

Every year, workers are accidentally exposed to unsafe levels of hydrogen sulfide (H₂S), also called sour gas, sewer gas, stink damp, and hydrosulphuric acid. H₂S can be deadly; too much of the gas can kill a worker in a few seconds.

This document describes the dangers of H₂S in the workplace, and how to avoid them. It also explains how to recognize and prevent H₂S poisoning, and the type of first aid to give to people overcome by the gas.

What is hydrogen sulfide?

H₂S is a very toxic gas. It has no colour, but it smells like rotten eggs. In larger amounts, H₂S quickly blocks the sense of smell. That is why odour should never be used to rate H₂S levels.

The gas can irritate the eyes, nose, throat, and lungs. Too much H₂S can halt the breathing centre in the brain, which can cause death. It may be possible to revive the victim, but only if first aid is given right away.

H₂S dissolves in water and oil, and it may be released when these liquids are heated, depressurized, or agitated.

Because H₂S is heavier than air, it may settle in low spots. This can pose risks when entering areas where the gas may be present.

H₂S burns and explodes easily. When it burns, H₂S gives off sulphur dioxide, another dangerous gas that is toxic, strong smelling, and irritating.

Where is H₂S found?

H₂S is often found in oil and natural gas deposits, and in some mineral rock. It may also form when organic material such as manure or vegetable matter breaks down without oxygen. This may happen, for example, with sewage in a septic tank. H₂S is often a byproduct in the making of pulp and paper, fertilizers, glues, dyes, plastic wrap, and other products.

Workers are likely to find H₂S in:

- The pulp and paper industry, where H₂S is a byproduct of wood breaking down into pulp
- The petroleum industry, especially at oil and natural gas wells; in refineries, where H₂S is removed from natural gas and oil; and in pipelines used to carry unrefined petroleum
- The construction industry, where H₂S could be released during excavation work in swamps or old landfills
- Sewers, sewage treatment plants, manure tanks, and other places where organic material breaks down without oxygen
- Iron smelters, coke ovens, and other places where H₂S may be a byproduct
- In some mines and tunnels where mineral rock may contain H₂S

H₂S warning signs

With high levels of H₂S, poisoning can be swift and deadly — with little warning. A worker who is not wearing protective equipment may pass out quickly. The body may tremble, and death may follow in seconds or minutes as a result of breathing failure.

At lower levels of the gas, the following symptoms may appear a few minutes after exposure, or be delayed for several hours:

- *Eye irritation* — soreness, light sensitivity, seeing “rainbows” around bright lights, or a gritty pain with a spasm of the eyelids known as “gas eye”
- *Breathing irritation* — sore nasal passages; sore throat; a tight, burning feeling in the chest; or fluid buildup in the lungs
- *Other symptoms* — headache, confusion, nausea, disorientation, or vomiting

H₂S incident

An oil worker operating a valve collapsed when exposed to H₂S. The foreman tried to rescue him and was overcome, as was a third rescue worker. Neither of the would-be rescuers had gas monitors or wore respiratory protection. Remaining crew members wearing self-contained breathing apparatus finally removed the injured workers from the area. The third worker was revived, but the first worker and the foreman died.

The following table describes the symptoms that may occur at specific H₂S levels.

H₂S warning signs

Concentration in parts per million (ppm)*	Observations and health effects
less than 1	Most people smell "rotten eggs."
3 to 5	Odour is strong.
20 to 150	Nose and throat feel dry and irritated. Eyes sting, itch, or water; and "gas eye" symptoms may occur. Prolonged exposure may cause coughing, hoarseness, shortness of breath, and runny nose.
150 to 200	Sense of smell is blocked (olfactory fatigue).
200 to 250	Major irritation of the nose, throat, and lungs occurs, along with headache, nausea, vomiting, and dizziness. Prolonged exposure can cause fluid buildup in the lungs (pulmonary edema), which can be fatal.
300 to 500	Symptoms are the same as above, but more severe. Death can occur within 1 to 4 hours of exposure.
Above 500	Immediate loss of consciousness. Death is rapid, sometimes immediate.

