When confronted with a H₂S event, it is of the utmost importance workers have easy access to an escape respirator and follow recommended and required safety procedures and protocols.

Hydrogen sulfide (H₂S) is one of the leading causes of death among gas inhalation-related fatalities in the workplace. In fact, the U.S. Bureau of Labor Statistics cites 64 fatal occupational injuries as a result of H₂S from 2003-2012. To keep workers a step ahead in their personal safety when confronted with a H₂S event, it is of the utmost importance they have easy access to an escape respirator and follow recommended and required safety procedures and protocols.

Worker safety in an environment where H₂S is present can be maintained only if the primary goal of the work site is to prevent its release. To impede a H₂S event, work sites must follow OSHA guidelines that personnel working with any hazardous process be protected by at least three lines of defense (OSHA 29 CFR 1910.110 Appendix C, Compliance Guidelines and Recommendations for Process Safety Management). To be effective, all three of the following guidelines need to be implemented simultaneously—because, if they are not, chances of disaster, including the possibility of death during a H₂S leak, increase greatly:

1. Containment: Using Standard Operating Procedures (SOPs) and engineering controls designed to control all hazardous substances. For example, keep it contained by using approved devices, piping, values, and process design specifications.
2. Backup controls: Control or mitigate exposure to workers and the environment in the event that the first line of defense is compromised or fails. For example, control the substance with relief valves, scrubbers, flares, surge/overflow tanks, fire suppression systems, etc.
3. Emergency response: Protect plant and human assets by providing a means of escape/response in the event that numbers one and two fail. For example, depending on the situation, this can range from a simple evacuation plan to a complex emergency response, including escape respirators, etc.

The emergency response component of the OSHA 29 CFR 1910.110 Appendix C often is overlooked. An escape respirator may be viewed as a redundant compliance measure because it cannot prevent an H₂S event from occurring.

However, to protect workers during an H₂S event, it is absolutely necessary that this guideline is followed. Part of that is investing in quality escape respirators. H₂S poses one of the greatest risks to the human respiratory system because the primary route of exposure is through inhalation, where H₂S is rapidly absorbed by the lungs. Resulting health effects can vary, depending on the levels of gas and the duration of H₂S exposure. They can include:

- Low: Irritation of the eyes, nose, and throat, as well as shortness of breath
- Moderate: Severe eye and respiratory irritation (including coughing, difficulty breathing, accumulation of fluid in the lungs) dizziness, vomiting, and staggering
- High: Shock, convulsions, inability to breathe,
extreme rapid unconsciousness, coma, and potentially death.  

COMING UP FOR AIR

To determine the most appropriate escape respirator for an H₂S event emergency response plan, the degrees of severity that the event will present and the potential exposure levels must be assessed. NIOSH’s document “Concept for CBRN Air-Purifying Escape Respirator Standard” classifies degrees of severity for emergencies as high, specific, and low:

- **High:** Any scenario involving a release or existence of unknown toxic substances in high or unknown concentrations, as well as oxygen-deficient atmospheres (less than 19.5 percent volume).
- **Specific:** Any scenario involving the release or existence of known toxic substances in any concentration. (Environments with “specific” hazards always have sufficient oxygen.)
- **Low:** Any scenario involving the release or existence of known toxic substances in low concentrations. (Environments with "low" hazards always have sufficient oxygen.)

EXPOSURE LEVELS

OSHA’s permissible exposure limit (PEL) for H₂S is 20 parts per million. However, if no other measurable exposure occurs during the eight-hour work shift, exposure may exceed 20 ppm, but be no more than 50 ppm, for a 10-minute period. The PELs for the construction and maritime industries are 10 ppm.

The assigned protection factor (APF) must be greater than the expected air contaminant concentration, divided by the exposure limit. NIOSH provides the following APF recommendations for H₂S:

Up to 100 ppm:
- (APF = 25) Any powered, air-purifying respirator (PAPR) with cartridge(s) providing protection against the
compound of concern.
- (APF = 50) Any air-purifying, full-facepiece respirator (APR) (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern.
- (APF = 10) Any supplied-air respirator (SAR).
- (APF = 50) Any self-contained breathing apparatus (SCBA) with a full facepiece.

Emergency or planned entry into unknown concentrations or Immediately Dangerous to Life and Health (IDLH) conditions:
- (APF = 10,000) Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.
- (APF = 10,000) Any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus.

Escape:
- (APF = 50) Any APR (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern.
- Any appropriate escape-type self-contained breathing apparatus.

IDENTIFYING THE BEST ESCAPE RESPIRATOR FOR AN H₂S EVENT

Through evaluating the degrees of severity of a potential H₂S event, as well as the possible exposure levels, companies can then determine which escape respirators will be most effective in their H₂S emergency response plan.

First, two main options exist for hazardous areas where there is a threat of a major release. In airline applications with a nearby "safe zone," SARs with an escape cylinder prove to be the best choice, whereas in airline applications with long distances to travel to a "safe zone," wearing an SCBA with airline would keep the worker safest.

Next, in general working areas where potential hazards cannot be accurately quantified or in areas where there is a chance of oxygen deficiency, one should consider a 5-10 minute Emergency Escape Breathing Apparatus (EEBA) with a cylinder and hood for short escape distances or a wall hanger SCBA for longer escape distances.

Finally, in general working areas with predictable concentrations and risk, both EEBA's and SCBA's will work, however, each provides more protection than required. These respirators can also be expensive, require periodic maintenance, are heavy and difficult to carry, and offer no protection once air is spent. The alternatives are an APR or AP and escape hood. They can effectively filter high concentrations of toxic gases of oxygen levels (above 19.5 percent volume), are less expensive, require low maintenance, are small and lightweight, can be belt worn, and can assist in longer escape times, depending on concentration.

RIGHT RESPIRATOR + THE RIGHT TRAINING = A FULLY PREPARED TEAM

The right respirator will only maximize safety for those workers who know how to make use of it in an H₂S event. Panic often ensues in these situations, making it necessary to train on why an escape respirator maybe needed and how it provides protection, in order to encourage second-nature use by employees.

Reinforcing the importance of proper and continual training and education are the results of a survey regarding the American Conference of Governmental Industrial Hygienists' recommendation of lowering the TLV for H₂S to 1 ppm. The survey, "The 1 ppm Hydrogen Sulfide Threshold: Are you prepared?" completed by Dräger with the American Society of Safety Engineers, polled ASSE members to determine their awareness and preparedness to meet the new ACGIH hydrogen sulfide TLV. Data
revealed that 53 percent of safety experts in the oil and gas industry were unaware of the new threshold standards, which look to prevent incidents related to H₂S exposure.

Study results found current alarm levels vary across the industry, from 39 percent using 10 ppm and 15 ppm to 15 percent using 10 ppm to 20 ppm. Lower alarm limits equal an earlier warning at lower concentrations and provide an opportunity for less expensive and easier-to-use escape respirators. In other words, the optimal respirator for safety can be used at the lowest cost.

**CONCLUSION**

While no one expects to come into a situation where an escape respirator would be necessary, understanding the pros and cons of various respirator options could mean the difference between life and death for users in the event of an H₂S leak. Identifying the early warning signs of a situation where hydrogen sulfide may be present and being ready with the appropriate respirator will protect workers’ lives and company assets.

**References**


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