Gas mixtures that contain trace amounts of a toxic constituent are typically non-toxic. However, Material Safety Data Sheets (MSDSs) typically give toxicity information for pure substances rather than the dilute mixture in the product. The purpose of this brief, is to justify use of engineering judgment in screening out these dilute mixtures.

The table below shows toxicity criteria for a Health Hazard Rating (HHR) of 3 or 4. This table is from NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*. For each HHR, I've bolded the criterion for inhalation toxicity of gases.

| Degree of Hazard* | Criteria |
|---|---|
| **4** — Materials that, under emergency conditions, can be lethal. | **Gases whose $LC_{50}$ for acute inhalation toxicity is ≤ 1000 ppm.** |
| | Any liquid whose saturated vapor concentration at 20°C (68°F) is ≥ ten times its $LC_{50}$ for acute inhalation toxicity, if its $LC_{50}$ is ≤ 1000 ppm. |
| | Dusts and mists whose $LC_{50}$ for acute inhalation toxicity is ≤ 0.5 mg/L. |
| | Materials whose $LD_{50}$ for acute dermal toxicity is ≤ 40 mg/kg. |
| | Materials whose $LD_{50}$ for acute oral toxicity is ≤ 5 mg/kg. |
| **3** — Materials that, under emergency conditions, can cause serious or permanent injury. | **Gases whose $LC_{50}$ for acute inhalation toxicity is > 1000 ppm but ≤ 3000 ppm.** |
| | Any liquid whose saturated vapor concentration at 20°C (68°F) is ≥ its $LC_{50}$ for acute inhalation toxicity, if its $LC_{50}$ is ≤ 3000 ppm and that does not meet the criteria for degree of hazard 4. |
| | Dusts and mists whose $LC_{50}$ for acute inhalation toxicity is > 0.5 mg/L but ≤ 2 mg/L. |
| | Materials whose $LD_{50}$ for acute dermal toxicity is > 40 mg/kg but ≤ 200 mg/kg. |
| | Materials that are corrosive to the respiratory tract. |
| | Materials that are corrosive to the eye or cause irreversible corneal opacity. |
| | Materials that are corrosive to skin. |
| | Cryogenic gases that cause frostbite and irreversible tissue damage. |
| | Compressed liquefied gases with boiling points at or below -55°C (-66.5°F) that cause frostbite and irreversible tissue damage. |
| | Materials whose $LD_{50}$ for acute oral toxicity is > 5 mg/kg but ≤ 50 mg/kg. |

According to DOE O 151.1C, we may screen out chemicals with an HHR < 3; therefore, we may screen out non-corrosive gases for which the $LC_{50}$ is > 3000 ppm (cryogenicity is explicitly excluded as a criterion in DOE G 151.1-2).

When screening a gas mixture, one should look at the $LC_{50}$ of the *mixture*, not any particular *constituent*. For example, assume product A is a mixture of 1% carbon monoxide in air. Exposure to 1000 ppm of product A is equivalent to an exposure of only 10 ppm carbon monoxide (0.01 x 1000 = 10). To be exposed to a carbon monoxide concentration of 3000 ppm, one must be exposed to a concentration of 300,000 ppm of the product (0.01 x 300,000 = 3000). So, to find the $LC_{50}$ of a *mixture*, one may divide the $LC_{50}$ of the *constituent* of interest by the *fraction* in the mixture.

Implicit in the screening of dilute mixtures is the assumption that the mixture is non-corrosive. This is a reasonable assumption for mixtures diluted to about 1% or less of the toxic constituent. For a point of reference, 40CFR355 *Emergency Planning and Notification* is applicable only to extremely hazardous substances at concentrations greater than 1 %. According to NFPA 704, materials that are *respiratory irritants* or that may *cause severe but reversible irritation to the eyes* may be given a HHR of 2.

From one distributor[1], I compiled $LC_{50}$ values for 5 gases of concern:

| **Chemical** | **Chemical $LC_{50}$**[2] (ppm) | **Maximum Fraction**[3] | **Mixture**[4] **$LC_{50}$** (ppm) |
|---|---|---|---|
| Ammonia | 7338 | 1000/1E6 = 1E-3 | >> 3000 |
| Carbon monoxide | 3760 | 1.01% = 1.01E-2 | >> 3000 |
| Hydrogen sulfide | 712 | 1022/1E6 = 1E-3 | >> 3000 |
| Nitrogen dioxide | 115 | 10,000/1E6 = 1E-2 | >> 3000 |
| Sulfur dioxide | 2520 | 1% = 1E-2 | >> 3000 |

I reviewed SRS's chemical inventory database and my method seems consistent with how their NFPA-equivalent HHR is assigned. Chemicals that, by themselves, have an HHR of 3 or 4 were given a lower rating when they appeared in small quantities in a gas mixture. For example, carbon monoxide mixtures up to 15% were given an HHR of 2; those that contained 20% or more were given a rating of 3.

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[1] Scott Specialty Gases
[2] Rat, 1 hour (values taken from MSDS). I used these values because all were based on a 1-hr exposure $LC_{50}$.
[3] Based on the maximum concentration (ppm or %) from a given EPHA calc.
[4] $LC_{50}$ of the pure chemical divided by its maximum concentration in the mixture