Power Head Room in Gas and Flame Detectors Saves Lives and Dollars

Safety engineers recognize the critical nature of gas and flame detection systems to the safety of people and property. It is easy to forget, however, that "protecting the protectors" by keeping these detection systems operating constantly is not a straightforward problem. The issue is power and power "head room", and decisions made in this arena can not only determine the critical uptime of detectors, they can also mean the difference in cost, application and installation time and requirements. Many people do not realize that the power requirements of gas and fire detectors vary widely and have an enormous impact on potential uptime.

One of the most common sources of fire and gas detection system failure is power supply interruption and disturbance. Power supply specifications of an instrument refer to the voltage that must appear at the instrument power terminals, not the power supply rated output. There are many factors that impact voltage reaching the fire or gas detector, any one of which may cause an unwanted shutdown or damage to the instrument. The most fundamental factor to consider is wire resistance between the power supply and the device, but there are many other factors. The total power or voltage required to be supplied per instrument is the "power required by the instrument" plus the "power loss in the wiring." Perhaps surprisingly, on installations with long wiring runs, the "power loss in the wiring" could exceed the "power required by the instrument."

Wire Selection

There are voltage losses across the length of the cable due to its resistance. The total wire length to the instrument and the return run must be included in calculations. If the instrument is 1,000 feet away then the wire length for loss calculations is 2,000 feet. Consider 18AWG wire at 7 ohms per 1,000 feet. If the nominal voltage of the UPS supply is 24Vdc one should consider that the batteries could at times fall to as low as 22Vdc and the voltage to the instrument may follow battery voltage. If the instrument requires a minimum of 18Vdc to operate, then there is room for a wiring loss of only 4Vdc, and even so, the instrument is on the edge of failure.

Suppose that the instrument is rated at 6.0 Watts. Is that a nominal wattage or a maximum? It is very important to consider power needs in the worst case scenario, i.e., full alarm with 21mA output, all relays energized, any required internal heaters are active, visual indicators illuminated and any other loads on the line active, such as local alarm devices. In this case, the current requirement is 6.0W/24.0Vdc = 250mA and there is a voltage drop of 0.250A X 7 ohms = 1.75Vdc per 1,000 ft. If the instrument is 1,200 ft from the power supply then the wire length is 2400 ft and the voltage lost is 4.2Vdc.

So, 22Vdc supplied less 4.2Vdc loss is 17.8Vdc so the instrument will not run. It would be a high risk to have these power cables more than 800 or 900 feet long.

Integrity of Wire Connections

While consideration of wire resistance is of primary importance, one must also consider voltage losses at each wire connection point. Industrial installations often include junction boxes and marshalling cabinets where wires are terminated coming in and going out. When these termination points degrade over time due to vibration, temperature, poor installation or corrosion, the resistance increases and more precious voltage is lost, possibly leading to failure.

Future Additions

Many safety instruments today have the ability to install options at a future date. If a system is operating on the edge of power required, then any future additions of option boards or local indication devices will cause the system to fail unexpectedly.

Voltage Boosters – DC-to-DC Converters

If the operating parameters of the 24Vdc UPS system are not variable, as is often the case, and more voltage is needed for the instruments to operate reliably then a commonly considered option is voltage boosters. These can patch the problem, but introduce another layer of complexity and another point of failure, and thus, a reduction of reliability. The cost of such a patch may include loss of reliability, and thus, exceed the benefit derived.

Power Supply/Chargers

Most supplies are a combined charger and power supply with battery backup. The dc power supply is normally supplied by 120Vac. If the ac main supply fails, the system reverts to a 24Vdc battery bank as the source. The battery voltage will eventually drop from 24Vdc to perhaps 22Vdc and eventually cut off. Does the supply output voltage to the instrument drop when battery voltage drops? If so, and there is insufficient voltage head room, then failure may be sudden.

Voltage Head Room – a Question of Safety and Cost

How much "spare" voltage is needed? There is no absolute answer to this, but all of the above concerns should be carefully considered and with understanding that the more spare voltage you have ... the better and safer you are.

Low power fire and gas detection instruments give the designer the greatest possible power supply "head room". The initial aspect of this design is keeping power consumption to a minimum; generally 40 to 50 percent lower than higher power detection instruments. This saves on total power and reduces the cost of higher capacity UPS systems – a difference in cost of many thousands of dollars. It also saves installation costs by providing the opportunity to use smaller wire gauge such as 18AWG where others may require 16 or 14AWG.

With any particular wire gauge chosen, it also means distances from the power supply to the instrument can be many times greater. With a low power instrument rated at 3.0 Watts and with its low operating voltage limit less than 10Vdc, it is possible to use 18AWG wire for distances up to 6,000 feet instead of 1,200 feet as imposed by many high power instruments, thus reducing the complexity and cost of installation.

Low power instruments not only save time and money in newly installed plants, they also fit well into older plants. Operators like the fact that they can get an advanced solution that gives them solid coverage when installed on their old grid. Low power detection instruments can provide safety engineers with a significant step in assuring the uptime and reliability of their safety systems.

About the Author

Geoff Wilson is product manager for flame and gas detection products at Emerson Process Management, Net Safety Monitoring. More information can be found at www.Net-Safety.com.