

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, nonpoisonous 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:

$$\text{LC}_{50} \text{ of Gas Mixture in ppm} = \frac{1 \times 10^6}{\frac{\text{ppm of Toxic \#1}}{\text{ppm LC50 of Toxic \#1}} + \frac{\text{ppm of Toxic \#2}}{\text{ppm LC50 of Toxic \#2}} + \dots}$$

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.

