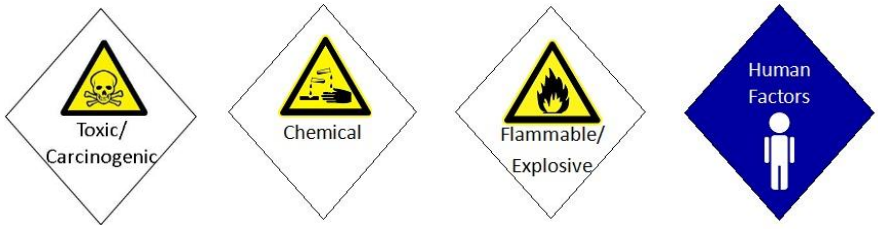

1. Introduction

Hydrogen Sulphide (H_2S) is a colourless, poisonous, flammable gas with a strong smell of rotten eggs. It is also known as sewer gas or stink damp and can be detected by smell at concentrations ranging from 0.01-0.3 parts per million (ppm). However, its odour cannot be relied on for detection because at concentrations above 100 ppm it deadens a person's sense of smell within a few minutes. The pure gas is heavier than air and can collect in low areas such as sewers, pits, tunnels, and gullies.

1.1. Purpose

The purpose of this COP is to ensure all reasonable precautions are in place to eliminate possible worker overexposure to H_2S. In addition, this COP will identify properties / hazards associated with H_2S, exposure limits, possible sources of H_2S, detection and monitoring requirements, required personal protective equipment, signage and product labeling requirements, worker training requirements, use of safe work procedures, emergency procedures in the event of exposure to H_2S, and individual responsibilities.

1.2 Application

This code of practice is to be followed any time Strike is working or directing work where there is confirmed, or the potential for, exposure to Hydrogen Suphide (H_2S). The goal is to minimize exposure and to ensure legislated limits are never exceeded.

1.3 Physical Properties

- Colour: colourless.
- Odour: very offensive, similar to rotten eggs in small quantities.
- Vapour Density: 1.189 (air 1.0), H_2S is heavier than air thus low-lying areas may have higher concentrations of H_2S.
- Boiling Point: minus 60 Degrees C.
- Explosive Limit: 4.3 to 46 percent by volume in air.
- Auto Ignition Temp: 260 Degrees C.
- Water Soluble: Yes – 4 volumes of gas in 1 volume of water at 0 Degrees C.
- Flammability: Is flammable in air at 40,000 ppm (4%) or higher.

Hydrogen sulphide can react with rust or corrosion deposits on equipment to form **Iron Sulphide**. This reaction occurs in an oxygen free atmosphere where hydrogen sulphide gas is present or where the concentration of hydrogen sulphide is greater than that of oxygen. This happens most often in closed vessels, tanks, or pipelines. **Iron sulphide is a pyrophoric material, which means that it can ignite spontaneously when it is exposed to air.**

1.4 Health Effects

Hydrogen sulphide is extremely toxic. Workers are exposed when they inhale hydrogen sulphide that is in the air and becomes quickly absorbed by the lungs. It is believed that exposure to hydrogen sulphide prevents the brain from using oxygen by inhibiting the enzyme cytochrome oxidase.

Short-Term Exposure

Short–term (acute) exposure to hydrogen sulphide can cause irritation to the nose, throat, eyes and lungs. Exposure to higher concentrations can cause very serious health effects, and even death.

Table 1 - Health effects from short-term exposure to hydrogen sulphide:

Concentration (ppm)	Health Effect
0.01 - 0.3	Odour threshold
1-20	Offensive odour, possible nausea, tearing of the eyes or headaches with prolonged exposure
20-50	Nose, throat and lung irritation; digestive upset and loss of appetite; sense of smell starts to become fatigued; acute conjunctivitis may occur (pain, tearing and light sensitivity)
100-200	Severe nose, throat and lung irritation; ability to smell odour completely disappears
250-500	Pulmonary edema (buildup of fluid in the lungs)
500	Severe lung irritation, excitement, headache, dizziness, staggering, sudden collapse (knockdown), unconsciousness and death within a few hours, loss of memory for the period of exposure
500-1000	Respiratory paralysis, irregular heartbeat, collapse and death without rescue
>1000	Rapid collapse and death

It is important to note that the symptoms of pulmonary edema (buildup of fluid in the lungs), such as chest pain or shortness of breath, can be delayed for up to 72 hours after exposure.

Workers who survive a serious hydrogen sulphide exposure (concentrations above 500 ppm) may recover completely or suffer long-term health effects. In some cases, there can be permanent nervous system effects, such as fatigue, anxiety, irritability, as well as impaired learning and memory. Some of these effects may be the result of less oxygen reaching the brain during a severe hydrogen sulphide exposure. Workers who experience knockdown (unconsciousness) tend to have a greater chance of having permanent effects to the respiratory system, with symptoms such as shortness of breath on exertion, wheezing, chest tightness, hypersensitive airways, and permanent lung damage.

