a process into nodes for analysis is commonly, but not exclusively, used in HAZOPs.	G71
<u>Nonconductive</u>	Possessing a conductivity less than 102 pS/m or a resistivity greater than 1010 W-m.	G67
<u>Nonflammable Gas (NFPA 55)</u>	A gas that does not meet the definition of a flammable gas.	G33
<u>Non-Process</u>	Industries which do not comprise the CPI as their primary function but which use comparable or equivalent complex equipment systems to perform their function.	G7

<u>NO<sub>x</sub></u>	Oxides of Nitrogen; undesirable air pollutants.	G17
	<b>Importance:</b> Often listed on a MSDS as a hazardous decomposition product.	
<u>Normal operations</u>	Any process operations intended to be performed between startup and shutdown to support continued operation within safe upper and lower operating limits.	G68
<u>Nose of Vapor Cloud</u>	The front surface of vapor cloud, that is, the surface farthest along in the along-wind direction. All surfaces of a vapor cloud are usually defined by a certain concentration such as the LFL.	G60
<u>NRC</u>	Nuclear Regulatory Commission	G75
<u>Obsolete</u>	Refers to PES equipment status. A PES becomes obsolete if the plant determines it shall be replaced or if the producer ceases support of the PES.	G24
<u>Occupational Incident</u>	An incident involving injury to workers.	G82
<u>Off-site exposure</u>	People, property, or the environment located outside of the site property line that may be impacted by an on-site incident.	G83
<u>Ohm (W)</u>	See "Resistance."	G67
<u>Ohm's Law</u>	The Current Density (Amperes per square meter) divided by Electric Field Intensity (volts per meter) is a constant known as Conductivity (Siemens per meter). For small conductors such as wires, the voltage between two points (volts) divided by the current (Amperes) is a constant known as Resistance (Ohm).	G67
<u>Olfactory</u>	Relating to the sense of smell.	G17
	<b>Importance:</b> The olfactory organ in the nasal cavity is the sensing element that detects odors and transmits information to the brain through the olfactory nerves. This sense of smell is a "built in" vapor detector.	
<u>On-Line</u>	A PES is said to be On-Line when it is in active control of a machine or process.	G24
<u>On-stream factor</u>	The fraction of the time that a process unit is operating	G83

<u>Onset temperature</u>	Defined to be the temperature at which the heat that is released by a reaction, can no longer be completely removed from the reaction vessel, and consequently, results in a detectable temperature increase. The onset temperature depends on detection sensitivity, reaction kinetics, on vessel size and on cooling, flow and agitation characteristics. Scaling of onset temperatures and application of "rules of thumb" concerning onset temperatures must be regarded as highly unreliable.	G35
<u>Onset temperature</u>	The temperature at which a deflection from the established baseline is first observed. ASTM E 1445	G81
<u>Open Loop Control</u>	A method of control by which signals are transmitted by one or more forward paths, exclusive of any monitoring feedback.	G24
<u>Operating Instructions</u>	A series of sequential written details describing how to operate equipment.	G3
<u>Operating Mode</u>	The method of operating equipment. See alternating mode, standby mode, running mode.	G7
<u>Operating Pressure</u>	The maximum pressure at which a flame arrester can be used according to its certification.	G64
<u>Operating Procedures</u>	All written information necessary to operate equipment, compiled in one document including operating instructions, process descriptions, operating limits, chemical hazards, and safety equipment requirements.	G3
<u>Operating Procedures</u>	Written, step-by-step instructions and associated information (cautions, notes, warnings) for safely performing a task within operating limits.	G68
<u>Operating System</u>	Manufacturer's provided functions intended to management of Internal PES interdependent functions.	G24
<u>Operating Time</u>	The amount of time an equipment is in its operating mode.	G7
<u>Operation</u>	A defined action, namely the act of obtaining a result from one or more operands in accordance with a rule that completely specifies the result for any permissible combination of operands. See instructions.	G24

<u>Operational Interruption</u>	is an event in which production rates or product quality is seriously impacted.	G82
<u>Operational reliability</u>	Also known as equipment reliability. The probability that, when operating under stated design conditions, process equipment will perform its intended function adequately for a specified exposure period.	G68
<u>Operator</u>	An individual responsible for monitoring, controlling, and performing tasks as necessary to accomplish the productive activities of a system. Often used in a generic sense to include people who perform all kinds of tasks (e.g., reading, calibration, maintenance).	G1+
<u>Optimum Mixture</u>	A specific mixture of fuel and oxidant that yields the most rapid combustion at a specific measured quantity or that yields the lowest value of the minimum ignition energy or that produces the maximum deflagration pressure. The optimum mixture is not always the same for each combustion property that is measured.	G64
<u>Oral</u>	Used in or taken into the body through the mouth.  <b>Importance:</b> A route of exposure to a hazardous material.	G17
<u>Oral Toxicity</u>	Adverse effects resulting from taking a substance into the body via the mouth.  <b>Importance:</b> Ordinarily used to denote effects in experimental animals.	G17

A term used to describe a commodity not having special properties or hazards and is categorized by its relative fire hazard. Ordinary commodities can be further classified as follows:

- Noncombustible (NFPA 13)—A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials that are reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, shall be considered noncombustible materials.
- Class I (NFPA 231/231C)—Class I commodity is defined as essentially noncombustible products on wood pallets, in ordinary corrugated cartons with or without single-thickness dividers, or in ordinary paper wrappings, all on wood pallets. Such products are permitted to have a negligible amount of plastic trim, such as knobs or handles.
- Class II (NFPA 231/231C)—Class II commodity is defined as Class I products in slatted wooden crates, solid wooden boxes, multi-wall corrugated cartons, or equivalent combustible packaging material on wood pallets.
- Class III (NFPA 231/231C)—Class III commodity is defined as wood, paper, natural fiber cloth, or Group C plastics or products thereof; on wood pallets. Products are permitted to contain a limited amount of Group A or B plastics. Wood dressers with plastic drawer glides, handles, and trim are examples of a commodity with a limited amount of plastic.
- Class IV (NFPA 231/231C)—Class IV commodity is defined as Class I, II, or III products containing an appreciable amount of Group A plastics in a paperboard carton or Class I, II, or III products with Group A plastic packing in paperboard cartons on wood pallets. Group B plastics and free-flowing Group A plastics are also included in this class.

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Examples of Class IV products are: small appliances, typewriters, and cameras with plastic parts; plastic-backed tapes and synthetic fabrics or clothing. An example of packing material is a metal product in a foamed plastic cocoon in a corrugated carton.

- Classification of Plastics, Elastomers, and Rubber (NFPA 231C)

NOTE: The following categories are based on unmodified plastic materials. The use of fire or flame-retarding modifiers or the physical form of the material may change the classification.

**Group A**

- ? ABS (acrylonitrile–butadiene–styrene copolymer)
- ? Acetal (polyformaldehyde)
- ? Acrylic (polymethyl methacrylate)
- ? Butyl rubber
- ? EPDM (ethylene–propylene rubber)
- ? FRP (fiberglass reinforced polyester)

<u>Organic Peroxide (NFPA 43B)</u>	Any organic compound having a double oxygen or “peroxy” (–O–O–) group in its chemical structure.	G33
<u>Organic peroxide</u>	An organic compound that contains the bivalent –O–O– structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical. OSHA 1994	G81
<u>Organic Peroxide Formulation (NFPA 43B)</u>	A pure organic peroxide or a mixture of one or more organic peroxides with one or more other materials in various combinations and concentrations. Organic Peroxide Formulations can be further classified as follows: <ul style="list-style-type: none"> <li>• Class I—Those formulations that are capable of deflagration but not detonation.</li> <li>• Class II—Those formulations that burn very rapidly and that present a severe reactivity hazard.</li> <li>• Class III—Those formulations that burn very rapidly and that present a moderate reactivity hazard.</li> <li>• Class IV—Those formulations that burn in the same manner as ordinary combustibles and that present a minimal reactivity hazard.</li> <li>• Class V—Those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that present no reactivity hazard.</li> </ul>	G33
<u>Organizational Error</u>	A latent management system problem that can result in human error.	G82
<u>OSBL</u>	Outside of battery limits	G83
<u>OSHA</u>	Occupational Safety and Health Administration of the U.S. Department of Labor.  <b>Importance:</b> Federal agency with safety and health regulatory and enforcement authorities for most U.S. industry and business.	G17
<u>OSHA Recordable Cases</u>	Work-related deaths, injuries and illnesses other than minor injuries requiring only first aid treatment and which involve medical treatment, loss of consciousness, restriction of work or motion, or transfer to another job.	G56 G82
<u>OSHA Reportable Event</u>	An incident that causes any fatality or the hospitalization of five employees or more requires a notification report to the nearest OSHA office.	G56 G82

<u>Output</u>	<p>The current, voltage, power or driving force delivered by a circuit or Device. Also call Output Value.</p> <p>The terminals or other places where current, voltage, power or driving force may be delivered by a circuit of Device, also called Output Terminals.</p> <p>Data which can be written the Application Program to an Interface between the user program execution function and another functional unit of the PES, also called Program Output.</p>	G24
<u>Output Device</u>	<p>Converts a computer level signal into an industrial level signal.</p> <p>A device that acts to change a physical condition as a result of a (logic) decision (i.e., fuel shutoff valve, steam turbine governor valves, etc.).</p> <p>In computers, a unit which delivers information from the computer to an external device or from internal storage to external storage.</p> <p>The part of a machine which translates the electrical impulses representing data processed by the machine into permanent results such as printed forms, punched cards, magnetic writing on tape or, into control signals for a process.</p> <p>Used to turn real-world devices on and off. Typical output devices are pilot lights, solenoid valves, and motor starters, actuated either electrically or pneumatically.</p>	G24
<u>Outsourced Manufacturing</u>	<p>Providing manufacturing services for a fee by a contractor, to a company issuing a contract for those services. Services can include reaction processes, formulation, blending, mixing or size reduction, separation, agglomeration, packaging/repackaging, and others or combination of the above. (See Tolling.)</p>	G68
<u>Over-Adiabatic mode</u>	<p>A quasi-adiabatic mode in which the (small) energy leaks to the environment are overcompensated by input of supplementary energy.</p>	G35
<u>Overpressure</u>	<p>The pressure increase above normal operating pressure that is caused by the flame.</p>	G64
<u>Overpressure , DP</u>	<p>The increase of pressure above ambient in an explosion wave.</p>	G60

<u>Overdriven Detonation</u>	The unstable condition that exists during a deflagration-to-detonation transition (DDT) before a state of stable detonation is reached. Transition occurs over the length of a few pipe diameters and propagation velocities of up to 2000 m/s have been measured for hydrocarbons in air. This is greater than the speed of sound as measured at the flame front. Overdriven detonations are typically accompanied by side-on pressure ratios (at the pipe wall) in the range 50–100. A severe test for detonation flame arresters is to adjust the run-up distance so the DDT occurs at the flame arrester, subjecting the device to the overdriven detonation impulse.	G64
<u>Override</u>	A control action which overrides the normal control action to prevent exceeding a process limit. Overrides normally are part of the POCS rather than the ESD.  To manually or otherwise deliberately overrule an automatic control system or circuit and thereby render it ineffective.  To cancel the influence of an automatic control by means of a manual control.	G24
<u>Override Control</u>	Generally, two control loops connected to a common final control element; one control loop being normally in control, with the second being switched in by some logic element when an abnormal condition occurs so that constant control is maintained. A technique in which more than one controller manipulates a final control element. The technique is used when constraint control is important.	G24
<u>Overriding Process Control</u>	Process control in which any one of several controllers associated with one control valve can be made to override another in accordance with a priority requirement of the process.	G24
<u>Overt Fault</u>	Fault that can be classified as announced, detected, revealed, etc	G62
<u>Overvoltage Category</u>	Per 64 (CO) 168, Revision of IEC 664.	G24
<u>Oxidant</u>	Any gaseous material that can react with a fuel (either gas, dust, or mist) to produce combustion. Oxygen in air is the most common oxidant.	G64
<u>Oxidant Concentration Reduction</u>	The technique of maintaining the concentration of the oxidant in a closed space below the concentration required for combustion to occur.	G64

<u>Oxidation</u>	Depending on the context, oxidation can either refer to (a) a reaction in which oxygen combines chemically with another substance or (b) any reaction in which electrons are transferred. For the latter definition, <i>oxidation</i> and <i>reduction</i> always occur simultaneously (redox reactions), and the substance that gains electrons is termed the <i>oxidizing agent</i> . Electrons might also be displaced within a molecule without being completely transferred away from it. CCPS 1995b	G81
<u>Oxidizer</u>	Any material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials. More generally, an oxidizer is any oxidizing agent. NFPA 430 2000	G81
<u>Oxidizing Agent, Oxidizer</u>	A chemical or substance which brings about an oxidation reaction. The agent may (1) provide the oxygen to the substance being oxidized (in which case the agent has to be oxygen, or contain oxygen), or (2) it may receive electrons being transferred from the substance undergoing oxidation. DOT defines an oxidizer or oxidizing material as a substance which yields oxygen readily to stimulate combustion (oxidation) or organic matter.  <b>Importance:</b> If a substance is listed as an oxidizer on the MSDS, precautions must be taken in the handling and storage of the substance. Keep away from flammables and combustibles.	G17
<u>Oxidizing Gas (NFPA 55)</u>	A gas that can support and accelerate combustion of other materials.	G33

