

Guidelines for
Vapor Cloud Explosion,
Pressure Vessel Burst,
BLEVE, and Flash Fire Hazards

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Guidelines for Vapor Cloud Explosion, Pressure Vessel Burst, BLEVE, and Flash Fire Hazards

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GLOSSARY

Blast: 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.

BLEVE (Boiling Liquid, Expanding Vapor Explosion): The explosively rapid vaporization and corresponding release of energy of a liquid, flammable or otherwise, upon its sudden release from containment under greater-than-atmospheric pressure at a temperature above its atmospheric boiling point. A BLEVE is often accompanied by a fireball if the suddenly depressurized liquid is flammable and its release results from vessel failure caused by an external fire. The energy released during flashing vaporization may contribute to a shock wave.

Burning velocity: The velocity of propagation of a flame burning through a flammable gas-air mixture. This velocity is measured relative to the unburned gases immediately ahead of the flame front. Laminar burning velocity is a fundamental property of a gas-air mixture.

Deflagration: A propagating chemical reaction of a substance in which the reaction front advances into the unreacted substance rapidly but at less than sonic velocity in the unreacted material.

Detonation: A propagating chemical reaction of a substance in which the reaction front advances into the unreacted substance at or greater than sonic velocity in the unreacted material.

Emissivity: The ratio of radiant energy emitted by a surface to that emitted by a black body of the same temperature.

Emissive power: The total radiative power discharged from the surface of a fire per unit area (also referred to as surface-emissive power).

Explosion: A release of energy that causes a blast.

Fireball: A burning fuel-air cloud whose energy is emitted primarily in the form of radiant heat. The inner core of the cloud consists almost

completely of fuel, whereas the outer layer (where ignition first occurs) consists of a flammable fuel-air mixture. As the buoyancy forces of hot gases increase, the burning cloud tends to rise, expand, and assume a spherical shape.

Flame speed: The speed of a flame burning through a flammable mixture of gas and air measured relative to a fixed observer, that is, the sum of the burning and translational velocities of the unburned gases.

Flammable limits: The minimum and maximum concentrations of combustible material in a homogeneous mixture with a gaseous oxidizer that will propagate a flame.

Flash vaporization: The instantaneous vaporization of some or all a liquid whose temperature is above its atmospheric boiling point when its pressure is suddenly reduced to atmospheric.

Flash fire: 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.

Impulse: A measure that can be used to define the ability of a blast wave to do damage. It is calculated by the integration of the pressure-time curve.

Jet: A 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.

Lean mixture: A mixture of flammable gas or vapor and air in which the fuel concentration is below the fuel's lower limit of flammability (LFL).

Negative phase: That portion of a blast wave whose pressure is below ambient.

Overpressure: Any pressure above atmospheric caused by a blast.

Positive phase: That portion of a blast wave whose pressure is above ambient.

Pressure wave: See Blast.

Reflected pressure: Impulse or pressure experienced by an object facing a blast.

Rich mixture: A mixture of flammable gas or vapor and air in which the fuel concentration is above the fuel's upper limit of flammability (UFL).

Shock wave: *See* Blast.

Side-on pressure: The impulse or pressure experienced by an object as a blast wave passes by it.

Stoichiometric ratio: The precise ratio of air (or oxygen) and flammable material which would allow all oxygen present to combine with all flammable material present to produce fully oxidized products.

Superheat limit temperature: The temperature of a liquid above which flash vaporization can proceed explosively.

Surface-emissive power: *See* Emissive power.

Transmissivity: The fraction of radiant energy transmitted from a radiating object through the atmosphere to a target after reduction by atmospheric absorption and scattering.

TNT equivalence: The amount of TNT (trinitrotoluene) that would produce observed damage effects similar to those of the explosion under consideration. For non-dense phase explosions, the equivalence has meaning only at a considerable distance from the explosion source, where the nature of the blast wave arising is more or less comparable with that of TNT.

Turbulence: A random-flow motion of a fluid superimposed on its mean flow.

Vapor cloud explosion: 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.

View factor: The ratio of the incident radiation received by a surface to the emissive power from the emitting surface per unit area.

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A NOTE ON NOMENCLATURE AND UNITS

The equations in this volume are from a number of reference sources, not all of which use consistent nomenclature (symbols) and units. In order to facilitate comparisons within sources, the conventions of each source were presented unchanged.

Nomenclature and units are given after each equation (or set of equations) in the text. Readers should ensure that they use the proper values when applying these equations to their problems.