Hydrogen Sulfide Awareness

Avoiding the Ostrich Zone

By Greg Gerganoff

Hazard recognition plays a vital role in keeping employees safe. Some hazards are easily recognized, for example an employee climbing up a 20-ft ladder while holding tools in both hands is an obvious fall hazard. While some safety hazards are immediately recognizable, others require training to spot and avoid. One such hazard is hydrogen sulfide (H_2S). Training is a key method to avoid the "ostrich zone." You do not want to bury your head when facing this hazard.

Analyzing H_2S

H_2S is a clear gas that is dangerous to human health/life, extremely flammable, corrosive and sometimes has a detectable odor of rotten eggs. It can be produced in bogs, swamps, volcanoes and hot springs (EPA, 1993). It can also be produced by industrial activities (e.g., oil and gas, natural gas pipeline transmission, refineries, sewage treatment plants, manholes, manure pits). Whether its source is natural or industrial, H_2S is the result of bacterial decomposition of organic material.

The Hazard

A very low-level H_2S exposure can result in serious illness or death. The NIOSH value for immediately dangerous to life or health (IDLH) is 100 ppm, and 1% of H_2S = 10,000 ppm.

In addition, this hazard occurs where one might not expect. For example, a 25-year-old waste hauling service worker died in an underground manure waste pit. The access opening was fitted with a removable stainless steel cover. There was no ventilation or gas monitor in use [OSHA(b)]. NIOSH (2012) lists multiple instances of H_2S-related fatalities occurring on farms and sanitation facilities involving enclosed/confined spaces harboring this deadly gas. In none of these cases was a gas monitor used to indicate the presence of this gas.

Why So Deadly?

H_2S is an inhalation, flammable, explosive and contact hazard. Inhalation symptoms at low-level exposures (20 ppm) include headache, dizziness, sleep disturbances, upset stomach and changes in appetite. Symptoms include altered breathing and drowsiness after 15 to 30 minutes at this level. Death may occur after 48 hours and exposures ranging to 500 to 700 ppm will likely result in staggering, collapse and death after 30 to 60 minutes. A level of 1,000 to 2,000 ppm would result in nearly instant death [OSHA(c)].

H_2S is also corrosive and will act on skin and eyes. Exposure levels of 50 to 100 ppm will cause eye irritation and marked conjunctivitis, and respiratory tract irritation after an hour at 200 to 300 ppm [OSHA(c)]. Acute exposure can cause painful conjunctivitis, sensitivity to light and corneal abrasions (CCOHS, 2013). H_2S is classified as a chemical asphyxiate similar to carbon monoxide and cyanide gasses. It inhibits cellular respiration uptake of oxygen causing biochemical suffocation (Kalusche).

Acute exposure affects the nervous and pulmonary systems, olfactory nerves, lungs, brain, respiratory control center and eyes. Symptoms include nausea, burning sensation in the eyes, coughing, dizziness, difficulty breathing, fluid accumulation in the lungs, headache, vomiting, staggering and excitability. The symptoms displayed depend on exposure level and length, and a worker's physical condition. Once any of these symptoms is exhibited, a dangerous exposure has already occurred.

Protecting Against H_2S

Training is key to recognizing this hazard and protecting against it. Training levels are dependent on the action expected of the employee/trainee. For example, if a person's work will rarely result in H_2S exposure and if the employee is expected to immediately evacuate a site upon H_2S detection, awareness training and training on use and care of a gas monitor is likely adequate.

If the employee works in a setting where H_2S is likely, then training must address more advanced topics, including special evacuation criteria; use of respiratory PPE and gas monitor use/care; first aid; expectations of employees in an exposure/release event (e.g., evacuate only or rescue); nature of work (confined space); exercises and drills; schedule for refresher training (annual); site-specific safe work practices; properties/characteristics of H_2S; detection methods and rescue techniques.[For more detail on effective training content, refer to ANSI/ASSE Z390.1-2006 (R2010), Accepted Practices for Hydrogen Sulfide Safety Training Programs.]

Sites where H_2S could be present require a contingency plan. This plan cites specific issues relating to H_2S, such as air flow directions, safe muster points, type of PPE/respiratory equipment, training drills, emergency procedures, worker responsibility, phone numbers/communication methods and nearby organizations, flag ratings (green, yellow and red) and locations of fixed gas monitors.

Since H_2S is corrosive, plants/equipment exposed to it can experience degradation of steel structures (e.g., ladders, anchor points for fall protection). Thus, employee training must include periodic structural evaluations and examinations. Using proper ladder climbing techniques is ineffective if the ladder in use is structurally compromised.

Those working in confined spaces must be trained on how to safely test the atmospheres. Leaning over a pit/tank with monitor in hand to check for H_2S is not safe. Techniques exist that keep the tester a safe distance from potential H_2S exposure. Classroom and practical training must cover such techniques.