<u>Oxidizer (NFPA 430)</u>	<p>Any material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials. Examples of other oxidizing gases include Bromine, Chlorine, and Fluorine. Oxidizers can be further classified as follows:</p> <ul style="list-style-type: none"> <li>• Class 1—An oxidizer whose primary hazard is that it slightly increases the burning rate but does not cause spontaneous ignition when it comes in contact with combustible materials.</li> <li>• Class 2—An oxidizer that will cause a moderate increase in the burning rate or that causes spontaneous ignition of combustible materials with which it comes in contact.</li> <li>• Class 3—An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes in contact or</li> </ul> <p><b>166 . Glossary of Terms</b></p> <p>that will undergo vigorous self-sustained decomposition due to contamination or exposure to heat.</p> <ul style="list-style-type: none"> <li>• Class 4—An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock. In addition, the oxidizer will enhance the burning rate and may cause spontaneous ignition of combustibles.</li> </ul>	G33
<u>Parameter</u>	<p>A quantity describing the relation of variables within a given system. Note: A parameter may be constant or depend on the time or the magnitude of some system variables.</p>	G24
<u>Parity</u>	<p>An error detection method in which that total number of ones in a binary work, byte, character, or message is set to an odd or even number by appending a redundancy bit. This number is subsequently checked to ensure that it remains odd or even; typically used as an error detection technique in communication and data storage.</p> <p>A code that is used to uncover data error by making the sum of the "1" bits in a data unit either an odd or even number.</p> <p>The concept of parity is a check on the accuracy of data. "Even parity" is defined to mean that the number of binary 1's in a digital work is an even number, "odd parity" means that the number of 1's is an odd number. Memory boards, for example, have circuitry that maintains either one parity or the other during a write; if that same parity is not present when the data is read, an error is signaled.</p>	G24

<u>Parity Bit</u>	<p>A binary digit appended to an array of bits to make the sum of all the bits always odd (odd parity) or always even.</p> <p>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 transmissions.</p> <p>A bit added to a digital word before processing, to control parity, and used later as one check of the accuracy of the processed data.</p>	G24
<u>Partial oxidation</u>	<p>The combination of oxygen with a material in an oxygen-deficient atmosphere that generally results in carbon monoxide being one of the combustion products.</p> <p>CCPS 1995b</p>	G81
<u>Partial Volume Deflagration (PVD)</u>	<p>A deflagration explosion developed from a flammable cloud of gas, aerosol, or dust that occupies only part of the volume in a confined space.</p>	G60
<u>Passive Dispersion</u>	<p>Dispersion caused by the normal turbulence in the atmosphere.</p> <p>See Gaussian model.</p>	G60
<u>Passive Equipment</u>	<p>Refers to hardware which is not physically actuated in order to perform its function, e.g., piping, valve bodies, pump bodies, and storage tanks.</p>	G7
<u>Passive Gas</u>	<p>A gas whose density is equal to that of the ambient air.</p> <p>Synonymous with neutral.</p>	G75
<u>Passive System</u>	<p>A system in which failures are only revealed by testing or when a demand has occurred.</p>	G24
<u>Peer Review</u>	<p>A series of informal reviews by, and at the discretion of, individual members of the matrix team; as well as more formal reviews (P&amp;ID hazard reviews) held by the entire project matrix or hazard review team in accordance with corporate standards.</p>	G24
<u>PEL</u>	<p>Permissible Exposure Limit; an exposure established by OSHA regulatory authority. May be a Time Weighted Average (TWA) limit or a maximum concentration exposure limit. See also, "Skin".</p> <p><b>Importance:</b> If a PEL is exceeded, a potential health hazard exists, and corrective action is necessary.</p>	G17

<u>Performance Shaping Factor</u>	Any factor that influences human performance. It may be external (heat, stress, etc.) or internal to the person (religious beliefs, education, personality, skills) and factors in the work situation (task demand, plant policy, plant design, training, etc.)	G1+ G6
<u>Peripheral</u>	Catalogued Device internal or external to the Permanent PES, the function of which is to program, supervise, monitor, test, and record the operation of PES.	G24
<u>Peripheral, Permanent</u>	A peripheral which is part of the permanent installation of the PES.	G24
<u>Peripheral, Portable</u>	Peripheral specifically designed to be carried by hand.	G24
<u>Peripheral, Transportable</u>	Peripheral which is not a permanent part of the installation and which is connectable to the system by means of cables or cords with connectors, or other means to establish communication with the system.	G24
<u>Permanent Installation</u>	The portion of the PES which must be present to perform the intended application functions.	G24
<u>Permissible Exposure Limits (PELs)</u>	Similar to TLVs (see below) but developed by the Occupational Safety and Health Administration (OSHA).	G3
<u>Permissive</u>	An action required before a subsequent action can take place.	G24
<u>Permittivity (e or <math>\epsilon_0</math>).</u>	The property of a material determining its ability to store energy when placed in an electric field, equal to the product of dielectric constant and permittivity of vacuum, expressed in Farad per meter. Energy storage is related to the polarizability of molecules in the electric field. Hence polar molecules have higher dielectric constants.	G67
<u>Permittivity of Vacuum (<math>\epsilon_0</math>).</u>	A constant equal to $8.854 \times 10^{-12}$ F/m.	G67
<u>Peroxide</u>	A chemical compound that contains the peroxy ( $-O-O-$ ) group, which may be considered a derivative of hydrogen peroxide (HOOH). CCPS 1995b	G81
<u>Peroxide former</u>	A material that reacts with oxygen or hydrogen peroxide to produce a peroxide of the reactant. CCPS 1995b	G81

<u>PES (Programmable Electronic System)</u>	A system based on a computer connected to sensors and/or actuators (in) a plant for the purpose of control, protection or monitoring (includes various types of computers (including mini and micro), PLCs, peripherals, interconnect systems, personal computers, instrument distributed control system controllers (including single and multi-loop controllers), and other associated equipment.	G24
<u>PES Program</u>	Synonymous with Application Program.	G24
<u>PFD</u>	Probability of failure on demand. The probability that a system will fail to perform a specified function on demand.	G82
<u>PFR</u>	Plug Flow Reactor; A tube reactor to one end of which the reactants are continuously charged and from the other end of which the products are continuously removed. Temperature, composition and heat production change along the length of the tube. The PFR is often used for potentially hazardous reactions because of its relatively small inventory.	G35
<u>PHA</u>	Process hazards analysis	G75
<u>PHA</u>	Process hazard analysis. A hazard evaluation of broad scope that identifies and qualitatively analyzes the significance of hazardous situations associated with a process or activity.	G82
<u>Phased Mission</u>	A task to be performed by a system, during the execution of which the system is altered such that the failure logic for the system is also altered at specified times. For example unloading a tank car consists of at least three phases: (1) connecting the tank car to unloading system, (2) unloading the tank car, and (3) disconnecting the tank car from the unloading system. An unloading hose rupture during phase 1 results in a minor operational problem. A rupture of the same hose during phase 2 (unloading) may be disastrous.	G6
<u>Phi-factor</u>	A correction factor which is based on the ratio of the total heat capacity of a vessel ( $m_{ves}C_{p,ves}$ ) and the total heat capacity of the vessel contents ( $mC_p$ ). The phi-factor ( $= 1 + (m_{ves}C_{p,ves}/mC_p)$ ) approaches the value of one for large vessels, for extremely light vessels, or at genuine adiabatic conditions.	G35
<u>Physical Explosion</u>	The catastrophic rupture of a pressurized gas/vapor-filled vessel by means other than reaction, or the sudden phase-change from liquid to vapor of a superheated liquid.	G60

<u>Physical hazard</u>	A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or waterreactive. OSHA 1994	G81
<u>Physical Models</u>	Models that provide quantitative information on source rates and extent of damage (thermal radiation, explosion overpressure, or concentration of dispersing vapor clouds).	G6
<u>Pico</u>	Subdivision equal to one part in 10 <sup>12</sup> .	G67
<u>Pilot</u>	To produce a small quantity of a product as a test prior to full-scale commercial production.	G68
<u>Piperack, pipeway, pipeband</u>	A structure that supports pipes, power leads, and instrument cable trays.	G83
<u>Piping and Instrument Diagram (P&amp;ID):</u>	A diagram that shows the details about the piping, vessels, and instrumentation.	G62
<u>Plane (Through Study Cube)</u>	A plane surface through the study cube on which the value of one of the three axes of the cube is constant.	G6
<u>Plant Approved</u>	Refers to PES equipment status. The PES is approved when it has operated properly and the plant wishes to use it in low risk and selected high business risk applications (e.g., equipment or production loss, but no environmental or safety hazard). The plant reviews the PES performance, checks plant PESs against the latest producer ECO levels, and finds no changes. The equipment is elevated to plant approved. Note that the PES must be approved before it is plant approved.	G24

<u>Plant Approved Safety</u>	<p>Refers to PES equipment status. After successful operations as plant approved equipment, the plant wants to elevate the PES to "plant approved safety." This is desired so the plant may utilize its PESs in critical applications where appropriate. The plant meets with the PES producer and jointly develops the following strategy:</p> <ul style="list-style-type: none"> <li>o The producer agrees to provide a plant approved safety controller "spin off" from the plant approved PES.</li> <li>o The producer "freezes" the "spin off" PES from any changes without the mutual consent of the plant.</li> <li>o All problems with the commercial PES are jointly reviewed (e.g., producer and plant) for impact on the "spin off" PES design.</li> <li>o The producer provides all unsafe failure modes of the plant.</li> <li>o The producer quantifies each unsafe failure mode for the plant.</li> <li>o The plant develops a program to continuously qualify the PES.</li> </ul> <p>With the proper development of the above data, the PES is classified "plant approved safety."</p>	G24
<u>Plant-Specific Data</u>	Failure rate data generated from collecting information on equipment failure experience at a specific plant.	G6
<u>Plant-Specific Data</u>	Data which pertains to a unique population of equipment specific to a particular operating plant.	G7
<u>Plausibility Analysis</u>	A comparison of values for process variables that allows faults in the measurement channels of the safety system to be recognized while the process is still in its normal operating range.	G62
<u>PLC</u>	Synonymous with Programmable Controller System.	G24
<u>PLC (Programmable Logic Controller)</u>	<p>Abbreviation for programmable logic controller, microcomputer-based control device used to replace relay logic.</p> <p>A solid-state control system which receives inputs from user-supplied control devices such as switches and sensors, implements them in a precise pattern determined by instructions stored in the PLC memory, and provides outputs for control or user-supplied devices such as relays and motor starters.</p>	G24

<u>Plug, Unplug</u>	Make, break, a physical connection (e.g., use a physical connector for interfacing a Peripheral or a Module to the rest of the PES). See Connect/Disconnect for logical connection/disconnection.	G24
<u>Pluggage</u>	See Equipment, On-Line Pluggage	G24
<u>Plume</u>	A cloud of pollutants resulting from a continuous but not necessarily steady release.	G75
<u>Plume rise</u>	Rise of plume in elevation above source due to buoyancy or momentum.	G75
<u>Poison, Class A</u>	A DOT term for extremely dangerous poisons, that is, poisonous gases or liquids of such nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life. Some examples: phosgene, cyanogen, hydrocyanic acid, nitrogen peroxide.	G17
<u>Poison, Class B</u>	A DOT term for liquid, solid, paste, or semisolid substances other than Class A poisons or irritating materials-which are known (or presumed on the basis of animal tests) to be so toxic to man as to afford a hazard to health during transportation.	G17
	<b>Importance:</b> If a substance is known to be a poison, health and safety hazards exist and special protection and precaution sections should be checked on the MSDS.	

<u>Poisson's Equation</u>	A more general form of the Laplace equation in which the intervening space between conductors may contain free charges.	G67
<u>Polarization</u>	The process by which charges are moved to new locations on a conductor by the creation of an electric field acting on the conductor or the movement of the conductor into the influence of an existing electric field. Electron redistribution occurs instantly in metals because owing to their infinite dielectric constants, internal electric fields cannot exist. The term is also used to describe the response of polar molecules to an electric field.	G67
<u>Polymer</u>	Substance made of giant molecules formed by the union of simple molecules (monomers); for example, polymerization of ethylene forms a polyethylene chain, or condensation of phenol and formaldehyde (with production of water) forms phenolformaldehyde resins. Parker 1997	G81
<u>Polymerization</u>	A chemical reaction in which one or more small molecules combine to form larger molecules. A hazardous polymerization is such a reaction which takes place at a rate which releases large amount of energy.  <b>Importance:</b> If hazardous polymerization can occur with a given material, the MSDS usually will list conditions which could start the reaction and the time period before any contained the inhibitor is used up.	G17
<u>Polymerization</u>	A chemical reaction generally associated with the production of plastic substances. The individual molecules of the chemical (liquid or gas) react with each other to produce what can be described as a long chain. DOT 2000	G81
<u>Pool Fire</u>	The combustion of material evaporating from a layer of liquid at the base of the fire.	G6 G60 G62 G83
<u>Porous Media</u>	Any solid material through which gas can flow, and that affords some measure of heat extractive capability and flame quenching by cooling.	G64
<u>Positively Buoyant Gas</u>	A gas with density less that of air at ambient temperature.	G6 G60

<u>Potential (f or V).</u>	The potential (f) any point is measured by the work required to bring unit positive charge from an infinite distance. Potential difference (V) between two points is measured by the work required to carry unit positive charge from one to the other. If the work is expressed in Joules and charge in Coulombs the potential difference is expressed in Volts. In practice, potentials are expressed relative to the earth which by convention is assigned a potential of zero volts. The potential difference between two points is commonly expressed as the difference in their potentials (volts) relative to that of the earth. <i>GLOSSARY 269</i>	G67
<u>Potential Explosion Site (PES)</u>	A volume within a plant with sufficient congestion and/or confinement that a flammable vapor cloud ignited there could likely develop into an explosion.	G60
<u>Potential temperature è</u>	The temperature that a parcel of air at height z at temperature T would have if it were brought adiabatically to mean sea level. The gradient, $dè/dz$ , is defined such that it equals the vertical gradient of actual temperature, $dT/dz$ , plus 1 C/100 m. Therefore, in a neutral atmosphere, the vertical gradient of potential temperature is 0.0 C/100 m.	G75
<u>Powder</u>	Generic term for subdivided solid material, comprising pellets, granules and dust. Pellets have a diameter greater than 2 mm and typically above 3 mm, although they may contain granules and small quantities of dust. Granules (e.g., granulated sugar) have a diameter between 0.42 and 2 mm, although granular powders typically contain dust. Dusts have a diameter less than 0.42mm and as low as 1 mm. Suspended particles smaller than 1 mm are known as fumes. In European publications, pellets are typically described as “granules.”	G67
<u>Power Rail</u>	Vertical lines bounding and connected to Ladder Diagrams on the left and, optionally, on the right.	G24
<u>ppb</u>	Parts per billion; a unit for measuring the concentration of a gas or vapor in air-parts (by volume) of the gas or vapor in a billion parts of air. Usually used to express measurement of extremely low concentrations of unusually toxic gases or vapors. Also used to indicate the concentration of a particular substance in a liquid or solid.  <b>Importance:</b> The effects of overexposure depend on the concentration or dose of a hazardous substance.	G17

