

NOMENCLATURE FOR HAZARD AND RISK ASSESSMENT IN THE PROCESS INDUSTRIES

HAZARD AND RISK

HAZARD A physical situation with a potential for human injury, damage to property, damage to the environment or some combination of these.

CHEMICAL HAZARD A hazard involving chemicals or processes, which may realise its potential through, agencies such as fire, explosion, toxic or corrosive effects.

MAJOR HAZARD An imprecise term for a large scale chemical hazard, especially one which may be realised through an acute event. Or, a popular term for an installation, which has on its premises, a quantity of a dangerous substance which exceeds the amount prescribed by the above references.

HAZARDOUS SUBSTANCE A substance which by virtue of its chemical properties constitutes a hazard.

DANGEROUS SUBSTANCE A specific term defined in the CIMAH Regulations referring to listed substances and others meeting given criteria.

RISK The likelihood of a specified undesired event occurring within a specified period or in specified circumstances. It may be either a frequency (the number of specified event occurring in unit time) or a probability (the probability of a specified event following a prior event), depending on the circumstances.

SOCIETAL RISK The relationship between frequency and the number of people suffering from a specified level of harm in a given population from the realisation of specified hazards.

INDIVIDUAL RISK The frequency at which an individual may be expected to sustain a given level of harm from the realisation of specified hazards.

CONSEQUENCES

EXPLOSION A release of energy, which causes a pressure discontinuity or blast wave.

BLAST WAVE A pressure pulse formed by an explosion.

SHOCK WAVE A pressure pulse formed by an explosion in which a sharp discontinuity in pressure is created as the wave travels through a fluid medium at greater than sonic velocity.

MISSILES Fragments or whole systems, which are projected by a release of energy.

Types of Explosions

DEFLAGRATION The chemical reaction of a substance in which the reaction front advances into the unrelated substance at less than sonic velocity. Where a blast wave is produced which has the potential to cause damage, the term explosive deflagration is usually used.

DETONATION An explosion caused by the extremely rapid chemical reaction of a substance in which the reaction front advances into the unrelated substance at greater than sonic velocity.

CONFINED EXPLOSION An explosion of a fuel-oxidant mixture inside a closed system (e.g. vessel or building).

VAPOUR CLOUD EXPLOSION (VCE) The preferred term for an explosion in the open air of a cloud made up of a mixture of a flammable vapour or gas with air.

UNCONFINED VAPOUR CLOUD EXPLOSION (UVCE) Defined as for VCE above and is an imprecise term.

PRESSURE BURST The rupture of a system under pressure, resulting in the formation of a blast wave and missiles, which may have the potential to cause damage.

RAPID PHASE TRANSITION The rapid change of state of a substance, which may produce a blast wave and missiles.

BLEVE Used to describe the sudden rupture of a vessel/system containing liquefied flammable gas under pressure due to fire impingement. The pressure burst and the flashing of the liquid to vapour creates a blast wave and potential missile damage, and immediate ignition of the expanding fuel-air mixture leads to intense combustion creating a fireball.

Common Technical Terms used in quantifying the Effects

OVERPRESSURE For a pressure pulse (blast wave), the pressure developed above atmospheric pressure at any stage or location is called the overpressure. Overpressure is sometimes used to describe exposure of equipment to pressures in excess of the design pressure, but the term overpressurisation is preferred for this purpose.

PEAK POSITIVE The maximum overpressure generated is called the peak positive

OVERPRESSURE	overpressure.
DURATION	The time taken for the pressure pulse to decline to zero is known as the positive phase duration, usually shortened to duration.
SIDE-ON OVERPRESSURE	If a pressure-sensitive device which offered no obstruction to the passage of the blast wave was placed in its path (i.e. one which was facing sideways in relation to its advance), the device would record side-on overpressure.
REFLECTED OVERPRESSURE	If a "rigid" object was perpendicular to the advance of the blast wave (i.e. facing), the object would reflect and diffract the wave. Due to this reflection, the object will experience an effective overpressure of at least twice the side-on overpressure.
EPICENTRE	The ground location beneath the inferred centre of a vapour cloud explosion.
EXPLOSION EFFICIENCY	The ratio of the energy in the blast wave to the energy theoretically available from the heat of combustion, usually expressed as a percentage.
TNT EQUIVALENT	The amount of TNT (trinitrotoluene) which would produce the same damage effects as those of the explosion under consideration. For non-dense phase explosions the equivalence has meaning only at a considerable distance where the nature of the blast wave arising is comparable with that of TNT.
Fires	
THERMAL RADIATION	The propagation of energy in the infra-red region of the electromagnetic spectrum.
FIRE	A process of combustion characterised by heat or smoke or flame of any combination of these.
BURNING RATE	The linear rate of evaporation of material from a liquid pool during a fire, or the mass rate of combustion of a gas or solid. The context in which the term is used should be specified.
JET FLAME	The combustion of material emerging with significant momentum from an orifice.
FLAME FRONT	The boundary between the burning and unburnt portions of a flammable vapour and air mixture, or other combusting system.

