

Introduction

Cylinder Information

Gas and Gas Mixture Shipping Classifications

The Department of Transportation (DOT) definitions of the three divisions for gases are as follows:

Division 2.1 (Flammable gas).

For the purpose of this subchapter, a "flammable gas" (Division 2.1) means any material which is a gas at 20°C (68°F) or less at 101.3 kPa (14.7 psia) which:

- (1) Is ignitable at 101.3 kPa (14.7 psia) when in a mixture of 13 percent or less by volume with air; or
- (2) Has a flammable range at 101.3 kPa (14.7 psia) with air of at least 12 percent regardless of the lower limit.

Division 2.2 (Non-flammable, non-poisonous compressed gas—including compressed gas, liquefied gas, pressurized cryogenic gas and compressed gas in solution asphyxiant gas and oxidizing gas).

For the purpose of this subchapter, a non-flammable, non-poisonous compressed gas" (Division 2.2) means any material (or mixture) which:

- (1) Exerts in the packaging an absolute pressure of 280 kPa (40.6 psia) or greater at 20°C (68°F) and
- (2) Does not meet the definition of Division 2.1 or 2.3.

Division 2.3 (Gas poisonous by inhalation).

For the purpose of this subchapter, "a gas poisonous by inhalation" (Division 2.3) means a material which is a gas at 20°C (68°F) or less and a pressure of 101.3 kPa (14.7 psia) (a material which has a boiling point of 20°C (68°F) or less at 101.3 kPa (14.7 psia) and which:

- (1) Is known to be so toxic to humans as to pose a hazard to health during transportation, or
- (2) In the absence of adequate data on human toxicity, is presumed to be toxic to humans because when tested on laboratory animals it has an LC₅₀ value not more than 5000 ml/m³.

Division 2.3 is divided into four groups known as hazard zones, which are:

- **Hazard Zone A:** gases and mixtures with an LC₅₀ ≤ 200 ppm
Examples: Arsine, Phosgene
- **Hazard Zone B:** gases and mixtures with an LC₅₀ ≤ 1000 ppm > 200 ppm
Examples: Methyl Bromide, Dichlorosilane
- **Hazard Zone C:** gases and mixtures with an LC₅₀ ≤ 3000 ppm > 1000 ppm
Examples: Methyl Mercaptan, Carbonyl Sulfide
- **Hazard Zone D:** gases and mixtures with an LC₅₀ ≤ 5000 ppm > 3000 ppm
Examples: Carbon Monoxide, Hydrogen Chloride

The LC₅₀ of a gas mixture can be calculated from the following formula providing the LC₅₀(s) of the toxic component(s) are known:

$$\text{LC}_{50} \text{ of Gas Mixture in ppm} = \frac{1 \times 10^6}{\frac{\text{ppm of Toxic \#1}}{\text{ppm LC}_{50} \text{ of Toxic \#1}} + \frac{\text{ppm of Toxic \#2}}{\text{ppm LC}_{50} \text{ of Toxic 2}} + \dots}$$

Further information regarding Division 2.3 classification is shown in 49 CFR 173.116 and 173.133 and the Compressed Gas Association Pamphlet "Standard for the Classification of Toxic Gas Mixtures", P-20-2003.

The International Organization for Standardization (ISO) published Standard 10156, "Gases and Gas Mixtures - Determination of Fire Potential and Oxidizing Ability for the Selection of Cylinder Valve Outlets in December 1990." The methods described differentiate the diluent effects of different background gases. For example:

The maximum concentration of hydrogen in nitrogen which produces a nonflammable mixture is 5.7%, if helium were the background gas the value would be 4.45%.

The application of these methods to gas mixtures which contain minor components which are both toxic and flammable mixed with a nonflammable background or diluent gas may yield as many as 6 different shipping descriptions. For this reason it becomes unwieldy to show the classifications in association with the product descriptions. Please see CGA P-23-2003 "Standard for Categorizing Gas Mixtures Containing Flammable and Non Flammable Components" for additional clarifying information.

