

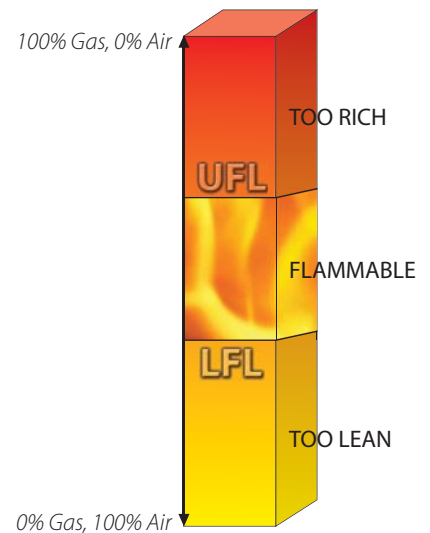
## Gas Vapor in Air Mixtures

Gas/vapor hazards usually are present in air. The amount of gas/vapor present reduces the amount of air present. There are three basic mixtures of a flammable gas/vapor in air:

1. Rich mixture: too much fuel; cannot burn
2. Flammable mixture
3. Lean mixture: not enough fuel; cannot burn
  - Note that the flammable range has an upper limit and a lower limit. Since the best way to control flammable hazards is to control the amount of fuel present, we will be focusing on staying below the Lower Flammable Limit.

The Lower Flammable Limit (LFL) is defined as the lowest concentration of flammable gas or vapor in air sufficient to propagate a flame, given a source of ignition.

- Some people refer to the Lower Flammable Limit as the LEL. Both terms are used interchangeably, although LFL is the technically correct term.

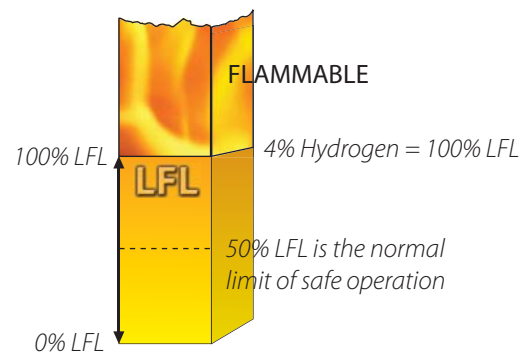


*Gas in Air Mixtures*  
As the concentration of flammable gas/vapor in air increases, the mixture changes from too lean to burn, to flammable, and then to too rich to burn.

## LFL Monitoring Range

Most flammable gases and vapors have an LFL between 1% and 10%. Let's consider hydrogen as an example: hydrogen has an LFL of 4% gas in air. Another way of saying this is: 4% hydrogen in air = 100% LFL hydrogen. LFL sensors operate from 0 to 100% of the LFL range of flammable gases and vapors. It is important to note that LFL sensors cannot accurately monitor mixtures in the flammable range. In fact, most safety rules state that flammable mixtures be kept below 50% of the LFL. In our example, this means that the sensor at least should be capable of accurately monitoring from 0 to 2% hydrogen in air (0 to 50% LFL hydrogen).

*The Lower Flammable Limit Range*  
Flammable gas monitoring is concerned with concentrations from zero to 100% of the lower flammable limit. Most gases and vapors have Lower Flammable Limits between 1% & 10%. To assure safe operation, most safety guidelines restrict flammable concentrations to 50% LFL or less.



## PPM Monitoring Range

Another way to describe gas concentrations is to convert the gas mixture into parts-per-million (ppm).

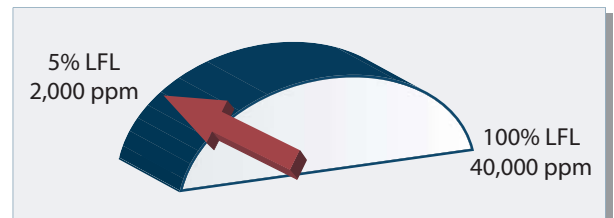
- For example, if: 4% hydrogen in air = 100% LFL hydrogen

and: 4% = 40,000 parts per million (ppm)

then: 40,000 ppm hydrogen = 100% LFL hydrogen

But we do not usually talk about flammable hazards as "parts-per-million" concentrations. It is much easier and more accurate to define a flammable hazard as %LFL.

Parts-per-million monitoring is typically conducted in the Low PPM range. For example, when monitoring hydrogen in a gas cabinet, the full scale range might be 2,000 PPM hydrogen, which is only 5% of the LFL. Also, PPM monitoring applications employ different sensor technologies than LFL monitoring applications.



*LFL vs PPM Range Monitoring*

*Most PPM monitoring ranges are only a fraction of the LFL*