FLASH FIRE	The combustion of a flammable vapour and air mixture in which flame passes through that mixture at less than sonic velocity, such that negligible damaging overpressure is generated.
LOWER FLAMMABLE LIMIT (LFL)	That concentration in air of a flammable material below which combustion will not propagate.
UPPER FLAMMABLE LIMIT (UFL)	That concentration in air of a flammable material above which combustion will not propagate.
FIREBALL	A fire, burning sufficiently rapidly for the burning mass to rise into the air as a cloud or ball.
FIRE STORM	An extremely large area fire resulting in a tremendous in-rush of air which may reach hurricane force.
EMISSIVITY	The ratio of the radiation emitted by any surface or substance to that emitted by a black body at the same temperature.
SURFACE FLUX	The radiant power emanating from unit area of a flame or other source.
VIEW FACTOR	The solid angle subtended by the source at the target, as a proportion of the solid angle of a hemisphere.
TRANSMISSIVITY	The fraction of incident thermal radiation passing unabsorbed through a path of unit length of a medium.
ABSORPTIVITY	The ratio of the radiant energy absorbed by any surface or substance, to that absorbed under the same conditions by a black body.
FIRE PREVENTION	Measures taken to prevent outbreaks of fire at a given location.
FIRE PROTECTION	Design features, systems or equipment which are intended to reduce the damage from a fire at a given location.

Toxic Substances

EXPOSURE	Amount of a toxic substance to which an individual is exposed. This may represent the amount ingested, absorbed or inhaled or it may refer to the integral of concentration with time in the immediate environment. Where ambiguity may arise the basis used to define the exposure should be specified.
DOSE	Used as a synonym with exposure
TOXIC	The property of substances which, when introduced into or absorbed by a living organism, destroy life or injure health.

POISON	Common term for a toxic substance
CORROSIVE	In the context of toxic substances a corrosive substance is one, which may, on contact with living tissues, destroy them.
ACUTE	Immediate, short-term. Relating to exposure: conditions, which develop rapidly and may cause harm within a short time. Relating to effects: effects, which appear promptly after exposure.
CHRONIC	Persistent, prolonged and repeated. Relating to exposure: frequent, or repeated, or continuous exposure to substances. Relating to effects: when physiological effects appear slowly and persist for a longer period or with frequent recurrences.
CARCINOGEN	A substance, which produces cancer.
TOXICITY	The relative power of a toxic material to cause harm.
IRRITANT	A non-corrosive material which may, through immediate prolonged or repeated contact with the skin or mucous membrane, cause pain, discomfort or minor injury. Such reactions may appear as a precursor to more serious injury.
ASPHYXIATION	Endangering life by causing a deficiency of oxygen.
CONTROL LIMIT	An occupational exposure limit, which should not normally be exceeded.
RECOMMENDED LIMIT	An occupational exposure limit which is considered to represent good practice and a realistic criterion for the control of exposure, plant design, engineering controls and the selection and use of personal protective equipment.
LONG TERM EXPOSURE LIMIT	A time weighted average concentration, usually average over 8 hours, which is appropriate for protecting against the effects of long term exposure.
SHORT TERM EXPOSURE LIMIT	A time weighted average concentration, usually average over 10 minutes, aimed at avoiding acute effects.
THRESHOLD LIMIT VALUE-TIME-WEIGHTED AVERAGE (TLA-TWA)	The time-weighted average concentration for a normal eight hour work day or 40-hour work week to which nearly all workers may be exposed, day after day, without adverse effect. (to be superseded by the term "Control Limit".)
THRESHOLD LIMIT VALUE-SHORT-TERM EXPOSURE LIMIT (TLV-STEL)	The maximum concentration to which workers can be exposed for a period of up to 15 minutes continuously without suffering from (1) intolerable irritation, (2) chronic or irreversible tissue change, or (3) narcosis of sufficient degree to increase accident proneness, impair self-rescue or materially reduce work efficiently; provided that the daily TLV-TWA also is not exceeded.