* 1 ppm = 1 part of gas per million parts of air by volume

H₂S levels of 100 ppm and higher are considered immediately dangerous to life and health (IDLH).

Besides its poor warning properties, H₂S is so dangerous because the level that can kill is much lower than that of many other toxic gases. That is why workers must be very careful when they encounter H₂S.

Workers usually recover quickly and completely from minor symptoms of H₂S poisoning. In fact, low doses of the gas (for example, less than 10 ppm) have not been shown to cause lasting harm. H₂S is not known to cause cancer.

Detecting hydrogen sulfide

As a rule, if you smell H₂S, and don't know how much of the gas is in the air, leave the area right away. Return only when the amount of the gas has been measured and found to be at a safe level.

Never use odour to assess H₂S levels. Tools for measuring H₂S levels include the following:

- *Gas detector tubes* — These clear tubes are about the size and shape of a ballpoint pen, and can be read much like a thermometer. The tube contains a material that may change colour when it reacts with air drawn through it by a small hand pump. The amount of colour change depends on the H₂S level.
- *Passive dosimeters and badges* — These monitors range in size from a watch to slightly larger than a credit card. They can be worn like a badge or placed in a specific location. They contain a material that reacts with the gas in the air to produce a colour change. The colour changes over time to show the total H₂S exposure of workers over a specified time period.
- *Electronic detectors* — These range from small personal samplers to large, stationary monitors. A display screen shows the gas level. When H₂S levels exceed a set limit, these detectors sound an alarm, flash a light, or vibrate.

Exposure limit

Employers must ensure workers are not exposed to H₂S levels above the occupational exposure limit (OEL). The OEL is the level of an airborne substance that workers may be exposed to without wearing protective equipment, and without normally suffering adverse health effects.

In British Columbia, the OEL for H₂S is a Ceiling Limit (not to be exceeded) of 10 ppm. At levels above this ceiling, only workers who are trained in the hazards of H₂S and are wearing required protective equipment may enter the work area. If an H₂S leak occurs, the area must be evacuated; only workers wearing appropriate protective equipment may enter to correct the problem.

H₂S incident

Workers complained of a rotten-egg smell, dizziness, and nausea while working in an excavation along the waterfront. H₂S had been released when workers drilled anchor holes in the excavation. The gas concentration was as high as 100 ppm (IDLH) near the holes.

Employer responsibilities

Employers must develop and implement an effective exposure control plan (ECP), which includes training workers and supervisors in relevant sections of the plan.

An effective ECP for any workplace where workers are exposed to H₂S must include:

- A written policy that:
 - States the employer's commitment to health and safety
 - States the plan's objectives
 - Defines the responsibilities and roles of the employer, supervisors, and workers
- An assessment of the workplace hazards (for example, where workers are likely to be exposed to H₂S)
- Controls used to reduce the hazards (for example, ventilation, barriers, or personal protective equipment)
- Written safe work procedures and emergency response procedures (for example, rescue procedures)
- Monitoring for H₂S (for example, when, where, and how monitoring devices such as dosimeters or personal monitors will be used in the workplace)
- Training for supervisors and workers
- Records and statistics (for example, first aid records for workers "knocked down" by H₂S)

Worker responsibilities

Workers also have responsibilities to help reduce the risk of exposure to H₂S. Workers (including subcontractors) must:

- Attend education and training sessions provided by the employer
- Use controls and follow safe work practices outlined in the ECP
- Use available personal protective equipment (for example, self-contained breathing apparatus) and personal monitors, as required
- Know how to report exposure incidents

Breathing protection

In areas with high H₂S levels or where an H₂S leak has occurred, workers must wear one of the following two types of breathing protection:

- *Positive-pressure, self-contained breathing apparatus (SCBA)* — This consists of an air cylinder, which is normally worn on the back, and a full-face mask to protect the eyes and face. A hose connects the face mask to the regulator and the air cylinder. "Positive pressure" means that the air pressure in the mask is higher than the air pressure outside the mask. This reduces the chance of toxic gases entering the face piece.
- *Positive-pressure, supplied-air (airline) respirator* — This consists of an airline attached to a regulator and a full-face piece. The worker must also wear an "escape" air bottle to allow escape if the air supply is cut off.