<u>ppm</u>	Parts per million; a unit for measuring the concentration of a gas or vapor in air-parts (by volume) of the gas or vapor in a million parts of air. Also used to indicate the concentration of a particular substance in a liquid or solid.	G17
	<b>Importance:</b> The effects of overexposure depend on the concentration or dose of a hazardous substance.	
<u>Pre-Alarm</u>	See Pre-Trip Alarm.	G24
<u>Pre-assessment questionnaire</u>	A screening tool to collect information that potential clients need to begin the selection processes.	G68
<u>Pre-Emergency</u>	See Pre-Trip Alarm.	G24
<u>Pre-Exponential Factor</u>	Constant $k^*$ in the Arrhenius equation (also called frequency factor). The pre-exponential factor is associated with the frequency of collisions between molecules (entropy) and with the probability that these collisions result in a reaction. (See also Arrhenius equation and Activation energy.)	G35
<u>Pre-Production Device</u>	A device that looks and operates like the final commercial unit. This device has the function and form agreed upon by both the supplier and the customer. It may be machined or soft-molded, and hand assembled. It may require redesign to facilitate mass-production.	G24
<u>Pre-Startup Safety Review (PSSR)</u>	A system to confirm, before the introduction of hazardous chemicals, that new or modified facilities are in accordance with design specifications; adequate procedures are in place; appropriate hazard analyses or management of change reviews have been conducted; and training of affected personnel has been completed.	G71
<u>Pre-Trip Alarm</u>	An alarm which allows an operator to take corrective action before an interlock system is tripped.	G24
<u>Pre-Volume Vessel</u>	A process vessel or piping system (length to diameter ratio of less than 5) in which a confined deflagration occurs (as defined in CEN Standard EN 12874).	G64
<u>Predicted Data</u>	Data generated by using correlations, factored estimation procedures, and analogies to predict equipment failure rates.	G6
<u>Predominant wind direction</u>	The compass direction from which the wind blows the majority of the time.	G83

<u>Pressure Piling</u>	In a compartmented system in which there are separate but interconnected volumes, the pressure developed by the deflagration in one compartment causes a pressure rise in the unburned gas in the interconnected compartment, so that the elevated pressure in the latter compartment becomes the starting pressure for a further deflagration. This effect is known as pressure piling, or cascading.	G64
<u>Pressure Relief Valve</u>	A relief valve is a spring-loaded valve actuated by static pressure upstream of the valve. The valve opens normally in proportion to the pressure increase over opening pressure. A relief valve is normally used with incompressible fluids.	G62
<u>Prevention</u>	The act of causing an event not to happen.	G82
<u>Preventive Maintenance</u>	Inspection or testing conducted on equipment to detect impending or minor failures and restoring the proper condition of the equipment.	G35 G68
<u>Preventive Measures</u>	Measures taken at the initial stages of a runaway to avoid further development of the runaway or to reduce its final effects.	G35
<u>Primary Event</u>	A basic independent event for which frequency can be obtained from experience or test.	G1 G24 G4
<u>Probabilistic Risk Assessment (PRA)</u>	A commonly used term in the nuclear industry to describe the quantitative evaluation of risk using probability theory.	G6 G7
<u>Probability</u>	The expression for the likelihood of occurrence of an event or an event sequence during an interval of time or the likelihood of the success or failure of an event on test or on demand. By definition probability must be expressed as a number ranging from 0 to 1.	G6 G83
<u>Probability</u>	The expression for the likelihood of occurrence of an event or an event sequence during an interval of time or the likelihood of the success or failure of an event on test or on demand. Probability is expressed as a dimensionless number ranging from 0 to 1.	G82

<u>Probit</u>	A random variable with a mean of 5 and a variance of 1, which is used in various effect models.	G6
<u>Process Capability (Cp)</u>	The ratio of the specification range to six standard deviations of the process.	G68
<u>Process Flow Diagram (PFD)</u>	A diagram that shows the material flow from one piece of equipment to the other in a process. It usually provides information about the pressure, temperature, composition, and flow rate of the various streams, heat duties of exchangers, and other such information pertaining to understanding and conceptualizing the process.	G62
<u>Process Hazard Analysis (PHA)</u>	The identification of undesired events that lead to hazardous events, the analysis of the mechanisms by which these undesired events could occur, and usually the estimation of the consequences.	G64
<u>Process Hazard Analysis (PHA)</u>	An organized effort to identify and evaluate hazards associated with chemical processes and operations to enable their control. This review normally involves the use of qualitative techniques to identify and assess the significance of hazards. Conclusions and appropriate recommendations are developed. Occasionally, quantitative methods are used to help prioritized risk reduction.	G68 G71
<u>Process Media</u>	The material (i.e., chemical substances) processed by the equipment.	G6
<u>Process Medium</u>	The material processed by the equipment.	G7
<u>Process Safety</u>	A discipline that focuses on the prevention and mitigation of fires, explosions, and accidental chemical releases at process facilities. Excludes classic worker health and safety issues involving working surfaces, ladders, protective equipment, etc.	G62
<u>Process Safety</u>	A discipline that focuses on the prevention of fires, explosions, and accidental chemical releases at chemical process facilities	G68
<u>Process Safety Information (PSI)</u>	Physical, chemical, and toxicological information related to the chemicals, process, and equipment. It is used to document the configuration of a process, its characteristics, its limitations, and as data for process hazard analyses.	G71 G68

<u>Process Safety Management</u>	A program or activity involving the application of management principles and analytical techniques to ensure the safety of chemical process facilities. Sometimes called process hazard management.	G1+ G60
<u>Process Safety Management</u>	A program or activity involving the application of management principles and analytical techniques to ensure the safety of chemical process facilities. Sometimes called process hazard management. Each principle is often termed an “element” or “component” of process safety.	G68 G71
<u>Process Safety System (PSS)</u>	A process safety system comprises the design, procedures, and hardware intended to operate and maintain the process safely.	G62
<u>Process Severity</u>	The indication of the degree of aggressiveness of the process medium on the hardware; aggressiveness would include erosion, stress, corrosion, temperature, blockage, etc. Four categories of severity are used in this book: Clean, General Industry, Moderately Severe, Severe. (See Chapter 2 for further explanation of these categories.)	G7
<u>Product stewardship</u>	The management practice supporting a philosophy of service to customers and minimizing effects on health and the environment throughout the complete life cycle of a product.	G68
<u>Products</u>	Chemicals produced during a reaction process	G35
<u>Program</u>	A series of actions proposed in order to achieve a certain result.	G24
<u>Program Level 1</u>	An implementation program level under the EPA RMP Rule. Applies to those facilities perceived to have a negligible potential for serious off-site consequences in the event of an accidental release. There are no requirements for an accidental release prevention program for this program level.	G71
<u>Program Level 2</u>	An implementation program level under the EPA RMP Rule. Applies to certain facilities perceived to have the potential for offsite consequences in the event of an accidental release. The accidental release prevention program requirements for this program level are less rigorous than the Program Level 3 requirements. <b>xiv</b> Glossary	G71

<u>Program Level 3</u>	An implementation program level under the EPA RMP Rule. Applies to certain facilities perceived to have the potential for offsite consequences in the event of an accidental release. The accidental release prevention program for this program level contains the most rigorous and detailed requirements under the RMP Rule.	G71
<u>Program Library</u>	A collection of available computer programs and routines.	G24
<u>Programmable Controller</u>	A digitally operating electronic system, designed for use in an industrial environment, which uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting, and arithmetic, to control, through digital or analog Inputs and Outputs, various types of machines or processes. Both the PES and its associated Peripheral are designed so that they can be easily integrated into an industrial control system and easily used in all their intended functions.	G24
	A digitally, operating electronic system, designed for use in an industrial environment which uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting, and arithmetic to control, through digital or analog inputs and outputs, various types of machines or processes.	
<u>Programmable Controller System (PC System)</u>	A user's built configuration consisting of a programmable controller and associated Peripherals, that is necessary for the intended Automated System. It consists of units interconnected by cables or plug-in connections for Permanent Installation and by cables or other means for Portable and Transportable Peripherals.	G24
<u>Programmable Electronic System (PES):</u>	A system based on a computer connected to sensors and/or actuators in a plant for the purpose of control, protection or monitoring (includes various types of computers, programmable logic controllers, peripherals, interconnect systems, instrument distributed control system controllers, and other associated equipment).	G62

<u>Programmable Logic Controller (PLC)</u>	): A microcomputer-based solid-state control system which receives inputs from user-supplied control devices such as switches and sensors, implements them in a precise pattern determined by instructions stored in the PLC memory, and provides outputs for control or user-supplied devices such as relays and motor starters.	G62
<u>Programming and Debugging Tools (PADT)</u>	A Catalogued Peripheral to assist in programming, testing, commissioning, and troubleshooting the PES application, program documentation and storage, and possible to be used as MMIs. PADTs are said to be "Pluggable" when they may be plugged or unplugged at any time into their associated interface, without any risk to the operators and the application. In all other cases PADTs are said to be "Fixed."	G24
<u>Project Definition</u>	A phase in the development of computerized systems in which a brief statement is developed as to what is to be accomplished and why.	G24
<u>Proof Test</u>	The exercising of a passive system. The test is required to simulate the actual operation as much as is possible to be valid.	G24
<u>Proof Testing</u>	A run through the process substituting nonhazardous materials (e.g., water) to check for the adequacy of the equipment e.g., heating/cooling load, and to verify procedural steps.	G62
<u>Proof Test Interval</u>	The time interval between checking a protection system.	G6
<u>Proof Test Time Interval (T)</u>	The interval of time between two successive proof tests. Dimension (Time).	G24
<u>Propagating Brush Discharge</u>	An energetic discharge caused by electrical breakdown of the dielectric layer in a capacitor and massive lateral surface discharge resulting in dissipation of most of the stored charge. The capacitor is typically formed by charged plastic coating on a metal substrate although plastic pipe and tote bins may also form the required charged double layer. The stored energy may exceed 1000 mJ, presenting both personnel shock and ignition hazards for a wide variety of materials, including dusts in air.	G67
<u>Propagating Factors</u>	Human, process, and environmental actions and influences that contribute to guiding, sustaining, continuing, transmitting, spreading, and extending the sequence of events following the initiating event.	G6

<u>Property Boundary</u>	The boundary that is or can be built upon including the opposite side of a public way. (NFPA 30)	G83
<u>Protected Side of Flame Arrester</u>	The side of a flame arrester and system to which it is connected where flame is to be excluded	G64
<u>Protective System</u>	Systems such as pressure vessel relief valves, which function to prevent or mitigate the occurrence of an incident.	G1+
<u>Protective System</u>	The collection of H/W and methodologies that comprise the effort to maintain a safe and operable plant in the event of failure in control systems or procedures, e. g., pressure vessel relief valves, that function to prevent or mitigate the occurrence of an incident.	G24
<u>Proximate Cause</u>	The cause factor which directly produces the effect without the intervention of any other cause. The cause nearest to the effect in time and space.	G56
<u>Public Emergency Exposure Limit (PEEL)</u>	The maximum concentration in air of a toxic material to which the public might be exposed without significant adverse impacts in the event of an accident.	G3
<u>Puff</u>	A cloud of pollutants resulting from a nearly instantaneous or short duration release.	G75
<u>Puff Release</u>	See Instantaneous Release.	G6
<u>Purge Gas</u>	A gas that is continuously or intermittently added to a system to render the atmosphere noncombustible. The purge gas can be inert or combustible	G64
<u>Pyrophoric</u>	Term used to describe a substance capable of spontaneous combustion when in contact with air.	G33
<u>Pyrophoric</u>	A chemical that will ignite spontaneously in air at a temperature of 130°F (54.4°C) or below. [Note that definitions of <i>pyrophoric</i> from other sources may specify a time frame, usually seconds or minutes, within which ignition must be observed.] OSHA 1994	G81
<u>Pyrophoric Gas (NFPA 55)</u>	A gas that will spontaneously ignite in air at or below a temperature of 130°F (54°C).	G33
<u>Qualitative Methods</u>	Refers to the method of evaluation gained through experience (e.g., application, operation, support) or essential, required and desirable features.	G24

<u>Quality Assurance</u>	A planned, systematic pattern of actions necessary to provide suitable confidence that a system or component will perform satisfactory in actual operation. A systematic pattern of actions throughout design and production, to ensure confidence in a product's conformance with specifications. A set of systematic actions intended to provide confidence that a product or service will continually fulfill a defined need.	G24
<u>Quantitative Methods</u>	Refers to the method of evaluation obtained through measurement or mathematical analysis of essential, required and desirable features.  Refers to the method of evaluation gained through measurement or mathematical analysis of essential, required and desirable features.	G24
<u>Quantitative Risk Assessment</u>	The systematic development of numerical estimates of the expected frequency and/or consequence of potential accidents associated with a facility or operation based on engineering evaluation and mathematical techniques.	G1+
<u>Quenching</u>	Rapid cooling from an elevated temperature, e.g., severe cooling of the reaction system in a short time (almost instantaneously), "freezes" the status of a reaction and prevents further decomposition or reaction.	G62
<u>Quenching</u>	Abruptly stopping a reaction by severe cooling or by catalyst inactivation in a very short time period; used to stop continuing reactions in a process thus preventing further decomposition or runaway. CCPS 1995a	G81
<u>Quenching Diameter</u>	The largest diameter of a cylindrical tube that will just quench (extinguish) the flame front of a particular fuel-air mixture	G64
<u>Quenching Distance</u>	The distance between two parallel plates (flat walls) that will just quench (extinguish) the flame front of a particular fueloxidant mixture. It is smaller than the quenching diameter in cylindrical tubes.	G64
<u>Quenching Length</u>	The length of a flame arrester element necessary to quench a high speed flame.	G64
<u>Radiant Heat</u>	The heat transferred from one body to another not in contact with it but by means of wave motion through space.	G83
<u>Rain Out</u>	When a superheated liquid is released to the atmosphere, a fraction of it will flash into vapor. Another fraction may remain suspended as an aerosol. The remaining liquid, as well as portions of aerosol, may "rain out" on the ground.	G6 G60