THRESHOLD LIMIT VALUE-CEILING (TLV-C)	The concentration, which should not be exceeded even instantaneously.
LETHAL DOSE (LD)	The quantity of material administered orally or by skin absorption which results in the death of 50% of the test group within a 14-day observation period.
LETHAL CONCENTRATION (LC)	The concentration of airborne material, the four-hour inhalation of which results in the death of 50% of test group within a 14-day observation period.
IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH)	Conditions such that an acute exposure will lead to acute or chronic effects.

RELEASES AND DISPERSIONS

Mechanisms of Releases

RELEASE	The discharge of energy or of a hazardous substance from its containment system.
CONTAINMENT SYSTEM	The process and storage equipment in which a hazardous substance is kept.
FRACTURE	The breaking open of a containment system by the propagation of a crack.
PUNCTURE	A perforation or hole in a containment system as a result of impact.
GUILLOTINE	Complete severance of piping.
CATASTROPHIC FAILURE (of containment)	The sudden opening up of a specified part of a containment system resulting in a rapid loss of contents.

Behaviour of Releases

INSTANTANEOUS RELEASE	The escape of a specified quantity of a hazardous substance over a short time span typically a few seconds.
CONTINUOUS RELEASE	The escape of a hazardous substance at a flow rate, which is sustained for a prolonged period.
FLASHING FLOW	Two phase flow in the leak path of a release of super-heated liquid.

FLASH FRACTION	The fraction of a superheated liquid that will vaporise under adiabatic conditions on depressurisation to atmospheric pressure.
MOMENTUM TURBULENCE	Turbulence induced by the speed with which the material is injected into the surrounding fluid.
REGRESSION RATE	The rate of decrease in depth of a liquid pool.
SOURCE TERM	The quantitative description of a release required as input to a consequence model, i.e. quantity or rate, concentration, temperature, density, etc.
Dispersion	
DISPERSION	The process of dilution of a hazardous substance by the surrounding fluid.
GAS	Adequately understood and used in common parlance. "Vapour" is sometimes used instead, particularly for the evaporation of a spill of liquid.
GAS CLOUD	The mass of gas/air mixture within a particular envelope of concentration mix.
PEAK CONCENTRATION	The highest concentration predicted at a point by a dispersion model.
ISOPLETH	A surface joining points of equal concentration, i.e. A three-dimensional "contour", in a gas cloud.
DENSE GAS CLOUD	A gas cloud which is heavier than the surrounding air immediately after the release process, because either the gas is a dense gas, or the mixture has a temperature sufficiently below ambient.
NEUTRAL DENSITY GAS CLOUD	A gas cloud, which has a density equal to that of the surrounding air.
BUOYANT GAS CLOUD	A gas cloud, which is lighter than the surrounding air.
DENSE GAS	A gas whose density exceeds that of air at the same temperature.
PASSIVE DISPERSION	A dispersion process depending only on atmospheric conditions in which the properties of the dispersing material do not affect the local turbulence.
WIND SPEED	The mean speed of the air past a stationary point at a specified height, e.g. 10m.
SURFACE ROUGHNESS	A measure related to that component of the turbulence of the atmosphere which is aided by the departure of the ground profile from perfect smoothness.

WEATHER CATEGORY	A measure related to that component of the intrinsic turbulence of the atmosphere, which is specifically determined by thermal stability.
PUFF	The gas cloud resulting from an instantaneous release.
PLUME	The gas cloud resulting from a continuous release.

ASSESSMENT TECHNIQUES

LOSS PREVENTION	A systematic approach to preventing accidents or minimising their effects. The activities may be associated with financial loss or safety issues and will often include many of the techniques defined in this report.
HAZARD ANALYSIS	The identification of undesired events that lead to the materialisation of a hazard, the analysis of the mechanisms by which these undesired events could occur and usually the estimation of the extent, magnitude and likelihood of any harmful effects.
RISK ASSESSMENT	The quantitative evaluation of the likelihood of undesired events and the likelihood of harm or damage being caused together with the value judgements made concerning the significance of the results.
HAZARD SURVEY	The total effort involved in an assessment of the hazards from an installation and their means of control.
RESIDUAL RISK	Is the remaining risk after all proposed improvements to the facility under study have been made?
SAFETY CASE	The presentation of a justification for the safety of an installation. (N.B. use in connection with CIMAH Regulations).
SAFETY AUDIT	A critical examination of all, or part, of a total operating system with relevance to safety.