Detection

Believing that one can detect H_2S using only the sense of smell is dangerous, as the sense of smell does not identify H_2S exposure level. Smelling offers a slight detection around the 0.13 ppm level. But, H_2S deadens the sense of smell, so one may only detect the gas momentarily. The fact that the odor disappears does not mean that the gas is gone. OSHA's exposure limit is 10 ppm. Short-term exposure limit (STEL) is 15 ppm for 15 minutes, per ACGIH. So, how does one detect H_2S? Use gas monitors, but first let's consider a couple of points.

Visual Cues

Workers must observe their surroundings and signage. They must look for H_2S danger signs posted upon approach or at the site entrance. Windsocks or streamers are also indicators of potential hazardous gas on site. While walking/working around the site, periodically notice the direction of wind flow per the windsocks.

If a site has fixed H_2S gas monitors, know what each alarm does (e.g., flashing lights, type of sound). New workers should ask about the nature of the alarm system, what to look for and evacuation points/directions. A contingency plan will also answer these questions.

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Additionally, colored flags may be present on site. Green means possible danger; yellow means moderate danger (this color indicates it is time to leave or use PPE); and red means extreme danger (use PPE, leave immediately).

Next, view the plant and surrounding terrain. H_2S is heavier than air, so any topography containing dips or low spots, or plant configuration such as vaults or pits could accumulate the gas. H_2S can dissolve in liquids (water and hydrocarbons), then be released if the liquid is agitated, depressurized, heated, circulated, pumped, flowed or swabbed into tanks. It can be found at the tops of open tanks, gauge hatches and vent lines [CCOHS(b)].

Recall the fatality cited earlier. That entry point hatch was stainless steel. As noted, H_2S is corrosive and will degrade various metals, but not stainless steel. Thus, the presence of stainless steel may indicate that H_2S is present. So, pay attention to the metals comprising mechanical devices, piping and storage facilities. In all instances, have a gas monitor with you and switched on.

Gas Monitors

Gas monitors are an effective means to detect H_2S. Some sites have fixed monitors that sample air in their vicinity and are placed where H_2S is likely found. However, only a personal gas monitor will sound if a worker walks into a pocket of gas that is beyond the fixed monitors' sensing range.

Therefore, it is safer to have a personal gas monitor at all times. Place the gas monitor 6 to 9 in. from the face (i.e., breathing zone). The device must be on to detect H_2S, and it must be set speficallay to detect the gas. For workers in industries in which H_2S is likely to be present, it is prudent to have a personal gas monitor at all times. Some devices can be attached to a tube that can then be lowered into a tank or vault to check for atmospheric presence of H_2S while keeping the worker safe from potential exposure during testing.

Caring for a gas monitor includes periodic bump testing and calibration according to manufacturer recommendations. If a monitor fails to properly bump test, presume it is not working properly. Second-guessing a possible malfunctioning monitor around H_2S is not prudent. Make sure the batteries are

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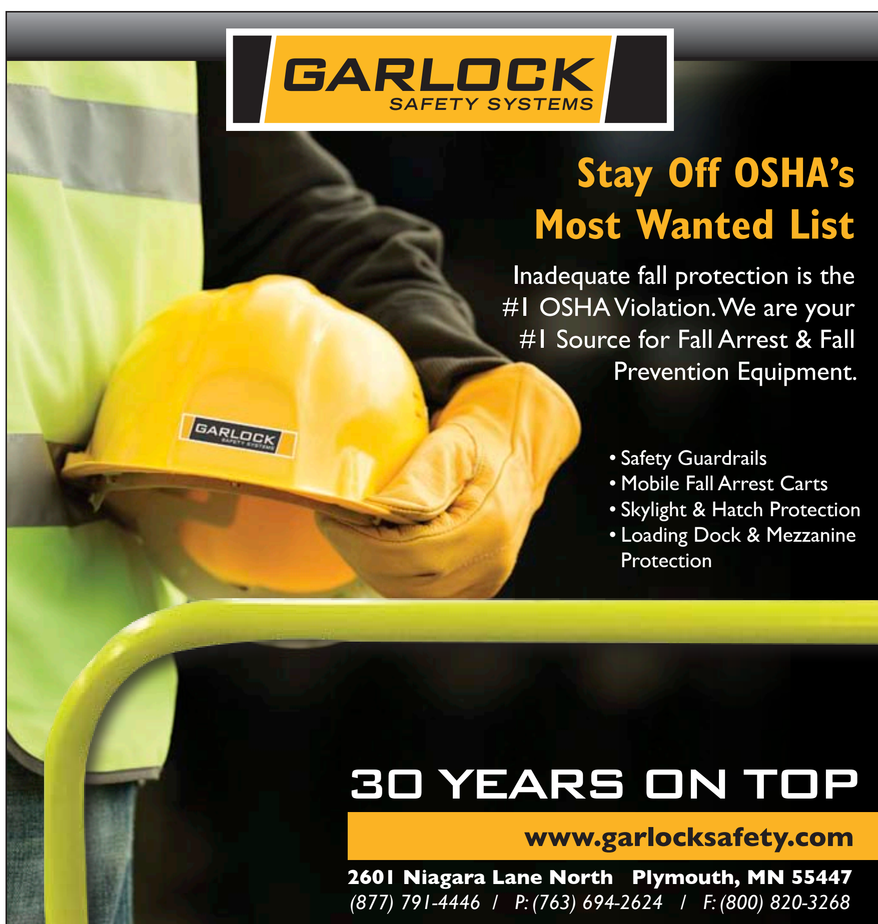