<u>Random Access Memory (RAM)</u>	Memory that allows the user to read or write into in approximately the same length of time.	G24
<u>Random Demands</u>	Where the time or approximate time of the demand occurrence is predictable, the primary concern is whether the ESD system is operational at that time. In other words, the criteria is related to the cumulative probability of failure of the ESD system over the appropriate time interval which ends with the occurrence of the demand.	G24
<u>Rare Event</u>	An event or accident whose expected frequency is very small. The event is not expected to occur during the normal life of a facility or operation.	G1+
<u>Rate of Reaction</u>	The rate at which the conversion of reactants takes place. The rate of reaction ( $r$ ) is a function of concentrations ( $F(c)$ ) and the reaction rate constant ( $k$ ): $r = k_0F(c_A, c_B, \dots, c_X)$ . The heat ( $q$ ) produced by a reaction is a linear function of the rate of reaction which makes the rate of reaction a basic parameter in determining the required cooling capacity during all stages of the reaction process.	G35
<u>Raw Data</u>	The original records from which reliability data is extracted; the facility records of equipment failure, repair, outage, and exposure hours or demands which require analysis and encoding in order to be placed into data elements.	G7
<u>Raw Plant Data</u>	Untreated field-equipment-specific failure information often collected as part of plant operating and maintenance records, required as input for preparing plant-specific failure rate data.	G6
<u>Reactants</u>	Chemicals that are converted into the required products during the reaction process.	G35 G60
<u>Reaction</u>	The process in which chemicals/materials (reactants) are converted in other chemicals/materials (products). Types of reactions are often named individually e.g. oxidations (= oxidation reactions), decompositions (= decomposition reactions), bromations (= reactions with Bromine).	G35
<u>Reaction</u>	Any transformation of material accompanied by a change of enthalpy which may be endothermic or exothermic. ASTM E 1445	G81
<u>Reaction Kinetics</u>	The complex of data (thermodynamical and kinetical), that determine a reaction.	G35

<u>Reaction Rate Constant</u>	The constant k in the rate of reaction. The reaction rate constant is the function of temperature as represented by the Arrhenius equation.	G35
<u>Reactive chemical</u>	A substance that can pose a chemical reactivity hazard by readily oxidizing in air without an ignition source (spontaneously combustible or peroxide forming), initiating or promoting combustion in other materials (oxidizer), reacting with water, or self-reacting (polymerizing, decomposing or rearranging). Initiation of the reaction can be spontaneous, by energy input such as thermal or mechanical energy, or by catalytic action increasing the reaction rate.	G81
<u>Reactive groups</u>	Categories of chemicals that react in similar ways, often because they are similar in their chemical structure. NOAA 2002	G81
<u>Reactive Substance/Material</u>	Substance or material which enters into a chemical reaction with other stable or unstable material.	G35
<u>Reaction induction time (RIT)</u>	The time a chemical compound or mixture may be held under isothermal conditions until it exhibits a specific exothermic reaction. ASTM E 1445	G81
<u>Reactivity</u>	The relative tendency of a substance to undergo chemical reaction (low, medium, or high).	G60
<u>Reactivity, chemical</u>	See chemical reactivity.	G81

<u>Reactors</u>	<ul style="list-style-type: none"> <li>• <b>Continuous-flow Stirred Tank Reactor (CSTR):</b> A reaction vessel in which the feed is continuously added, and the products continuously removed. The vessel (tank) is continuously stirred to maintain a uniform concentration within the vessel.</li> <li>• <b>Plug Flow Reactor (PFR):</b> A plug flow reactor is a tubular reactor where the feed is continuously introduced at one end and the products continuously removed from the other end. The concentration/temperature profile in the reactor varies with position.</li> <li>• <b>Batch Reactor:</b> In a batch reactor, the reactants are added to the reactor at the start of the reaction. The reactants are allowed to react in the reactor for a fixed time. No feed is added or product withdrawn during this time. The reaction products are removed at the end of the batch.</li> <li>• <b>Semi-Batch Reactor:</b> In a semi-batch reactor, some reactants are added to the reactor at the start of the batch, while others are fed intermittently or continuously during the course of the reaction.</li> </ul>	G62
<u>Read Only Memory (ROM)</u>	Memory that allows the user to read from but not to write into.	G24
<u>Real Number</u>	A number with a decimal point.	G24
<u>Rearrangement</u>	Disproportionation, isomerization or tautomerization.	G81
<u>Receptor</u>	An instrument, person, or hypothetical location where the pollutant concentration is observed or calculated.	G75
<u>Recirculation cavity</u>	A volume downwind of an obstacle where the flow recirculates.	G75
<u>Recommendation</u>	A suggested course of action intended to prevent the occurrence (or recurrence) of an accident event sequence, or to mitigate its consequences.	G71
<u>Recovery Factors</u>	Factors that limit or prevent the undesirable consequences of a human error.	G1+
<u>Redo</u>	To conduct a new PHA.	G71
<u>Reducing Agent</u>	<p>In a reduction reaction (which always occurs simultaneously with an oxidation reaction) the reducing agent is the chemical or substance which (1) combines with oxygen, (2) loses electrons in the reaction. See also, "Oxidizing Agent".</p> <p><b>Importance:</b> If a material is listed as a reducing agent on the MSDS, precautions must be taken in the handling and storage of the substance. Keep separate from oxidizing agents.</p>	G17

<u>Redundancy</u>	The employment of several devices, each performing the same function, in order to improve the reliability of a particular function.  An identical, secondary system component (e.g., CPU, power supply) designed to assume the function of the primary component upon failure of the primary. Redundancy can also mean two or more components performing the same function simultaneously (e.g., two shutdown valves).	G24
<u>Redundant</u>	A parallel path in a system structure to improve the system safety or reliability.	G24
<u>Reflected Pressure</u>	The pressure on a structure perpendicular to the shock wave.	G6
<u>Refrigerated Liquid</u>	A gas that is maintained as liquid at temperatures at or below ambient temperature to reduce the storage pressure. This includes fully refrigerated LP-Gas for pressures near atmospheric pressure but not exceeding 15 psi (103 kPa) and semi refrigerated LP-Gas for pressures above 15 psi (103 kPa). (NFPA 58)	G83
<u>Reflux</u>	A system condition in which a component in the reaction system (usually a solvent or diluent) is continuously boiled off, condensed in a nearby condenser and subsequently re-supplied to the reaction system. Reflux is often applied to operate at a preset temperature or to avoid operating at unacceptably high temperatures.	G35
<u>Register</u>	A storage device having a specified storage capacity such as bit a byte or a computer word and usually intended for a special purpose.	G24
<u>Registry of Toxic Effects of Chemical Substances</u>	A system developed by the National Institute for Occupational Safety and Health in which a nine position alphanumeric designation is assigned to a chemical name.	G33
<u>Regulatory Control</u>	[ no text given ]	G24
<u>Relative Application (of CPQRA)</u>	A comparison and ranking of various risk estimates to prioritize risk reduction strategies based on their competitive effectiveness.	G6
<u>Relative Ranking</u>	[ no text give ]	G1+

<u>Relaxation Time (t)</u>	Time constant equal to the time in seconds for charge to decay by Ohm's Law to $e^{-1}$ (36.7%) of its initial value. For a capacitor, the time constant (s) is the product of resistance (W) and capacitance (F). For a charged material sample, either solid or liquid, the time constant is the product of permittivity (F/m) and resistivity (W-m).	G67
<u>Relay Ladder Diagram</u>	Synonymous with Ladder Diagram.	G24
<u>Reliability</u>	The probability that an item is able to perform a required function under stated conditions for a stated period of time or for a stated demand.	G7
<u>Reliability Analysis</u>	The determination of reliability of a process, system, or equipment.	G7
<u>Reliability Parameters</u>	The collection of mathematically defined properties (e.g., Reliability, Availability, Dependability) used in reliability engineering to describe the behavior of systems and their elements, such as chemical processes, process systems, equipment and their components. (See Appendix E.)	G6
<u>Remote Input/Output Station (RIOS)</u>	A manufacturer's catalogued part of a PES including Input and/or Output interfaces allowed to operate only under the hierarchy of the Main Processing Unit (MPU), for I/O multiplexing/demultiplexing and data preprocessing/postprocessing. The RIOS is only permitted limited autonomous operation (e.g., under emergency conditions such as breakdown of the communication link to the MPU or of the MPU itself, or when maintenance and troubleshooting operations are to be performed).	G24
<u>Removal by settling, deposition, washout, and chemical reactions</u>	Material can be removed from the atmosphere by a variety of processes.	G75
<u>Repair Time</u>	The time necessary to identify and repair a fault. The average detection and repair time is called the MTTR. Dimension (Time).	G24
<u>Representative Set (of incidents)</u>	A selection of incidents designed so as to contain one or more incidents from each of the three incident classes (localized, major, and catastrophic).	G6

<u>Resistance (R)</u>	The property of conductors depending on material, dimensions and temperature which determines the current produced by a given difference of potential. The practical unit of resistance, the ohm, is that resistance through which a difference of potential of 1 V will produce a current of 1 A.	G67
<u>Resistivity (<math>\rho_v</math>)</u>	The volume resistance of a sample of material having unit length and unit cross-sectional area. If the length is expressed in meters and the area in square meters; the resistivity is given in ohm-meters (Methods ASTM D991-83 and D257-78).	G67
<u>Resource</u>	See Data resource.	G7
<u>Respiratory System</u>	The breathing system; in includes the lungs and air passages (trachea or "windpipe", larynx, mouth, and nose) to the air outside the body, plus the associated nervous and circulatory supply.  <b>Importance:</b> Inhalation is the most common route of exposure in the occupational workplace.	G17
<u>Responsible Care®</u>	An initiative implemented by the Chemical Manufacturers Association (CMA) in 1988 to assist in leading chemical processing industry companies in ethical ways that increasingly benefit society, the economy and the environment while adhering to ten key principles.	G68
<u>Restart, Cold Start</u>	Restart of the PES and its Application Program after all dynamic data (Variables such as I/O Image, internal Registers, Timers, Counters, etc., and Program Contexts) are reset to a predetermined state. A Cold Restart may be automatic (e.g., after a Power Failure, a loss of information in the dynamic portions of the memories of manual (e.g., push-button reset, etc.)).	G24
<u>Restart, Hot Restart</u>	Restart after power failure which occurs within the process dependent maximum time allowed for the PES to recover as if there had been no power failure. All I/O-information and other dynamic data as well as the Application Program context are restored or unchanged. Restart capability requires a separately powered real time clock or timer to determine elapsed time since the power failure was detected and a user accessible means to program the process dependent maximum time allowed.	G24

<u>Restart, Warm Restart</u>	Restart after Power Failure with a user programmed predetermined set of dynamic data and a system predetermined Application Program context. A Warm Restart is identified by a status flag or equivalent means made available to the Application Program indicating that the Power Failure shutdown of the PES was deleted in the RUM mode.	G24
<u>Retains</u>	The amount of a substance left behind during chemical processing. Also refers to samples retained for reference after undergoing analysis.	G68
<u>Retrofit, Update, and Revalidate</u>	To correct substantive deficiencies in the prior PHA, and then update and revalidate it (See Update and Revalidate).	G71
<u>Revealed Faults</u>	A failure may be immediately or almost immediately apparent through an alarm or indicator system. This can lead to corrective action within a relatively short period of time.	G24
<u>Review (Process Safety Review)</u>	An inspection of a plant/process unit, drawings, procedures, emergency plans and/or management systems, etc., usually by an on-site team and usually problem-solving in nature. (See "Audit" for contrast).	G4 G24 G1+
<u>RFI (Radio Frequency Interference)</u>	Any electrical signal capable of being propagated into and interfering with the proper operation of electrical or electronic equipment. The frequency range of such interference may be taken to include the entire electromagnetic spectrum.  Type of electrical noise that can affect electronic circuits adversely.	G24
<u>Ri (Richardson Number)</u>	Measure of atmospheric stability proportional to the vertical gradient of potential temperature, $\cdot \dot{Y}è/ \dot{Y}z$ , divided by the square of the vertical gradient of wind speed, $\cdot \dot{Y}u/ \dot{Y}z$ .	G75
<u>Risk</u>	A measure of potential economic loss, human injury, or environmental damage (cost) in terms of the probability of the loss, injury, or damage over a period of time, normally a year. Plotting the cost vs. probability gives one representation. The integral under this curve gives another, called the Societal Risk.	G60
<u>Risk</u>	A measure of human injury, environmental damage, or economic loss in terms of the incident likelihood and the magnitude of the loss or injury. (CCPS, 2000)	G83

