

MEASURING AND CONTROLLING HAZARDS

The vastly different burning characteristics of gases, liquids, and solids pose different types of hazards.

The methods for measuring and controlling them are also different. The Table shows the different kinds of measurement techniques available for different components of hazard. It is most convenient to think of hazard control in terms of first controlling the likelihood of ignition, then controlling or containing the fire spread, and finally managing fire impact if ignition and spread cannot be prevented.

Fire Hazards of Gases and Dusts

Combustible gases and dusts burn rapidly once ignited, so avoidance of ignition is very important. The two steps for doing this are (1) the determination of flammability limits, that is, the concentration range of a particular gas or dust (usually in air) within which ignition will occur, and (2) operating in a manner such that the concentration is maintained outside those limits. It is also possible to reduce the likelihood of ignition of a gas or dust by adding chemical inhibitors to raise the lower flammability limit. In practice, however, this is rarely done, either because of expense or because it alters otherwise desirable properties.

Ignition control is generally effected by stringent storage and handling safeguards; the bulk of the discussion in the chapters of this handbook on flammable gases are concerned with these procedures. It is also possible in closed environments to reduce the amount of oxygen available and thereby to raise the effective flammability limit. Conversely, atmospheres that are enriched with oxygen beyond normal atmospheric concentrations offer special explosion hazards for vapors and dusts. The intensity of a fire resulting from gases, vapors, or dust is a function of the density of gas or the concentration and particle size of the dust. Gases (hydrogen, for example) and very finely divided dust are rapidly dispersed and can lead to the onset of explosive conditions in short periods of time.

Fire and explosion control efforts concentrate on containing the products and, under specialized conditions, providing for automatic suppression of an

incipient explosion. This is done by rapidly introducing a suppressant, such as water vapor or a chemical inhibitor, into the exploding cloud. To be effective, automatic suppression must occur in a time scale of a few hundredths of a second. There has been concern over the possibility of large flammable gas fires in populated areas. With vast quantities of gaseous fuels now being transported either in bulk or by pipeline and the renewed interest in importation of liquefied natural gas by oceangoing tank vessels, the likelihood of such occurrences commands attention. The principal means by which the impact of such accidents is minimized is the use of hazardous material identification systems, for example, placarding and NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response. In the absence of a major breakthrough in the prevention or suppression of such fires, the most appropriate means of minimizing fire impact is the advanced planning, preparedness, and response of trained emergency personnel.

Fire Hazards of Liquids

Since burning actually occurs in the vapor phase, the most hazardous combustible liquids are those with a high vapor pressure, or volatility. An empirical measure that combines volatility with the heat-producing capabilities of the vapor is the flashpoint determination.

The flashpoint is simply the temperature at which a liquid gives off vapors that can be ignited under specified laboratory conditions. Flashpoint determinations give rise to hazard classification systems, the most severe hazard being afforded by those liquids with the lowest flashpoints. As in the case of gases, however, the principal means of controlling the ignition of combustible liquids is in handling safeguards. Elaborate procedures exist to minimize the escape of flammable vapors in the handling of volatile liquids and to avoid sources of ignition.

If a fire involving such materials is initiated, means are also available to prevent the supply of additional combustible fuel to the fire. These means include designs for the safe venting from storage tanks of vapors produced by heating due to fire exposure as well as flame arrestors to guard against the travel of

the flame into the storage area itself. Storage and separation criteria for bulk storage of flammable liquids are also used to minimize the likelihood that additional supplies of flammable liquids will come in contact with the fire. As described in a previous section, the intensity of the fire once begun is controlled by (1) the fuel’s volatility and (2) the amount of heat released when the fuel burns. Thus, heavy oils or tars may be difficult to ignite, but can burn readily once underway.

Some fire-fighting techniques interfere with the passage of fuel from the liquid to the vapor phase. These include cooling the liquid to slow vaporization and the use of foam to cover the liquid surface.

Fire Hazards of Solids

The part of the Table relating to solids concentrates on common materials; it ignores the large group of chemicals that are primarily found in specialized industrial environments. Unless these materials are present as dusts, foams, or in other forms that present high surface areas, their fire hazards are similar to those of liquids.

In the Table, solid materials are divided into two major classes: (1) flexible materials, such as textiles

and cushioning; and (2) structural materials, which can include everything from steel and concrete to wood and synthetic structural plastic foams. For both of these classes of materials there is a variety of tests to determine their susceptibility to ignition. However, since ignition requires the volatilization of some of the solid fuel, ignition behavior is strongly dependent on the amount of heat applied to the surface. Therefore, different ignition tests often give different results, depending on the size of the ignition source. The same principle applies to tests that attempt to measure flame spread over small samples. In many such tests, a sample receives no radiant heat load except that available from its own burning. The larger the amount of sample burning, the greater the heat transferred to the unburned area ahead of the flame and a large sample will appear to have a higher flame spread rate than a small one.

The fire hazards posed by inorganic structural materials are most likely to be passive. For example, steel can lose its strength, concrete can crack and spall, and glass can break and melt on exposure to high temperature. Such materials are therefore rated on their ability to withstand such high-temperature effects.

Reference:

O’Connor, Daniel J. and Bert Cohn. Strategies for Occupant Evacuation During Emergencies. Fire Protection Handbook 20th Edition. Massachusetts: NFPA. (2008)

Hazard Component Material	Ignition		Spread and Growth		Fire Impact	
	Measurement	Ignition Control	Measurement	Control of Spread and Growth	Measurement	Control of Fire Impact
Gases	Flammability limits	1. Storage and handling safeguards 2. Inerting of atmospheres	Flammability limits, density, diffusion coefficient	Tank venting procedures	Placarding, NFPA hazardous materials identifiers	1. Emergency response and evacuation 2. Placarding, NFPA hazardous materials identifiers
Liquids	Flashpoint	1. Handling safeguards 2. Hazard classification systems	Volatility	1. Ventilation and flame arrest 2. Storage and tank separation	Placarding, NFPA hazardous materials identifiers	1. Emergency response and evacuation 2. Placarding, NFPA hazardous materials identifiers
Solids 1. Textiles, cushioning materials	1. Ease of ignition tests and small-scale flame spread tests	1. Flame-resistant materials and treatments 2. Protective layers	1. Supported flame spread 2. Rate-of-heat release	1. Material selection and assembly 2. Detection and suppression	1. Smoke hazard assessment	1. Breathing apparatus for fire fighters 2. Smoke control systems
2. Structural materials, building components and finishes	Same	Same	Flame spread, rate-of-heat release	1. Fire resistivity 2. Low combustibility 3. Fire-resistant coatings 4. Detection and suppression	1. Fire endurance (stability, integrity, insulation) 2. Smoke hazard	Same, plus construction design: compartmentation; separation

Disclaimer
 This article has been compiled in good faith to the best of our knowledge and ability for the purpose of risk management interest. However, Global Intrima, PT hereby disclaims any responsibility whatsoever for any error or omission contained herein or for any damage or liability howsoever caused, arising from the use of this article of the information it contains by any party whatsoever.