Hazard Identification Methods

GUIDEWORDS	A list of words applied to system items or functions in a hazard study to identify undesired deviations.
FAILURE MODE AND EFFECTS ANALYSIS	A process for hazard identification where all known failure modes of components or features of a system are considered in turn and undesired outcomes are noted.
INITIATING EVENT	A postulated occurrence capable of leading to the realisation of a hazard
HAZARD AND	A study carried out by application of guidewords to identify all deviations

OPERABILITY (HAZOP) STUDY from design intent with undesirable effects for safety or operability.

CHECKLIST A method of hazard identification by comparison with experience in the form of a list of failure modes and hazardous situations.

HAZARD INDICES A checklist method of hazard identification, which provides a comparative ranking of the degree of hazard posed by particular design conditions.

Analytical Techniques

LOGIC DIAGRAM A representation of the logical combination or sequence of events leading to or from a specified state.

FAULT TREE ANALYSIS A method for representing the logical combinations of various system stages, which lead to a particular outcome (top event).

EVENT TREE ANALYSIS A method for illustrating the intermediate and final outcomes, which may arise after the occurrence of a selected initial event.

CAUSE-CONSEQUENCE ANALYSIS A method for illustrating the possible outcomes arising from the logical combination of selected input events or states.

TOP EVENT The selected outcome whose possible causes are analysed in a fault tree.

GATE A symbol in a logic diagram which specifies the logical combination of inputs required for an output to be propagated

Quantification of Event Frequency

FREQUENCY The number of occurrences per unit of time.

PROBABILITY A number in a scale from 0 to 1, which expresses the likelihood that one event, will succeed another.

RELIABILITY 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.

DEMAND A condition, which requires a protective system to operate.

FRACTIONAL DEAD TIME The mean fraction of time in which a component or system is unable to operate on demand.

FAILURE MODE The manner in which a component fails.

FAIL-TO-DANGER FAULT*	A fault, which moves a plant towards a dangerous condition or limits the ability of a protective system to respond to a dangerous condition.
FAIL-SAFE FAULT*	A fault, which results in no deterioration of safety.
REDUNDANCY	The performance of the same function by a number of identical but independent means.
DIVERSITY	The performance of the same function by a number of independent and different means.
COMMON CAUSE FAILURE	The failure of more than one component, item or system due to the same cause.
COMMON MODE FAILURE	The failure of components in the same manner.

Quantification of Event Consequences

HAZARD RANGE	The relationship between distance from the source of hazard and detriment.
VULNERABILITY MODEL	The mathematical models applied in the estimation of hazard range.
F-N CURVE	A plot showing, for a specified hazard, the frequency of all events causing a situated degree of harm to N or more people, against N.

CRITERIA

CRITERION	Is a standard of performance with which assessed performance may be compared?
TWO BOUNDARY CRITERION	Is a compound criterion with a lower standard, which must be achieved, and an upper standard as an ultimate goal.
SOCIETAL RISK CRITERIA	Criteria relating to the likelihood of a number of people suffering a specified level of harm in a given population from the realisation of specified hazards.
MAJOR INCIDENT CRITERION	Criterion (expressed as a frequency) for incidents falling within a defined category or consequences.
INDIVIDUAL RISK CRITERIA	Criteria relating to the likelihood with which an individual may be expected to sustain a given level of harm from the realisation of specified hazards.

AVERAGE INDIVIDUAL RISK	Is the average chance of an individual in a defined population sustaining a given level of harm from incidents, which are considered to be limited to that population.
PEAK INDIVIDUAL RISK	Is the highest individual risk for any person in the exposed population
FATAL ACCIDENT RATE (FAR)	(previously known as FAFR) is the number of deaths that have occurred or are predicted to occur in a defined group, in a given environment, during 10 hours of total exposure.
PERCEIVED RISK	Is that risk though by an individual or group to be presenting in a given situation.