<u>Risk Analysis</u>	The development of a quantitative estimate of risk based on engineering evaluation and mathematical techniques for combining estimates of incident consequences and frequencies.	G6 G24 G7 G8 G83
<u>Risk Assessment</u>	The process by which the results of a risk analysis (i.e., risk estimates) are used to make decisions, either through relative ranking of risk reduction strategies or through comparison with risk targets.	G1+ G83
<u>Risk Contour</u>	Lines that connect points of equal risk around the facility ("isorisk" lines).	G6
<u>Risk Estimation</u>	Combining the estimated consequences and likelihood of all incident outcomes from all selected incidents to provide a measure of risk.	G24 G6
<u>Risk Evaluation</u>	The assessment of risk, coupled with an appraisal of the significance of the results, both overall and from individual events.	G3
<u>Risk Management</u>	The systematic application of management policies, procedures, and practices to the tasks of analyzing, assessing, and controlling risk in order to protect employees, the general public, and the environment as well as company assets, while avoiding business interruptions. Includes decisions to use suitable engineering and administrative controls for reducing risk.	G56
<u>Risk Management</u>	The systematic application of management policies, procedures, and practices to the tasks of analyzing, assessing, and controlling risk in order to protect employees, the general public, and the environment as well as company assets while avoiding business interruptions. (CCPS, 2000)	G83
<u>Risk Management Program (RMP)</u>	EPA's rule requiring some facilities to prepare, submit, and implement a risk management plan.	G68
<u>Risk Management Program (RMP) Rule</u>	EPA's accidental release prevention Rule, which requires covered facilities to prepare, submit, and implement a risk management plan.	G71

<u>Risk Measures</u>	Ways of combining information on likelihood with the magnitude of loss or injury (e.g., risk indexes, individual risk measures, and societal risk measures).	G1+ G24 G6
<u>Risk Targets</u>	Objective-based risk criteria established as goals or guidelines for performance.	G6
<u>Riverine Flood</u>	A flood resulting from an overflow of a river, stream or creek.	G33
<u>Roll Over</u>	The spontaneous and sudden movement of a large mass of liquid from the bottom to the top surface of a refrigerated storage reservoir due to the instability caused by an adverse density gradient. Rollover can cause a sudden pressure increase and can affect vessel integrity. (API 2510)	G83
<u>Root Causes</u>	Management system failures such as faulty design, inadequate training, etc. that lead to the unsafe acts or conditions that resulted in an incident.	G56
<u>Roughness sublayer</u>	The lower part of the boundary layer, typically of depth a few $H_r$ , where the flow depends explicitly on the presence of the obstacles, their size, and their geometry. <b>198 <i>Wind Flow and Vapor Cloud Dispersion at Industrial and Urban Sites</i></b>	G75
<u>Round robin</u>	A process involving an exchange of samples intended to transfer analytical capabilities from the client to the toller to support the toll project.	G68
<u>Rule Based Action</u>	Behavior in which a person follows remembered or written rules. Examples might be the use of a written checklist to calibrate an instrument or a maintenance manual to repair a pump.	G6
<u>Run-up Distance or Run-up Length</u>	The distance in the direction of flame propagation from the point of ignition to any point in a pipe system. Deflagration flames accelerate over this distance due to turbulence and precompression effects. Depending on pipe diameter, surface roughness, and the presence of turbulence-producing obstacles (elbows, valves, etc.) this distance may be sufficient for DDT to occur	G64
<u>Runaway</u>	A thermally unstable reaction system which exhibits an uncontrolled accelerating rate of reaction leading to rapid increases in temperature and pressure.	G62

<u>Runaway Reaction</u>	A thermally unstable reaction system which shows an accelerating increase of temperature and reaction rate.	G60
<u>Runaway Reaction</u>	A reaction that is out of control because the rate of heat generation by an exothermic chemical reaction exceeds the rate of cooling available. HSE 2000	G81
<u>Rung</u>	A network in a Ladder Diagram Program with its attached left Power Rail and optionally attached right Power Rail.	G24
<u>Running Mode</u>	Normal hardware operation, e.g., an unspared compressor which must operate to run the process.	G7
<u>Sachs' Scaling</u>	Dimensionless terms for TNT equivalence explosion modeling.	G60
<u>SADT</u>	Self-Accelerating Decomposition Temperature; The lowest ambient temperature at which auto-accelerative decomposition of an unstable substance is observed (minimum self-heating rate of 5°C/week), when the substance as packaged in its commercial container is subjected to that minimum temperature during one week in the testing facility (see also CSST).	G35
<u>Safe Burning Time</u>	The period of stabilized burning on a flame arrester without flame being transmitted through the arrester.	G64
<u>Safe haven</u>	A building or enclosure that is designed to provide protection to its occupants from exposure to outside hazards	G83
<u>Safety</u>	The expectation that a system does not, under defined conditions, lead to a state in which human life, economics or environment are endangered.	G24
<u>Safety Instrumented System (SIS):</u>	The instrumentation, controls, and interlocks provided for safe operation of the process.	G62
<u>Safety Integrity</u>	(there is no definition for this CPQRA) is defined as the likelihood that a safety-related system will achieve its required safety functions under all the stated conditions within a specified period of time.	G24
<u>Safety Interlocking</u>	Same as interlocking except a failure to control out-of-limit conditions can cause injury or unacceptable environmental contamination.	G24

<u>Safety Layer</u>	<p>A system or subsystem that is considered adequate to protect against a specific hazard. The safety layer</p> <ul style="list-style-type: none"> <li>• is totally independent of any other protective layers</li> <li>• cannot be compromised by the failure of another safety layer</li> </ul> <p><b>Glossary 165</b></p> <ul style="list-style-type: none"> <li>• must have acceptable reliability</li> <li>• must be approved according to company policy and procedures</li> <li>• must meet proper equipment classification</li> <li>• may be a noncontrol alternative (i.e., chemical, mechanical)</li> <li>• may require diverse hardware and software packages</li> <li>• may be an administrative procedure</li> </ul>	G62
<u>Safety System</u>	<p>Equipment and/or Procedures designed to respond to an accident event sequence by preventing accident propagation, thereby preventing the accident and its consequences.</p>	G24 G1 G4 G7
<u>Sampling Time</u>	<p>The length of time in atmospheric dispersion testing over which concentration data are sampled. Sampling time is normally synonymous with averaging time.</p>	G6
<u>Satellite Instrument House (SIH)</u>	<p>A structure containing instrument and process control equipment for one or more process units</p>	G83
<u>SBR</u>	<p>Semi-Batch Reactor; A type of batch reactor that is characterized by the supply of a key reactant to the reactor during the reaction. Products are only taken from the reactor upon conclusion of the reaction process. Both heat generation and concentrations in the batch reactor vary during the reaction process.</p>	G35
<u>Scan Time</u>	<p>See Time.</p>	G24
<u>Scenario</u>	<p>[In the context of identifying incompatibilities:] A detailed physical description of the process whereby a potential inadvertent combination of materials may occur.</p>	G81

<u>SCIPUFF</u>	Second Order Closure Puff model (Sykes et al., 1998)	G75
<u>SCR (Silicon Controlled Rectifier)</u>	A semiconductor device that functions as an electrically controlled switch for DC loads. The SCR is one type of thyristor.  A semiconductor device used to provide stepless control of an electric power circuit without the necessity of load matching; usually, two rectifiers are used in the circuit to provide full-wave control of the heater element, but in some instances two SCRs are used in a single package, known as a triac.	G24
<u>Screening Tool</u>	A simplified dispersion model with limited capabilities, suitable for screening-level studies.	G60
<u>Security</u>	A password, key, procedure, or other device which has the ability to limit change in selected parameters.  The existence and enforcement of techniques which restrict access to data, and the conditions under which data may be obtained.	G24
<u>Selectivity</u>	The selectivity (ap) is the ratio of the amount of a desired product P obtained and the amount of a key reactant converted.	G35

<u>Self-Accelerating Decomposition Temperature</u>	The minimum temperature that a mass of material, capable of an exothermic decomposition reaction, must be held such that the heat of decomposition exceeds the amount of energy lost to the surroundings. This will result in an increase in the mass temperature and acceleration of the decomposition reaction rate.	G33
<u>Self-accelerating decomposition temperature (SADT)</u>	Certain compounds, such as organic peroxides, when held at moderate ambient temperatures for an extended period of time, may undergo an exothermic reaction that accelerates with increase in temperature. If the heat liberated by this reaction is not lost to the environment, the bulk material increases in temperature, which leads to an increase in the rate of decomposition. Unchecked, the temperature grows exponentially to a point at which the decomposition cannot be stopped or slowed. The minimum temperature at which this exponential growth occurs in a material packed in its largest standard shipping container is defined as the selfaccelerating decomposition temperature. Selfaccelerating decomposition temperature is a measure of the ease in which decomposition occurs under normal storage conditions. It is not an indicator of the violence of any decomposition reaction under conditions of fire exposure or contact with incompatible materials. NFPA 49 2001	G81
<u>Self-igniting</u>	The ignition and sustained combustion of a substance without introduction of any ignition source besides thermal energy or heat of reaction resulting when combined with other substances in the surrounding environment. Self-igniting materials include materials above their autoignition temperature, chemicals that ignite due to heat of reaction with oxygen in air, and chemicals that are unstable and spontaneously combust when released.	G83
<u>Self-reactive</u>	Capable of polymerization, decomposition or rearrangement. Initiation of the reaction can be spontaneous, by energy input such as thermal or mechanical energy, or by catalytic action increasing the reaction rate.	G81
<u>Semiconductive</u>	Possessing a conductivity between $10^2$ and $10^4$ pS/m or a resistivity between $10^8$ and $10^{10}$ W-m.	G67

<u>Semiconductive Hose</u>	Having an electrical resistance great enough to limit the flow of stray electric current to safe levels, yet not so great as to prevent relaxation of static electrical charges to ground. Typically achieved using carbon-loaded layers yielding 103 to 105 W/m of hose length. In a flammable atmosphere the resistance from any metal connector or wand to ground should be less than 106 W. If only a thin inner layer of a solids transfer hose is semiconductive it should be ensured that abrasion does not cause an unacceptable increase of resistance. 270 GLOSSARY	G67
<u>Sensitive Gas</u>	A gas that is much more likely to cause a failure in a flame arrester test because of its low AIT or other characteristics not obvious from its IEC standard MESH value	G64
<u>Sensitivity</u>	The sensitivity of a measure to a parameter is defined as the change in the measure per unit change in that parameter.	G6
<u>Sensitizer</u>	A substance which on first exposure causes little or no reaction in man or test animals, but which on repeated exposure may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization in the industrial setting, although respiratory sensitization to a few chemicals is also known to occur.	G17
	<b>Importance:</b> Knowing that a substance is a sensitizer allows you to be aware of the signs and symptoms of overexposure.	
<u>Separate</u>	Means accessible only to plant personnel responsible for the proper operation and maintenance of ESD.	G24
<u>Sequence</u>	An arrangement of control devices, wiring, or software programming such that the operation of connected equipment must follow a predetermined order.	G24
<u>Sequence Control</u>	Automatic control of a series of operations in a predetermined order.  A system of control in which a series of machine movements occurs in a desired order, the completion of one movement initiating the next, and in which the extent of the movements is not specified by numerical input data.	G24

<u>Sequential Control System</u>	A control system in which the individual steps are processed in a predetermined order, progression from one sequence step to the next being dependent on defined conditions being satisfied. Such a system may be time-dependent, in which the step transition conditions are functions of time only; on external-event dependent, where the conditions are functions of Input signals only; or combinations of these (and perhaps more complex) conditions.	G24
<u>Sequential Function Chart (SFC)</u>	A graphical representation of a Sequential Program consisting of interconnected steps, actions and directed links with transition conditions.	G24
<u>Sequential Program</u>	A plan which prescribes the actions on a system in a predetermined order and in which some actions depend on the execution of preceding ones or on the fulfillment of certain conditions.	G24
<u>Serial (Data Transmission)</u>	A system wherein the bits of a character occur serially in time, implies only a single transmission channel.	G24
<u>Serious Injury</u>	The classification for an occupational injury which includes: (a) all disabling work injuries and (b) non-disabling work injuries as follows: (1) eye injuries requiring treatment by a physician, (2) fractures, (3) injuries requiring hospitalization, (4) loss of consciousness, (5) injuries requiring treatment by a doctor and (6) injuries requiring restriction of motion or work, or assignment to another job.	G56
<u>Shallow-Layer Model with Terrain Effects</u>	A dispersion model capable of predicting flows in variable terrain by using a simplification in the model formulation that makes the equations applicable only to a shallow layer of fluid.	G60
<u>Sheltering</u>	Physical protection (such as an enclosed building) against the outcome of an incident.	G6
<u>Shock Absorber Device</u>	See Detonation Momentum Attenuator.	G64
<u>Shock sensitive</u>	A relatively unstable material, the energetic decomposition of which can be initiated by merely the input of mechanical energy at normal ambient conditions. Materials are considered as shock sensitive if they are more easily initiated than dinitrobenzene in a standard drop-weight test. CCPS 1995b	G81

<u>Shock Wave</u>	A transient change in the gas density, pressure, and velocity of the air surrounding an explosion point. The initial change can be either discontinuous or gradual. A discontinuous change is referred to as a shock wave, and a gradual change is known as a pressure wave.	G64
<u>Short-term Public Emergency Guidance Levels (SPEGLs)</u>	For exposures whose occurrence is expected to be rare in the lifetime of any one individual, the 60-minute exposure concentration that reflects an acceptance of the statistical likelihood of a non-incapacitating reversible effect in an exposed population, while avoiding significant decrements in performance. Developed by the National Academy of Science (NAS).	G3
<u>Shutdown (S/D)</u>	A process by which an operating plant or system is brought to a safe and nonoperating mode.	G24
<u>Short-Stop Agent</u>	A material added to a reaction mixture to stop or greatly reduce the reaction rate. This is usually done to prevent a runaway reaction.	G62
<u>Side-on Pressure</u>	The level of overpressure in the pressure wave from an explosion measured perpendicular to the direction of propagation of that pressure wave.	G60
<u>Siemen (S)</u>	Reciprocal ohm, formerly termed a "mho." See "Conductivity."	G67
<u>Similarity model</u>	A model of flow or dispersion where the key variables are scaled by similarity variables such as $u^*$ , $L$ , or $z_0$ . The resulting scaled dimensionless variables may follow "similar" curves and relationships.	G75
<u>Sink Mode Output</u>	A mode of operation of solid state output devices in which the device controls the current from the load, i.e., when the output is energized it connects the load to the negative polarity of the supply.	G24
<u>Siting</u>	The process of locating a complex, site, plant, or unit.	G83
<u>Skill Based Action</u>	The performance of more or less subconscious routines governed by stored patterns of behavior. Examples might be the use of a hand tool by an experienced mechanic or the initiation of an emergency procedure by a trained and experienced operator.	G6