Some research indicates that short-term exposure to lower concentrations of hydrogen sulphide (1-10 ppm) may cause health effects. However, significantly more research is needed before such effects can be confirmed.

Long-Term Exposure

Hydrogen sulphide does not accumulate in the body. Repeated or prolonged exposure has been reported to cause low blood pressure, headache, nausea, loss of appetite, eye inflammation and chronic cough.

The following health effects due to long-term (chronic) exposure to hydrogen sulphide have also been reported in the scientific literature:

- Reduced lung function (smoking together with hydrogen sulphide exposure may worsen this effect),

- Neurological effects such as headaches, nausea, depression, weakness, personality changes. Exposure to other reduced sulphur gases such as dimethyl sulphide and thiols (mercaptans) at the same time may contribute to this effect,
- Eye irritation,
- Irritation to the mucous membranes, and
- Damage to the cardiovascular system. More research is needed to confirm the human health effects from chronic exposure. Hydrogen sulphide has not been classified as a carcinogen by the International Agency for Research on Cancer (IARC).

2.0 Responsibilities

2.1 Management

Management is responsible to:

- Ensure workers have appropriate education/training to prevent H_2S exposure
- Not assign work tasks to a worker for which they are not competent
- Providing the necessary equipment and PPE
- Engaging with the client/owner at the pre-job planning stage to identify and assess if and where H_2S hazards expected to be encountered, and their concentrations
- Ensuring that this code of practice is utilized and adhered to by supervisors and workers

2.2 Supervisor

Supervisors are responsible to:

- Lead the safe work planning process – work scope, hazard assessment, hazard controls
- Ensure that workers undertake only the work that they are competent to perform
- Provide and assist in the pre-use inspection of all applicable PPE
- Ensure that this code of practice is utilized and adhered to by workers

2.3 Worker (Employee / ISP)

Workers are responsible to:

- Participate in the safe work planning process (pre-job meeting and HIAC)
- Refuse to perform any work if it is deemed unsafe (until appropriate hazard controls can be implemented)
- Inspect any required PPE before use
- Follow the direction of the supervisor
- Adhere to the direction provided by this code of practice

2.4 Sub-Contractors

Subcontractors are responsible to:

- Participate in the hazard assessment process (HIAC)
- Communicate the hazards of a worksite to the OA and/or PA
- Implement hazard controls as identified on the work permit
- Conduct pre-job safety meetings as required
- Participate in the safe work planning process (pre-job meeting and HIAC)
- Refuse to perform any work they deem to be unsafe (until appropriate hazard controls can be implemented)
- Inspect any required PPE before use

2.5 HSE Department

The HSE Department are responsible to:

- Provide guidance to workers, contractors, and worksite consultants
- Provide guidance regarding hazard assessment
- Provide guidance regarding regulatory requirements

3.0 Training

3.1 Courses

- WHMIS training
- Strike internal PPE training
- Gas Detection/Testing (where required)
- H_2S Alive
- Current Fit Test

4.0 Hazard Identification, Assessment and Control (HIAC)

Prior to commencement of work a Safe Work Permit must be in place. If Strike is Performing Authority, then the Operating Authority (Client, or Prime Contractor) is responsible for the site will issue the Safe Work Permit. If Strike is the Prime Contractor, Strike will issue the Safe Work Permit in accordance with Code of Practice 9.

Avoiding exposure to hydrogen sulphide is the best way to protect health. Options that should be considered include the use of the following (in order of preference):

- Engineering controls
- Administrative controls
- Personal protective equipment

Evaluating the hazard from hydrogen sulphide must be included in the hazard assessment for the work site. Some sample questions that should be asked when assessing safety procedures for hydrogen sulphide.

Questions to Consider During the Hazard Assessment Process

1. Has the potential for a release of H2S into the atmosphere at levels of 10 ppm or greater been evaluated?
2. Does every worker on the work site know where and how an uncontrolled release of H2S could occur?
3. Does every worker know what precautions to take when there is a potential for an H2S release?
4. Do workers know what to do in case of an emergency?
5. Have the areas which require the mandatory use of breathing apparatus been identified?
6. Does every worker who could be exposed to H2S have appropriate training?
7. Is there a procedure to test the atmosphere for H2S concentrations and do workers understand this procedure?
8. Is all the necessary equipment readily available to workers who require it?