Workers who use respirators must be clean shaven where the respirator seals with the face. This helps provide a good seal that keeps harmful gases out.

Air-purifying respirators must not be used where H₂S levels are above the 10 ppm Ceiling Limit. These respirators — when fitted with the appropriate acid-gas cartridges — may be used for escape only.

At sites with a high risk of exposure, workers must have easy access to escape respirators, or must carry them while working. An SCBA must be used for escape where workers might have to flee from high H₂S levels or over long distances where escape air-purifying respirators would not provide enough protection.

First aid and rescue

If H₂S causes the eyes to sting, itch, or water, see the first aid attendant. Flush the eyes with lukewarm water immediately, for at least 30 minutes. If the eyes keep itching, see a doctor as soon as possible.

If a worker is overcome by H₂S:

- To attempt a rescue in an area with high H₂S levels, wear only a positive-pressure, self-contained breathing apparatus (SCBA), or a full-face, supplied air (airline) respirator with an “escape” air bottle.
- Move the worker to fresh air and give oxygen, if available.
- If the worker is having trouble breathing or is not breathing, start assisted ventilation using a pocket mask, and add oxygen to the mask if available. If the worker has no pulse, begin cardiopulmonary resuscitation (CPR). Because the body rids itself of H₂S if removed from the exposure, it is critical to continue to give the worker assisted ventilation with oxygen until medical aid arrives.

Transport the worker to the nearest hospital as soon as possible.

H₂S risk factors

The following factors may increase the risk of workers being exposed to unsafe levels of H₂S:

- *Confined spaces* — Workers who enter a confined space such as a sewer or tank could be overcome by H₂S.
- *Smoking and other ignition sources* — H₂S explodes easily near lit matches, cigarettes, pipes, and other sources of spark or intense heat. The gas can explode when its concentration in the air ranges from about 4% (40,000 ppm) to 46% (460,000 ppm).
- *Worker attitude* — Workers are more likely to be harmed if they don't know the hazards of H₂S, or if they're so used to working with H₂S they become lax about safety.
- *Still air* — The gas can build up to unsafe levels if there is no breeze or air movement.
- *Contact lenses* — Workers who are exposed to H₂S should be aware that wearing soft contact lenses may pose a risk. Soft contact lenses may absorb irritants and hold irritants such as H₂S against the eye.

H₂S incident

Two workers were asked to investigate an H₂S leak of unknown origin or strength in a “suspect” building. Without respiratory protection, the workers entered the building to conduct air quality tests. One worker's personal H₂S alarm went off at the entrance to the building, and both workers left the area. One worker returned with a monitor on a broom handle and measured 250 ppm H₂S (more than twice the IDLH) in the problem area. Both workers sought medical attention.

Reducing the H₂S risk

The risk of unsafe levels of H₂S can be reduced with the following controls:

- *Engineering* — Where practical, install effective exhaust ventilation.
- *Isolation controls* — Isolate workers from dangerous work areas.
- *Regular maintenance* — To lessen the risk of leaks, regularly check pipes, valves, tanks, and containers of dangerous gases and liquids.
- *Education* — Workers must be taught how to prevent and recognize H₂S poisoning, and how to give first aid to those overcome by the gas. Workers must be taught — and practice — how to use protective breathing equipment.
- *Monitoring* — H₂S levels must be monitored where there is a risk of H₂S exposure.
- *Labeling and posting* — Where H₂S is used, collected, or produced, all piping and valves that carry the gas must be clearly identified. Workers must also have easy access to the material safety data sheet (MSDS) for H₂S. Wherever an H₂S leak or buildup is possible, warning signs bearing “Hydrogen Sulfide” plus precautions must be posted just outside or at the entrances to the area.
- *Emergency plans* — Where H₂S is used, employers must train workers in H₂S hazards, emergency procedures, escape routes, and the location of emergency equipment and safe areas.
- *Confined space precautions* — Confined spaces must be tested, ventilated, and confirmed safe before workers enter them.
- *Proper storage* — Keep cylinders containing H₂S clean, isolated, shaded, and in a ventilated area. In case of fire, remove the cylinders (if it is safe to do so) and cool with water.