



HAZARDOUS ATMOSPHERES

Automation dealers are continuing to gain business that was once reserved only for specialty and industrial contractors. It's a trend that is accelerating very rapidly, and the fastest growth is in the areas of hazardous locations and the monitoring of toxic and combustible gases. Kele is committed to providing the products and technical support needed to assist our customers in these important areas. By way of introduction, this article covers the basics of a hazardous atmosphere and the equipment used to monitor combustible gases. See additional articles in Technical Reference for information relating to principles and application of intrinsically safe systems, explosion-proof systems, and other available means of dealing with electrical equipment in hazardous atmospheres.

What Is "Hazardous?"

The widely known Fire Triangle illustration (Figure 1) shows the three components required to support combustion. All three must be present, and the methods we use to prevent explosions are designed to eliminate one of the three legs of the triangle. What the triangle doesn't show, though, is that fuel and oxygen must be mixed in the proper proportion in order to burn. If the fuel is methane (CH₄), the major component of natural gas, the concentration in air must be between 5% and 15% or else the mixture will not ignite. Those of us old enough to have worked with finicky carburetors on gasoline engines are familiar with this principle. If the mixture was too lean (not enough fuel) or too rich (too much fuel), the engine would not start. The same applies to ignition of any combustible gas in air.

Get the Mixture Right

The lowest concentration of a gas in air that will ignite is its lower explosive limit (LEL), and the highest concentration that will ignite is its upper explosive limit (UEL). These values are also sometimes referred to as the lower and upper flammability-

limits (LFL, UFL). Limits for some common fuels are shown in Table 1 below. If a system is designed to keep the fuel concentration below the LEL, the fuel leg is effectively removed from the fire triangle. Under certain conditions (in an oil field, for example), it is easier to maintain the concentration above the UEL. In this case, the oxygen leg is eliminated. In either case, combustion cannot happen.

Silent Sentries

It is often advisable to monitor the concentration of fuel in air in order to take action or sound an alarm if it is moving toward an explosive level. The **GMT Series** combustible gas monitors are ideal for this purpose. The **GMT-COMB-S1** provides a 4-20 mA signal over the range of 0% to 100% of the LEL, and it has an alarm relay set to energize at 25% of the LEL (an industry standard alarm point). The sensor responds to a very wide range of combustible gases, and the outputs (analog and relay) are factory-calibrated for the gas specified at the time of order. For example, if the gas is methane (5% LEL), the **GMT-COMB-S1 (CH₄)** will output 4 mA at 0% methane and 20 mA at 5% methane. The alarm relay will energize at 1.25% methane. With this device, the alarm relay or an automation system responding to the analog signal can cause electricity (source of ignition) to be shut off in an area if the gas concentration is rising toward the explosive level (LEL). If the **GMT** itself must remain energized, an explosionproof enclosure is available to prevent it from becoming the source of ignition itself.

The system described here is based on removing the fuel leg from the fire triangle, then having an automatic means of removing the ignition source leg if the fuel begins to return. This is the first of many ways we will discuss to work safely with electricity in hazardous locations.

FIGURE 1. FIRE TRIANGLE



TABLE 1. FLAMMABILITY LIMITS

Fuel	Lower Explosive Limit (LEL) (Percent by volume in air)	Upper Explosive Limit (UEL) (Percent by volume in air)
Methane	5.0	15.0
Butane	1.6	8.4
Propane	2.1	9.6
Ethanol	3.3	19.0
Gasoline (100 Octane)	1.4	7.8
Isopropyl alcohol	2.0	12.7
Ethyl ether	1.9	36.0
Xylene	0.9	7.0
Toluene	1.0	7.1
Hydrogen	4.0	75.0
Acetylene	2.5	85.0

Note: Multiply percentages by 10,000 to convert to parts per million (ppm)