PS EXTRA In 2013, Dräger worked with ASSE to conduct a survey of its members to determine their awareness of ACGIH's lower H_2S threshold limit value and gauge the preparedness of their organizations to meet the 1 ppm threshold. A white paper summarizes the results of the survey. Find a link to it at www.asse.org/psextra.

charged. Some devices have low-battery indicators so check the battery status before and during use.

Detection Limits for Gas Monitor

OSHA's exposure limit is 10 ppm with a 15-minute ceiling at 15 ppm (Draeger, 2013). Data reveal that in the oil and gas industry, 39% use 10 ppm and 15 ppm; 35% use 5 ppm and 10 ppm; 15% use 10 ppm and 20 ppm (West Texas Safety Training Center).

However, ACGIH has a lower threshold limit value of 1 ppm. While it is not a legal standard, OSHA(b) references it in its Oil and Gas Well Drilling and Servicing E Tool, Appendix A. To understand this in practice, consider this scenario: Suppose the nature or lack of PPE available combined with the work environment to create an evacuation travel time greater than 15 minutes (assuming the exposure is a maximum of 15 ppm). Is the employee truly able to evacuate in a timely manner? Does a lower trigger threshold for gas monitors make sense given the character of the work site and time needed to safely evacuate? Factor in the work environment and site conditions when establishing the monitor H_2S detection/alarm level threshold.

Escape/Rescue From H_2S Exposure

The gas monitor is on, you have visually inspected the site's physical condition/situation and the gas monitor sounds. What do you do? Immediately check the wind direction from any flag or windsock. Next, start moving. As you move tell others nearby about the alarm. Conventional wisdom says to move upwind, but what if the source of H_2S is directly upwind? Move perpendicular, then upwind. If your car is parked downwind do not head toward it thinking it is the fastest means of escape. You cannot outrun H_2S. You can only run away.

What if you see a person down and not moving? Leave them. Unless you are trained as a rescuer or possess the necessary PPE, any action other than immediate evacuation will likely result in two people down; many H_2S victims are would-be rescuers.

What Does Rescue Involve?

Rescue involves several key elements.

1) PPE is essential. Rescuers must also have an auxiliary self-contained air supply (OSHA, 2005), and protective clothing such as gloves/fire and acid-proof covering/clothes.

Some PPE are more suitable for dealing with H_2S than others. Short-term air-bottle-fed systems for escape offer 5 to 8 minutes of air. Self-contained breathing apparatus are designed for long-term use (30 to 45 minutes), as are supplied air systems. Full-face respirators with the appropriate cartridges are strictly for escape use.

If H_2S contacts the body, rinse with water for 15 minutes. Clothing must be washed before reuse and removed immediately after exposure.

2) Proper moving techniques for an unconscious person are critical to a rescue, as the person could have fallen and sustained injury. Therefore, rescuers must know and practice these techniques.

3) First-aid training is also essential. While the H_2S hazard primarily is inhalatiuon, the gas also presents skin and eye hazards, as it has potential for frost bite from liquid contact. Rescue must include preparation to remove clothing, quick drench capability for skin/eyes and clothing contact situations (NIOSH, 2012). In instances where respiratory assistance is called for, use mechanical devices and not mouth-to-mouth, as the victim's lungs may contain H_2S.

H_2S Exposure

Any person exposed to or thought to have been exposed to H_2S must immediately be medically evaluated. Tests can determine whether an event resulted in exposure. Some of these tests must be conducted within several hours of the exposure to ascertain a medical event (Lambert, Goodwin, Stefani, et al., 2006). It is important to tell medical providers of any medicines (prescribed or recreational) used by the exposed person, as H_2S effects may be aggravated by certain drugs.

Since H_2S is corrosive, be sure to inspect air supply systems that have metal parts to verify that no damage has occurred due to the exposure.

One final note: Some petroleum processing sites flare H_2S. When burned, it produces a blue flame. The gas produced from burning H_2S is sulfur dioxide, which in itself is toxic, has many H_2S characteristics (e.g., it heavier than air), will produce similar symptoms (e.g., irritation of throat, burning eyes) and can produce serious/fatal results. The sole difference is that sulfur dioxide is not flammable.

Conclusion

Can employees work around H_2S locations safely? Absolutely. Does understanding the hazards of H_2S make a difference? Absolutely. Do many people work safely around H_2S and go home safe and sound each day? Absolutely. But they do so because of their knowledge, precautions and preparation. Remember, working with H_2S is a no ostrich zone.

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