<u>Skin</u>	A notation, sometimes used with PEL or TLV exposure date; indicates that the stated substance may be absorbed by the skin, mucous membranes, and eyes-either by airborne or by direct contact-and that this additional exposure must be considered part of the total exposure to avoid exceeding the PEL or TLV for that substance.	G17
	<b>Importance:</b> Even if workplace concentrations of a chemical do not exceed the TLV or PEL, the risk to health may be severe because breathing and skin contact are combined. Skin protection is advised.	
<u>Skin friction coefficient</u> $2(u^*/u_{ref})^2$	or the nondimensional local surface shear stress coefficient. The engineering "skin friction coefficient," $c_f$ , is traditionally tabulated in engineering texts. It is sometimes given as a function of surface type and ratio of roughness element height to pipe or boundary layer thickness. Often it is implicitly presented through the classic Moody diagram (Schlichting, 1955) which covers aerodynamically smooth and rough surfaces over a comprehensive range of Reynolds numbers including laminar, transitional, and turbulent flows	G75
<u>Skin Sensitizer</u>	See "Sensitizer".	G17
<u>Skin Toxicity</u>	See "Dermal Toxicity".	G17
<u>SLAB</u>	A dense gas dispersion model based on the slab solutions (Ermak, 1990).	G75
<u>Slip Flange</u>	Loose "ring" flange for connecting flared or stub end pipe. Continuity may be lost across connection due to insulation by nonconductive gasket plus painted surfaces on the slip flange and/or pipe. A conductive gasket (such as flexible graphite filled, spiral wound metal type) or jumper cable may be required.	G67
<u>Societal Risk</u>	A measure of risk to a group of people. It is most often expressed in terms of the frequency distribution of multiple casualty events.	G6

<u>Software (S/W)</u>	<p>Programs, procedures, rules, and associated documentation required for the operating and/or maintenance of a digital system.</p> <p>Computer programs, routines, programming Languages and systems.</p> <p>The collection of related utility, assembly, and other programs that are desirable for properly presenting a given machine to a user. Including:</p> <ul style="list-style-type: none"> <li>o Detailed procedures to be followed, whether expressed as programs for a computer or as procedures for an operator or other person.</li> <li>o Documents, including hardware manuals and drawings, computer program listing, and diagrams, etc.</li> <li>o Items such as those listed above, as contrasted with hardware.</li> </ul>	G24
<u>Software Interlock</u>	An interlock accomplished through an application program within a PES (see hard-wired interlock).	G24
<u>Softwired</u>	See Software Interlock.	G24
<u>Solidity</u> (ranges from 0 to 1)	Measure of lack of porosity of an object. For example, a solid building has a solidity of 1.0, while a pipe rack at a refinery has a solidity of 0.5.	G75
<u>Solubility in Water</u>	<p>A term expressing the percentage of a material (by weight) that will dissolve in water at ambient temperature.</p> <p><b>Importance:</b> Solubility information can be useful in determining spill cleanup methods and fire-extinguishing agents and methods for a material.</p>	G17
<u>Source Mode Output</u>	A mode of operation of solid state output devices in which the device controls the current to the load (i.e., when the output is energized it connects the load to the positive polarity of the supply).	G24
<u>Source Term</u>	The estimation, based on the release specification, of the actual cloud conditions of temperature, aerosol content, density, size, velocity and mass to be input into the dispersion model.	G6
<u>SO<sub>x</sub></u>	<p>Oxides of Sulfure; undesirable air pollutants.</p> <p><b>Importance:</b> Often listed on a MSDS as a hazardous decomposition product.</p>	G17

<u>Spark Discharge</u>	Transient discrete electric discharge which takes place between two conductors which are at different potentials, bridging the gap in the form of a single ionization channel.	G67
<u>Special Precautions</u>	Instructions that describe proper handling and storage procedures specific to that material.  <b>Importance:</b> Following these procedures would prevent excessive employee exposure. These procedure tell you additional information needed to handle the material safely.	G17
<u>Special Protection Information</u>	A description of engineering precautions and personal protection that should be provided when working with a chemical in order to reduce an employee's exposure.  <b>Importance:</b> Reducing the potential for exposure reduces the risk to health and safety.	G17
<u>Specific Gravity</u>	A dimensionless, temperature dependent ratio of the density of one substance with that of a reference substance. For solids and liquids the reference substance is water at 39°F (4°C). For gases and vapors, the reference substance is dry air at 60°F (15.6°C).	G33
<u>Specific Impulse</u>	The area under the overpressure versus time curve.	G64
<u>Spill or Leak Procedures</u>	Steps that should be taken if a chemical spill or leak occurs.  <b>Importance:</b> Proper removal of a chemical spill or leak from the work area eliminates the potential accumulation of hazardous concentrations of the chemical, reduces the risk of creating an environmental pollution problem and conforms with local, state and federal regulations.	G17
<u>Spill Prevention Control and Countermeasures Plan</u>	The document prepared in compliance with U.S. regulation "Guidelines For The Preparation and Implementation of a Spill Prevention Control and Countermeasure Plan (SPCC)"—EPA 40 CFR part 112.7. 216 GLOSSARY	G68
<u>Spontaneously combustible</u>	Capable of igniting and burning in air without the presence of an ignition source. <i>Pyrophoric</i> materials are spontaneously combustible, although some pyrophorics require the presence of a minimum amount of moisture (humidity) to spontaneously ignite. Other spontaneously combustible substances and mixtures may require more time or an insulating environment to self-heat to the point of ignition.	G81

<u>Stability</u>	Refers to the ratio of the suppression of turbulence by thermal effects to the generation of turbulence by mechanical effects such as wind shears. Transport and dispersion models characterize the effect of stability through use of one or more dimensionless stability parameters, such as the Richardson number, $Ri$ , the Monin–Obukhov length, $L$ , or the Pasquill stability class.	G75
<u>Stability class</u>	The Pasquill stability class scheme is based on time of day, wind speed, cloudiness, and sun's intensity. The six stability classes are denoted by the letters A through F, with A being very unstable, D being neutral, and F being very stable	G75
<u>Stabilized Burning</u>	Steady burning of a flame, stabilized at, or close to the flame arrester element. <b>206 Glossary</b>	G64
<u>Stable Detonation</u>	A detonation that progresses through a confined system without significant variation of velocity and pressure characteristics. For atmospheric conditions, typical velocities range between 1600 and 2200 m/s for standard test mixtures and test procedures.	G64
<u>Stable materials</u>	Those materials that normally have the capacity to resist changes in their chemical composition, despite exposure to air, water, and heat as encountered in fire emergencies. NFPA 704 2001	G81
<u>Staging</u>	Assembling, testing, and operating a process control system in a controlled environment prior to plant implementation according to a test plan to ensure that it performs properly and meets all requirements of the functional specification. Staging is performed after the standard vendor system acceptance test has been conducted and is done under the end user's supervision to thoroughly exercise all essential control system function. Testing often includes some type of simulation of the actual plant operation with real or simulated inputs to test key application-related functions, such as program interaction.	G24
<u>Standard Deviation (cloud concentration),s</u>	The square root of the sum of squared values of concentration minus centerline concentration. The cloud half-width can be defined as the distance corresponding to a concentration of two or three standard deviations from the centerline.	G60
<u>Standby Mode</u>	Hardware operation that is normally not running but must be ready run, e.g., an emergency diesel generator.	G7
<u>Stand-Off Distance, <math>R</math></u>	Distance from the center of an explosion	G60

<u>Statement</u>	A programming language construct that represents a set of declarations or a step in a sequence of actions.	G24
<u>Static Electricity</u>	The class of phenomena recognized by the presence of electrical charges, either stationary or moving, and the interaction of these charges, this interaction being solely by reason of the charges themselves and their position and not by reason of their motion.	G67
<u>Static Flame Arrester</u>	A flame arrester designed to prevent flame transmission by quenching gaps (apertures). These are usually dry type flame arresters with elements such as crimped metal ribbon, parallel plates, wire gauze (mesh), and sintered metal.	G64
<u>Stationary Conditions</u>	Conditions that are characterized by constant concentrations and temperatures as a function of time, i.e. the time derivatives of all variables are zero.	G35
<u>Statistical Dependence</u>	Two events (A and B) are statistically dependent if the probability that A occurs given B has already occurred is different than the separate probability of A occurring. That is, $P(A B) \neq P(A)$ .	G6
<u>Statistical Independence</u>	Two events (A and B) are statistically independent if the probability that they both occur is the product of their separate probabilities: $P(A \text{ and } B) = P(A) * P(B)$ .	G6
<u>Statistical Process Control (SPC)</u>	The use of statistical techniques (such as control charts) to analyze a process and take appropriate action to maintain statistical control and improve process capability.	G68
<u>STEL</u>	Short Term Exposure Limit; ACGIH terminology. See also, "TLV-STEL."	G17
<u>Stoichiometric Concentration</u>	A term used to describe a balanced ratio of chemical reactants that would result in all of the chemical reactants becoming products if a chemical reaction were to occur.	G33
<u>Stoichiometric Mixture</u>	A balanced mixture of fuel and oxidizer such that no excess of either remains after combustion.	G64
<u>Stratification</u>	As used here, any concentration profile that develops in an enclosure. The flammable mass will be between the LFL and UFL concentrations along such a concentration profile.	G60
<u>Stray Capacitance</u>	Capacitance unessential for the function of a circuit and of relatively small value that nevertheless may introduce errors if not eliminated or unaccounted for. Of particular importance in high voltage, low capacitance spark ignition tests and in the measurement of small charges and currents.	G67

<u>Stray Currents</u>	Electric currents which wholly or in part do not follow the original circuits designed for them.	G67
<u>Streaming Current</u>	The charging current introduced to a system by liquid flow, expressed in Amperes.	G67
<u>Street canyons and tunnel entrances</u>	Special situations for which models are developed based on empirical analysis of field data, simplified scaling models, or CFD models.	G75
<u>Study Cube</u>	A geometrical representation of the variety of depths of study possible for a CPQRA using the three major factors that define the scope of a CPQRA: risk estimation technique, complexity of analysis, and number of incidents selected for study.	G6
<u>Subsystem</u>	A portion of a system.	G7
<u>Superheated Liquids</u>	Liquids at a temperature above their normal boiling point.	G60
<u>Suppressant</u>	A chemical agent used in a deflagration suppressant system to extinguish the deflagration.	G64
<u>Suppressant Barrier</u>	An isolation system using a suppressant.	G64
<u>Surface boundary layer</u>	Layer of depth 50 to 100 m where the friction velocity $u^*$ can be assumed constant.	G75
<u>Surface Charge Density (Qs or s).</u>	The charge per unit area of solid surface expressed in Coulomb/square meter. For a unidirectional, uniform field in air the maximum surface charge density before air breakdown occurs is $2.65 \times 10^{-5} \text{ C}\cdot\text{m}^{-2}$ . Only a fraction of this value is achieved in most practical situations. However, for nonuniform fields around a charged particle much greater charge densities can be supported in air, depending on the radius of the particle. Also, much greater surface charge densities can be supported when nonconductive charged surfaces have a metal substrate so as to form a capacitor. Since the electric field is primarily exerted through the nonconductor to the substrate the maximum charge density may be limited by the breakdown strength of the nonconductor. <b>GLOSSARY 271</b>	G67

<u>Surface heat flux <math>H_s</math></u>	Turbulent heat flux upward from the surface, measured by fast response turbulence instruments using the identity $H_s = \overline{w' T'}$ , where $w'$ is the fluctuation in vertical wind speed and $T'$ is the fluctuation in temperature, and the average is taken over about one hour. A typical value of $H_s$ in the daytime is about 200 W/m <sup>2</sup> (J/sm <sup>2</sup> ) and at night is about – 20 W/m <sup>2</sup> . <b>Glossary 199</b>	G75
<u>Surface Resistivity (rs)</u>	The resistance across a surface element having unit length and unit width, expressed in ohm/square or ohm (Method : ASTM D257). In EOS/ESD S11.11-1993, a static dissipative packaging material is defined as having a surface resistivity equal to or greater than 1.0×10 <sup>4</sup> Ω and less than 1.0 × 10 <sup>11</sup> Ω, while an insulative packaging material has a surface resistivity equal to or greater than 1.0 × 10 <sup>11</sup> Ω.	G67
<u>Surface roughness length, <math>z_0</math></u>	A measure of the amount of mechanical mixing introduced by the surface roughness elements and, as a rough rule of thumb, is equal to about 0.1 times the average height, $H_r$ , of the roughness elements.	G75
<u>Surface Streamer</u>	A wall-to-surface discharge observed on charged liquids during tanker filling, appearing as a flash up to 2 ft long and accompanied by crackling sound. Effective energy unknown but possibly up to about 10 mJ. Also observed on tribocharged solid surfaces such as between aircraft windshields and metal airframe, where puncturing does not occur.	G67
<u>Synchronous</u>	Pertaining to two or more processes that depend upon the occurrence of a specific event such as a common timing signal.	G24
<u>Synonym</u>	Another name or names by which a material is know. Methyl alcohol, for example, is also know as methanol, or wood alcohol.  <b>Importance:</b> A MSDS will list common name(s) to help identify specific materials.	G17
<u>Syntax</u>	The rules governing the structure of a language.	G24
<u>System</u>	A collection of people, machines and methods organized to accomplish a set of specific functions.	G24
<u>System Designer</u>	The individual responsible for designing the complete computerized system.	G24