Table 2 - Legislated Worker Exposure Limits for H2S by Jurisdiction:

Jurisdiction	**TWA** (8-hour time weighted average)	**STEL** (Short Term Exposure Limit)	**Ceiling** (Never Exceed without respirator protection)
Alberta	10 ppm	N/D	15 ppm
British Columbia	N/D	N/D	10 ppm
Saskatchewan	10 ppm	15 ppm	N/D
Manitoba	1 ppm	5 ppm	N/D

Northwest Territories	10 ppm	15 ppm	N/D
Nunavut	10 ppm	15 ppm	N/D
Ontario	10 ppm	15 ppm	N/D
Yukon	10 ppm	15 ppm	N/D
Federal	1 ppm	5 ppm	N/D

Always ensure that gas monitors are calibrated according to the jurisdiction the work is being performed in.

1. Initial Gas Detection and Continuous Monitoring

When conducting monitoring for hydrogen sulphide to comply with the OEL, the method specified required by any Applicable OHS Regulation must be used (in Alberta Section 20 of the OHS Code). When a direct-reading instrument is used to measure hydrogen sulphide exposure, it must be used, calibrated, and maintained according to the manufacturer's instructions. In addition, the employer is responsible to ensure that the instrument is operating properly when it is used at the work site.

Initial gas detection must be completed by a competent person, prior to workers entering the work area. A suction style monitor must be used for the initial testing where required. After the area has been cleared, workers then can enter the work area wearing personal passive gas monitors.

Testing logs must be maintained for the duration of the work being performed in the area that requires monitoring.

2. Personal Protective Equipment

A full-face, positive pressure supplied air respirator is needed for work areas where system integrity is being broken on piping that contained hydrogen sulphide. Once the system is open to atmosphere concentrations need to be monitored and when H_2S levels continue to exceed the OEL. The National Institute for Occupational Safety and Health (NIOSH) specifies an immediately dangerous to life or health (IDLH) concentration for hydrogen sulphide of 100 ppm. Above the IDLH concentrations, or for emergency or planned entry into unknown concentrations, a full-face, positive pressure, supplied air respirator must be used. Whatever the type of respirator used, the worker must be clean-shaven where it seals to the skin of the face and must be fit-tested for the type of equipment being used.

Other mandatory PPE includes fire retardant outerwear, safety glasses, hard hat and steel toed boots and gloves appropriate for the work being done.

3. Emergency Response

Before commencing work in an area where there is H_2S or there is a potential for H_2S Review the site-specific Emergency Response Plan. Plan your escape routes, know where the windsock is and the wind direction.

Initial Response Strategy:

1. **Evacuate:** Get to a safe area immediately.
2. **Alarm:** Call for help, if there is an alarm, activate it.
3. **Assess:** Account for personnel, injuries, other hazards.
4. **Protect:** Put on breathing apparatus before attempting a rescue.
5. **Rescue:** Remove any casualties to a safe area.
6. **First Aid:** Treat any injured personnel according to First Aid Standards.
7. **Medical Aid:** Coordinate transportation of injured/exposed workers to a medical facility.

Treatment of Hydrogen Sulphide Exposure

Workers who are overcome by hydrogen sulphide must be quickly and carefully rescued to ensure that additional victims are not created in the process. **Workers who do not have the necessary protective equipment must not attempt to rescue others.** Rescue workers must be provided with, and wear, a positive pressure supplied air respirator and other personal protective equipment appropriate to the hazards that are present. Resuscitation must be prompt and close medical supervision of the individual is required for at least 48 hours following exposure.

First Aid Measures

- Immediately remove the victim from further exposure. Designated rescuers must wear properly fitting, positive pressure self-contained breathing apparatus (SCBA) and other required safety equipment appropriate to the work site.
- If the worker is not breathing, apply cardio-pulmonary resuscitation in the nearest safe area.
- Remove contaminated clothing but keep the individual warm.
- Keep conscious individuals at rest.
- Be aware of possible accompanying injuries (e.g., the victim may have fallen when they were overcome) and treat them accordingly.
- If the victim's eyes are red and painful, flush with large amounts of clean water for at least 15 minutes.
- Ensure the worker receives medical care as soon as possible. The worker must not be allowed to return to work or other activities

References/Additional Information

COP 02 Respiratory Protection Equipment
COP 03 Confined Space Entry
COP 05 Lock Out /Tag Out
COP 09 Safe Work Permit System
SWP 17 Chemical and Biological Hazards and Harmful Substances
SWP 33 Hazardous Materials/Products/Substances
SWP 36 Monitoring for Escaping Hydrocarbon Gases
SWP 45 Operating Facilities (Working Near)
SWP 58 Fire and Explosion
SJP 07 Cold Cutting Existing Pipe
SJP 08 Hot Tapping
SJP 20 Using Non-Intrinsically Safe Tools
SJP 25 Tie-in to Existing Piping Systems
SJP 33 Building Entry

Alberta OHS Code
Part 37
British Columbia OHS Regulation
Part 23
Saskatchewan
Part 29
Manitoba
Part 41

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