<u>System Documentation</u>	The accumulated documents relating to a computerized system that are prepared as the development project proceeds. System documentation is not a separated phase of development.	G24
<u>System Evaluation</u>	A phase in the development of computerized systems in which the system is compared with its requirements to determine possibilities for growth and improvement and to preserve the lessons of that development project in preparation for the next one.	G24
<u>System Generation</u>	The process of selecting optional parts of an operating system and of creating a particular operating system tailored to the requirements of a data processing installation.	G24
<u>System Interaction</u>	Failure in one system that propagates to another.	G7
<u>System Reliability</u>	See Reliability	G24
<u>System Software</u>	Software written by the Device manufacturer which defines the operation of the Device with or without an Application Program. typically a collection of subroutines which acts as an interpreter in converting the instructions of the user entered Application Program into the machine code required by the Device hardware.	G24
<u>Task Analysis</u>	A human error analysis method that requires breaking down a procedure or overall tasks into unit tasks and combing this information in the form of event trees. It involves determining the detailed performance required of people and equipment and determining the effects of environmental conditions, malfunctions, and other unexpected events on both.	G1+
<u>Task Analysis</u>	A method for determining the detailed performance required of people and equipment and determining the effects of the surroundings, malfunctions, and other unexpected events on both.	G68
<u>Tautomerizing</u>	Converting from one isomer into another in organic compounds that differ from one another in the position of a hydrogen atom and a double bond. CCPS 1995b	G81
<u>Taxonomy</u>	A hierarchical organization of data cells, where the items contained in a given level have more equipment reliability characteristics in common with each other than they do with items in any other level.	G6 G7

<u>Taxonomy number</u>	The precise address of a data cell as defined by the classification scheme of the CCPS Taxonomy.	G7
<u>Technology package</u>	Information typically provided to a toller by their client delineating specifications for the equipment, chemicals, processing and quality control for a toll. Process safety information is a subset of the technology package.	G68
<u>Temperature of no return</u>	The temperature at which the rate of heat generation of a reaction or decomposition is equal to the maximum rate of cooling available. Barton and Rogers 1997	G81
<u>Teratogen</u>	A substance or agent to which exposure of a pregnant female can result in malformations in the fetus.  <b>Importance:</b> If a substance is known to be a teratogen, a potential health hazard exists and special protection and precaution sections should be checked on a MSDS.	G17
<u>Test Equipment (TE)</u>	A manufacturer's Catalogued Peripheral equipped with pushbuttons, lamps, keyboards, displays, or equivalent, etc., for troubleshooting or the PES and/or the controlled application. TE is said to be Pluggage when it may be plugged or unplugged at any time into its associated interface, without any risk to the operators and the application. In all other cases TEs are said to be Fixed. TEs may be Permanently Installed or not. TEs are intended for use by authorized personnel only.	G24
<u>Thermally Unstable</u>	Chemicals and materials are thermally unstable if they decompose, degrade or react as a function of temperature and time.	G35
<u>Thermally Unstable</u>	A material that will undergo an exothermic, selfsustaining or accelerating self-reaction (decomposition, polymerization or rearrangement) when heated to a specific temperature for given conditions of pressure, volume, composition and containment. Thus, the self-reaction can be initiated by thermal energy alone. CCPS 1995b	G81
<u>Thermodynamic Data</u>	Data associated with the aspects of a reaction that are based on the thermodynamical law's of energy, such as Gibb's free energy, and the enthalpy (heat) of reaction.	G35

<u>Threshold Limit Value Ceiling (TLV-C)</u>	The concentration in air that should not be exceeded during any part of the working exposure. Ceiling limits may supplement other limits or stand alone. Developed by the American Conference of Governmental Industrial Hygienists (ACGIH).	G3
<u>Threshold Limit Value-Short-Term Exposure Limit (TLV-STEL)</u>	A 15-minute, time -weighted average concentration to which workers may be exposed up to four times per day with at least 60 minutes between successive exposures with no ill effect if the TLV-TWA (see below) is not exceeded. The limit supplements the TLV-TWA where there are recognized acute effects from a substance with toxic effects that result primarily from chronic exposures. Developed by the ACGIH.	G3
<u>Threshold Limit Value-Time-Weighted Average (TLV-TWA)</u>	The time-weighted average concentration limit for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. Developed by the ACGIH.	G3
<u>Time, Total Input System Transfer Time</u>	<ul style="list-style-type: none"> <li>o For digital input : sum of TID and TIT.</li> <li>o For analog input : sum of TAID and TAIT.</li> </ul>	G24
<u>Time, Delay Time, Digital Input (TID), Analog Input (TAID)</u>	The delay encountered by the signal (*) as it passes through the input filter (from the Field Input Terminal(S) to the input conversion circuit boundary).	G24
<u>Time, Relay Time, Digital Output (TQD), Analog Output (TAQD)</u>	The delay encountered by the signal (*) as it passes through the output filter (from the output interface boundary to the Field Output Terminal(s)).	G24
<u>Time, Response Time, Analog</u>	The time required, following the initiation of a specified stimulus to a system, for an output going in the direction of necessary corrective action to first reach a specified value EANSI/IEEE Std 100-1977s.	G24
<u>Time, Scan Time (TSC)</u>	The time elapsed between two subsequent initiations of the same portion of the Application Program, including the time required to update the I/O Image Table, where applicable.	G24
<u>Time to thermal runaway</u>	An estimation of the time required for an exothermic reaction, in an adiabatic container, (that is, no heat gain or loss to the environment), to reach the point of thermal runaway. ASTM E 1445	G81

<u>Time, Total Output System Transfer Time</u>	<ul style="list-style-type: none"> <li>o For digital output : sum of TQT and TQD.</li> <li>o For analog output : sum of TAQT and TQAD.</li> </ul>	G24
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Note: For digital input or output, signal is synonymous with O/1 or 1/O transition. For analog input, signal is synonymous with noticeable change of analog value of the measured signal. For analog output, TAQD is the analog response time of the digital to analog output circuitry.

<u>Time, Total System Response Time, Digital (TRT)</u>	The time elapsed between a change input signal state at the Field Input Terminals and the corresponding change in the output signal(s) state(s) at the Field Output Terminals. TRT is the sum of all individual (partial) times encountered by the signal (information) as it pass through the PES from the field Input Interface to the Field Output Interface. Generally all partial times may vary depending upon many conditions such as the hardware configuration (e.g., RIOSs communication links that may affect TIT and TQT, the method used to acquire and process data such as periodic scan interrupts, and the instantaneous load of the application program.	G24
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<u>Time, Transfer Time, Digital Output (TQT), Analog Output (TAQT)</u>	The time required by the signal to pass (transfer) from the data storage in a MPU memory (since it is elaborated by the Application Program) to the output storage at the output interface boundary.	G24
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<u>Time, Transfer Time, Digital Input (TIT), Analog Input (TAIT)</u>	The time required by the signal to pass (transfer) from the data storage in a MPU memory (e.g., to be made available to the APPLICATION PROGRAM.)	G24
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<u>Time, User Task Execution Time (TUT)</u>	The time required by a MPU to carry out a specified portion of a user's Application Program (e.g., a Statement, a Program Module, etc.), including reading from memory and storing the result, and additional time required by the System Software.	G24
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<u>Time In Service</u>	Time from that moment when equipment installation is complete, the time period for equipment commissioning, and the operating time thereafter.	G6
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<u>Time of Day</u>	The time within a 24-hour day, represented according to ISO 3307.	G24
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<u>Time Related Failure</u>	A failure that is primarily due to the degradation over the time that a device or system is in service. For example, the failure of a pump after 2000 hours of continuous service due to wear on the bearings would be considered a time-related failure.	G6
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<u>Time To Failure</u>	The time period measured from the moment when equipment installation is complete to the equipment's inability to perform its duty or intended function.	G6
<u>Time Varying Continuous Release</u>	A subset of continuous release (See Continuous Release) that the release rate varies significantly with time.	G6
<u>Timer, Off-Delay</u>	A function block delaying a boolean input a specified Duration when changing from one to zero.	G24
<u>Timer, On-Delay Timer</u>	A function block delaying a boolean input signal a specified Duration when changing from zero to one.	G24
<u>TLm</u>	Median Tolerance Limit at which approximately 50% of the exposed species will show abnormal behavior including death under the conditions of concentration and time given.	G33
<u>TLV</u>	<p>Threshold Limit Value; a term used by ACGIH to express the airborne concentration of a material to which nearly all persons can be exposed day after day without adverse effect. ACGIH expresses TLV's in three ways:</p> <p>TLV-TWA: The allowable Time Weighted Average concentration for a normal 8-hour workday or 40-hour work week.</p> <p>TLV-STEL: The Short-Term Exposure Limit, or maximum concentration for a continuous 15-minute exposure period (maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided that the daily TLV-TWA is not exceeded).</p> <p>TLV-CL: The Ceiling exposure limit - the concentration that should not be exceeded even instantaneously.</p> <p>TLV's are reviewed and revised annually where necessary by the ACGIH.</p> <p><b>Importance:</b> If a TLV is exceeded, a potential health hazard exists and corrective action is necessary. Also see "Skin" relative to TLV's.</p>	G17
<u>TNT Equivalence Models</u>	Models of explosion characteristics relating vapor cloud explosions to the explosion of an equivalent mass of TNT (trinitrotoluene).	G60
<u>Tolerable Risk Level</u>	The maximum level of risk of a particular technical process or condition that is regarded as tolerable in the context of the circumstances in questions. Ref. WG10.	G24
<u>Tolerance</u>	A measure of the uncertainty arising from the physical and the environmental differences between members of differing equipment populations when failure rate data is aggregated to produce a final generic data set.	G7

<u>Toll manufacturer</u>	Contract manufacturer (external manufacturer).	G81
<u>Toller</u>	An outsourced manufacturing company contracted to process materials to another company's specifications. Sometimes called third party service provider, toll processor, supplier of outside services, external contract manufacturer, contract processor, contract manufacturer, custom chemical manufacturer.	G68
<u>Tolling</u>	Providing manufacturing services for a fee by a contractor (the toller), to a company issuing (letting) a contract for those services. Tolloed services can include, reaction processes, formulation, blending, mixing or size reduction, separation, agglomeration, packaging/repackaging, and others or a combination of the above. GLOSSARY 217	G68
<u>Top Event</u>	The unwanted event or incident at the "top" of a fault tree that is traced downward to more basic failures using logic gates to determine its causes and likelihood.	G35 G24 G6
<u>Top-Hat Dispersion Models</u>	Dispersion models with no concentration gradients within the vapor cloud. The concentration is modeled as a well-mixed system within the vapor cloud and zero outside the cloud.	G60
<u>Toxic Dose</u>	The combination of concentration and time for inhalation of a toxic gas that produces a specific harmful effect.	G6
<u>Toxic Hazard</u>	In the context of these guidelines, a measure of the danger posed to living organisms by a toxic agent, determined not only by the toxicity of the agent itself, but also by the means by which it may be introduced into the subject organisms under prevailing conditions.	G3 G4
<u>Toxicity</u>	The quality, state, or degree to which a substance is poisonous and/or may chemically produce an injurious or deadly effect upon introduction into a living organism.	G3
<u>Toxic Gas (NFPA 55)</u>	A gas having a health hazard rating of 3 or 4 as defined in NFPA 704. 10.3. Design and Construction <b>167</b>	G33
<u>Taxonomy number</u>	The precise address of a data cell as defined by the classification scheme of the CCPS Taxonomy.	G7

<u>Trade Name</u>	The trademark name or commercial trade name for a material.	G17
	<b>Importance:</b> A MSDS will list trade name(s) to help identify specific materials.	
<u>Transition region</u>	Any region marking the area where one formula is used at smaller values of the independent variable (say, $x$ , or $z$ ) and another formula is used at larger values of the independent variable. In this book, transition or interpolation formulas are suggested so the solution varies smoothly across the transition region.	G75
<u>Transitional Brush Discharge</u>	A partial discharge from a nonconductive layer on a conductive substrate. The effective energy is highly dependent on the breakdown voltage of the layer and is intermediate between brush discharges and propagating brush discharges. The more energetic of these discharges might ignite dust in air.	G67
<u>Transmissivity</u>	The fraction of radiant energy that is transmitted from the radiating object through the atmosphere to a target. The transmissivity is reduced due to the absorption and scattering of energy by the atmosphere itself.	G6
<u>Triac</u>	A bidirectional rectifier (essentially two SCRs in parallel) that function as an electrically controlled switch for ac loads and having an npnpn structure that can be triggered into either forward or reverse conduction by a pulse applied to its gate electrode. A triac will pass an alternating current. (Formal name is bidirectional triode thyristor.) A thyristor that can be triggered into conduction in either direction. Terminals are called "main terminal 1", and "gate".	G24
	Semiconductor switching element. Commonly used in a-c output modules for (PESs).	
	A solid-state switch which, when turned on, will conduct electrical current in either direction.	
<u>Tribocharging</u>	Charge separation caused by rubbing of surfaces, creating "triboelectricity."	G67
<u>Trillion</u>	The cube of ten thousand. Similarly in the US system, a billion is the cube of one thousand and a million is the cube of one hundred.	G67
<u>Turbulence intensity</u>	The ratio of the turbulent velocity to the mean wind speed (e.g., $\sigma u/u$ ).	G75
<u>Turbulent Burning Velocity</u>	See Burning Velocity	G64

<u>Turbulent dispersion</u>	Rate of spread in the vertical (z), lateral (y), or downwind (x) directions of the pollutant cloud about its center of mass due to atmospheric turbulence in the atmosphere.	G75
<u>Turbulent velocities</u>	Components of turbulent speed fluctuations. For example, the lateral, longitudinal, and vertical turbulent velocities in the boundary layer are equal to about $\sigma_u$ (m/s) = $1.9u^*$ , $\sigma_v$ (m/s) = $2.4u^*$ , and $\sigma_w$ (m/s) = $1.25u^*$ .	G75
<u>Turnaround</u>	A time during which a unit is shut down for repair and maintenance after a normal run, before it is returned to operation. (Harcourt.com)	G83
<u>Unavailability</u>	The probability the fault event exists at a specified time.	G24
<u>Uncertainty</u>	A measure, often quantitative, of the degree of doubt or lack of certainty associated with an estimate of the true value of a parameter.	G6
<u>Unconfined Vapor Cloud Explosion (UVCE)</u>	When a flammable vapor is released, its mixture with air will form a flammable vapor cloud. If ignited, the flame speed may accelerate to high velocities and produce significant blast overpressure.	G6
<u>Undependability</u>	The probability the fault event exists at a specified time or occurs during a specified time interval.	G6
<u>Underlying Causes</u>	Actual root causes.	G56
<u>Undeveloped Event</u>	A base event that is not developed because of insufficient consequence or because information is unavailable.	G6 G24
<u>Unidirectional Flame Arrester</u>	An in-line flame arrester that is designed to stop flame propagation approaching from only one direction.	G64

<u>Uninterruptible Power Supply (UPS)</u>	<p>A power supply that employes automatic switching of main power supply from primary to secondary (usually battery and/or diesel generator) upon failure of the primary.</p> <p>A means of providing uninterrupted power to critical instrumentation for a limited period of time even in the event of a plant power failure. Usually accomplished by an inverter, transfer switch and batteries. Alternatives means may include motor generators.</p> <p>A type of power supply that can provide electrical power even when line power is lost.</p> <p>An iverter (AC from DC batteries) which provides a bumpless transition of power to the process control system in the event of plant power failure. the UPS will supply for a limited period (e.g., 15 minutes).</p>	G24
<u>UN/NA Number</u>	<p>A four digit number used by both the United Nations and the U.S. Department of Transportation. This number is assigned to a hazardous chemical or group of hazardous chemicals.</p>	G33
<u>Unprotected Side of Flame Arrester</u>	<p>The side of a flame arrester and system to which it is connected where flame is expected</p>	G64
<u>Unreliability</u>	<p>The probability that the fault event occurs during a specified time interval.</p>	G6 G24
<u>Unrevealed Faults</u>	<p>A failure may lie dormant in the system and only be discovered as a result of a thorough diagnostic testing procedure.</p>	G24
<u>Unstable</u>	<p>Tending toward decomposition or other unwanted chemical change during normal handling or storage.</p> <p><b>Importance:</b> A MSDS will list materials that are unstable and conditions to avoid to prevent decomposition or unwanted chemical changes.</p>	G17

<u>Unstable Detonation</u>	See Overdriven Detonation.	G64
<u>Unstable material</u>	A material that, in the pure state or as commercially produced, will vigorously polymerize, decompose or condense, become self-reactive, or otherwise undergo a violent chemical change under conditions of shock, pressure, or temperature. NFPA 704 2001	G81
<u>Unstable Substance/Material</u>	Substance or material which in a pure state or as normally produced decomposes either or not violently.	G35
<u>Update and Revalidate</u>	To revise a prior PHA, as required, to reflect any changes that have occurred since the prior PHA; new learnings about the hazards of the process; changes in risk management requirements; etc.	G71
<u>Upper Flammable Limit (UFL):</u>	The highest concentration of combustible material that will propagate a flame from an ignition source through a mixture of flammable gas, aerosol, or combustible dust in air. Also known as the Upper Explosive Limit (UEL).	G60
<u>Upper Flammable Limit (UFL)</u>	The highest concentration of a vapor or gas (the highest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. See also Lower Flammable Limit. At concentrations higher than the UFL, the mixture is too "rich" to burn.	G62
<u>Upper Flammable Limit (UFL)</u>	That concentration of a combustible material in air above which ignition will not occur. It is often, interchangeably, called Upper Explosive Limit (UEL). Mixtures above this limit are said to be "too rich."	G64
<u>Upper Flammable Limit (UFL)</u>	The highest molar (or volume) concentration of a combustible substance in an oxidizing medium that will propagate a flame.	G67
<u>UPS</u>	See Uninterruptible Power Supply.	G24

<u>URA</u>	Uniform Roughness Array used at the Kit Fox experiments, consisting of rectangular plywood boards with width, $W = 0.8$ m, and with height, $Hr = 0.2$ m.	G75
<u>Urban/industrial heat island</u>	Because of heat generated by man's activities and by industrial processes, an urban or industrial area is often several degrees warmer than its surroundings. This is called a heat island. The thermal input from home heating or from industrial processes are typically of order 10 to 100 W/m <sup>2</sup> , or the same order as the natural boundary layer daytime heat flux, $H_s$	G75
<u>User Program</u>	Synonymous with Application Program.	G24
<u>User Program Memory</u>	The portion of the PES memory reserved for the storage of Application Programs.	G24
<u>UVCE</u>	Unconfined Vapor Cloud Explosion; Explosive oxidation of a vapor cloud in a non-confined space (i.e. not in vessels, buildings, etc.). Vapor cloud explosions in densely packed plant areas (pipe lanes, units, etc.) may show accelerations in flame speeds and intensification of blast.	G35
<u>Vapor</u>	A gas that is at a temperature below the critical temperature, so that it can be liquefied by compression, without lowering its temperature. It is the gas phase of a substance, particularly of those that are normally liquids or solids at ordinary temperatures.	G64
<u>Vapor Cloud Explosion (VCE):</u>	Explosive oxidation of a vapor cloud in a nonconfined space (not in vessels, buildings, etc.). The flame speed may accelerate to high velocities and produce significant blast overpressure. Vapor cloud explosions in plant areas with dense equipment layouts may show acceleration in flame speed and intensification of blast.	G62
<u>Vapor Cloud Explosion (VCE):</u>	The explosion resulting from the ignition of a cloud of flammable vapor, gas, or mist in which flame speeds accelerate to sufficiently high velocities to produce significant overpressure. (CCPS, 1994)	G83
<u>Vapor Collection System</u>	A piping system to which vessels are connected, that collects vapors from these vessels and directs them to environmental control equipment such as flares, incinerators, scrubbers, and activated carbon adsorbers.	G64

<u>Vapor Density</u>	<p>The weight of a vapor or gas compared to the weight of an equal volume of air; an expression of the density of the vapor or gas. Materials lighter than air have vapor densities less than 1.0 (example: acetylene, methane, hydrogen). Materials heavier than air (examples: propane, hydrogen sulfide, ethane, butane, chlorine, sulfur dioxide) have vapor densities greater than 1.0.</p> <p><b>Importance:</b> All vapors and gases will mix with air, but the lighter materials will tend to rise and dissipate (unless confined). Heavier vapors and gases are likely to concentrate in low places - along or under floors, in sumps, sewers and manholes, in trenches and ditches - and can travel great distances undetected where they may create fire or health hazards.</p>	G17
<u>Valve Failure Positions</u>	<p>In the event of instrument air or electrical power failure, valves either Fail Closed (FC), Fail Open (FO), or Fail in the last position (FL). The position of failure must be carefully selected so as to bring the system to, or leave the system in a safe operating state.</p>	G62
<u>Vapor Pressure</u>	<p>The pressure exerted by a vapor above its own liquid. The higher the vapor pressure, the easier it is for a liquid to evaporate and fill the work area with vapors which can cause health or fire hazards.</p>	G62
<u>Vapor Pressure, <math>P_s</math></u>	<p>The pressure exerted by a saturated vapor in equilibrium with its own liquid.</p>	G60
<u>Variable</u>	<p>A quantity or condition whose value is subject to change and can usually be measured.</p> <p>A language object that may take different values, one at a time. Note: the values of a variable are usually restricted to a certain data type.</p>	G24
<u>Velocity Flame Stopper</u>	<p>See Flow Controlled Aperture.</p>	G64
<u>Vendor</u>	<p>The hardware and software suppliers of a computerized system. There may be multiple vendors for a computerized system. The vendor may or may not be a manufacturer of the computerized system. For example, the vendor may be a systems house who simply integrates subsystems or components manufactured by others or may be a computer store.</p>	G24
<u>Vent</u>	<p>An opening for the passage of, or dissipation of, fluids, such as gases, fumes, smoke, and the like.</p>	G64

<u>Vent models</u>	A group of specialized models for expressing the concentration on the roof or side of a building resulting from emissions from a short vent on the building.	G75
<u>Ventilation</u>	The process of supplying or removing an atmosphere to or from any space by natural or mechanical means.	G64
<u>Venting</u>	Emergency flow of vessel contents out of a vessel. The pressure is controlled or reduced by venting, thus avoiding a failure of the vessel by overpressurization. The emergency flow can be one-phase or multi-phase, each of which results in different flow characteristics.	G62
<u>Vent Manifold</u>	See Vapor Collection System	G64
<u>Very near-field</u>	The area very close to the source where the specific geometry of one or two individual obstacles influence the flow and dispersion. <b>200 Wind Flow and Vapor Cloud Dispersion at Industrial and Urban Sites</b>	G75
<u>Virtual Source</u>	The offset in distance to the specified source of a gas or vapor release that results in a maximum concentration of 100% at the source using a gaussian dispersion model.	G6
<u>Virtual source method</u>	This method is applied when there is a change in dispersion conditions at some point along a plume trajectory due to changes in underlying surface, stability, wind speed, or other effects. In order that the calculated plume dispersion coefficient has no discontinuities, a virtual distance is calculated upwind of the position of interest so that the dispersion coefficient is the same at that point for the upstream conditions and the downstream conditions.	G75
<u>Viscous Nonconductive Liquid</u>	Nonconductive liquid having a kinematic viscosity above 30–100 cS and a very slow rate of charge dissipation, equivalent to a conductivity of about 0.02 pS/m and a relaxation time of about 1000 s.	G67
<u>Voltage (V)</u>	See “Potential.”	G67
<u>Voltage-Common Mode</u>	The voltage common to all conductors of a group as measured between that group at a given location and an arbitrary reference (usually Earth).	G24
<u>Voltage-Transverse Mode (Differential)</u>	The voltage at a given location between two conductors of a group.	G24
<u>Volume Blockage Ratio (VBR):</u>	The ratio of the volume occupied by congestion elements such as pipes, beams, plates, etc. to the volume of the portion of the plant under consideration.	G60

<u>Volume-Source Explosion Models</u>	Models that predict explosion characteristics based on the volumetric portion of the flammable cloud involved in the explosion (that portion of the flammable cloud that is influenced by congested and/or confined volumes in a plant).	G60
<u>Voting System</u>	An out of n redundant system which requires at least m of the n channels to be working to ensure the system is working.	G24
<u>Watch Dog Timer (WDT)</u>	A timer implemented to prevent the system from looping endlessly or becoming idle because of program errors or equipment faults.	G24
	Program Control Monitor indicates when a program execution has exceeded a prescribed time period.	
<u>Watchdog</u>	A manufacturer provided means performing specific actions if the integrity of the PES is violated.	G24
	A manufacturer provided means which independently monitors the Duration of internal hardware functions, and/or Application Program functions, and/or Operating System Software functions, and which will cause specific actions to be performed if not periodically reset at a predetermined interval.	
	In control systems, a combination of hardware and software which acts as an interlock scheme, disconnecting the system's output from the process in event of system malfunction.	
<u>Watchdog Timer (External)</u>	An external watchdog timer is preferred to an internal watchdog timer to assure that outputs go to the Off state if the watchdog's logic is not properly executed every scan. Same as an "internal" WDT except the WDT performance cannot be compromised by any failure in the system it is monitoring (e.g., no common mode fault within the PES). As a result many WDTs provided with PESs are not suitable as safety WDTs.	G24
<u>Watchdog Timer (Internal)</u>	A time interval to the CPU used to ensure that a scan is completed at least once each 200 milliseconds. Internal WDTs are subject to misoperation due to faults in the PES they are monitoring (e.g., common mode faults).	G24

<u>Water reactive</u>	A material that will react upon contact with water under normal ambient conditions. Includes materials that react violently with water and other materials that react slower but can generate heat or gases that can result in elevated pressure if contained. CCPS 1995b	G81
<u>Wet deposition</u>	Removal of gas and aerosol pollutants by rain or cloud droplets.	G75
<u>Wind Rose</u>	A plan view diagram that shows the percentage of time the wind is blowing in a particular direction.	G6
<u>Wind tunnel</u>	Used for fluid modeling experiments at small scale. <b>Glossary 201</b>	G75
<u>Witness</u>	A person who has facts related, directly or indirectly, to the accident or incident.	G56
<u>Word</u>	A data element of length 16 bits.	G24
<u>Work Function</u>	The minimum energy required to extract the weakest bound electron from a particle surface and remove it to infinity.	G67
<u>Workplace Environmental Exposure Levels (WEELs)</u>	Similar to TLVs, but for materials not address by ACGIH or OSHA. Developed by the American Industrial Hygiene Association (AIHA).	G3
<u>Worst Case Consequence</u>	A conservative (high) estimate of the consequences of the most sever accident identified. For example, the assumption that the entire contents of a contained volume of toxic material is released to the most vulnerable area in such a way (all at once or continuous) as to have the maximum effect on the public or employees in that area. The contained volume could be chosen as the containers and pipes between shutoff valves or the entire process unit but probably not the entire plant.	G1 G24 G4
<u>Worst Case Scenario (WCS)</u>	The basis for an off-site consequence analysis required by the EPA RMP Rule. This intentionally conservative accident scenario assumes the release of the entire inventory of a vessel, under the most unfavorable conditions, and with the failure of most protective features. <b>Glossary xv</b>	G71

<u>Worst Credible Incident</u>	The most severe incident, considering only incident outcomes and their consequences, of all identified incidents and their outcomes, that is considered plausible or reasonably believable.	G1+ G6
<u>Worst Possible Incident</u>	The most severe incident, considering only incident outcomes and their consequences of all identified incidents and their outcomes	G1+ G6
<u>Zone</u>	Classification system for electrical and electronic equipment and wiring for all voltages in locations where fire or explosion hazards may exist, as defined in Article 505 of NFPA 70 "National Electrical Code." <b>272 GLOSSARY</b>	G67