Hazardous Gas Policy

Health and Safety FCX-HS17 | Release 04/2021 | Version 1

POTENTIAL FATAL RISKS

Exposure to Hazardous Substances – Acute
Exposure to Hazardous Substances – Chronic
Underground Hazardous Atmosphere

CRITICAL CONTROLS

Access Control
Alarm Systems
Engineered Controls (pH range, Ventilation, cell voltage, operating temperature, concentrations)
Handling Requirements
Loading and Unloading Protection
PPE
Mechanical Integrity of Storage and Distribution

TRAINING REQUIREMENTS

Site Specific Training
Task/Technical Training

TECHNICAL SUPPLEMENTS

Hazardous Gas Generation on Leach Stockpiles
Site Specific Hazardous Gas Program
Industrial Hygiene Technical Supplement

POLICY

OVERVIEW

This policy applies wherever a hazardous gas release event or an oxygen deficient atmosphere may be created (i.e. labs, confined spaces, leach pads, plant operations). This policy will also outline the requirements for a site-specific Hazardous Gas Program.

ACTIONS TO STAY SAFE

- Wear personal monitor in designated areas; bump test according to manufacturer specifications and regulatory requirements.
- Operate within required parameters, such as pH, temperature, etc.
- Be mindful of potential cross-sensitivities with gas sensors.
- Report any damage to ducting, fans, or entrainment.
- Inspect work area for signs of unintended releases or conditions where unintended mixing of chemicals/reagents can occur.
- Review SDS of chemicals being used to ensure compatibility and that hazardous gases will not be generated.
- Evaluate any process changes or equipment changes through a risk assessment process, such as Management of Change (MOC).
- Hoods/Ventilation should be utilized when possible while handing chemicals, especially within laboratory settings.

SITE REQUIREMENTS

Working with divisional leadership and the Industrial Hygiene/Health and Safety Departments, each site will develop a site-specific Hazardous Gas Program. The following information should be included in the program for each department/area:

- Gases of concern, including potential sources and methods of generation
- Specific details on site-specific Critical Controls clarifying; Access controls, handling requirements, PPE (including respiratory protection) and engineering controls

- Area Specific SOP requirements
- Area and Personal Monitor Alarm set points and locations- consideration of alarm set points should ensure employees:
    - know to take immediate action in response to upset conditions

PROCESS AREA REQUIREMENTS

- Use a combination of stationary monitors and/or personal monitors in areas where there are potentials for hazardous gas exposures to occur.
    - Consider areas near release/discharge points, along chemical delivery lines, and perimeter of process areas.
- Maintain legible labels of contents on lines, tanks, vessels, containers, etc.
- Install visual warning lamps with audio and gas-specific signage near fixed sensors. Further controls or procedures should be in place if all of these are not able to be present.
- Follow manufacturer's recommendations for fixed sensor life and preventative maintenance.
- Install windsocks in locations visible throughout the area in case evacuation is required.
- Demarcation of areas where potential upset conditions can occur.
- Maintain a PM schedule for alarms and equipment that distributes, stores, or entrains hazardous gases.

LEACH STOCKPILE AREA REQUIREMENTS

- Leach stockpiles require site-specific leach hazard recognition training and controlled access.
- Wear personal monitors in breathing zone at all times on active leach fields according to site specific policies.
- Stationary and Personal monitors should have sensors to detect the site identified/specified gases.
    - Any changes to this sensor array will require a MOC. The MOC approval should be routed to the Manager of Processing Operational Improvement for review by the Hydromet Managers Team.
- Install air relief valves at high point elevations and at the end of the main feed pipeline.
- Sites will develop and maintain a list of potential leach hazardous gas generation locations and activities. This list will be readily available and included as part of the site-specific leach hazard recognition training.
- Personal monitors should be carried by individuals in the vicinity of an acid dilution/delivery system that is open/vented to atmosphere.
- Additional information on leach best practices can be found in the "Hazardous Gas Generation on Leach Stockpiles" document.
- Information on requirements for inactive leach stockpiles can be found in site specific Haz Gas Program.

Technical Supplement

Hazardous Gas FCX-HS17 |Rev 0 | Release 6/2022

SCOPE

This Technical Supplement is intended to be a reference document for Health and Safety Professionals for the administration of the Hazardous Gas Policy (FCX-HS17). Understanding the capabilities and limitations of gas monitoring equipment will lead to effective implementation plans and procedures. Refer to the manufacturer's recommendations and monitor user manuals to gain better understanding of equipment. This document helps create flexibility for site programs, and maximization of the intended use of the monitors and their capabilities.

ALARM CRITERIA

- The purpose of this section is to minimize the risk of employees becoming complacent to alarms.
    - Example: Employees wearing half-mask respirators are protected for elevated levels of certain gasses, but not for 0_2. To avoid employees becoming complacent to the alarm of their monitor, we can adjust the alarm thresholds for the protection offered. If this isn't possible for the specific monitor, an attendant could continue to closely monitor that sensors are not alarming at levels above the level of respiratory protection.
- FMI occupational exposure limits (OEL) are the basis for alarm setpoints unless appropriate PPE is in use.
- Alarm setpoints should alert an employee to process deviations that would cause an immediate unacceptable exposure.
    - The presence of a gas could signal a process issue that could quickly change to hazardous concentrations (pipe leak, incorrect ratio of chemicals, introduction of contaminant, etc.).
    - Consider fixed monitors to alert employees *before* entering an area in the case of process deviation or unintended release of hazardous gas.
    - Where possible, integrate fixed monitors into PI ProcessBook.
- Gas monitors provide the following alarms to be set: Gas alert, Low, High, Short Term Exposure Limit (STEL) and Time Weighted Average (TWA). Each of these alarm settings trigger different responses such as acknowledgement, donning Personal Protective Equipment (PPE), or evacuation.
    - Most monitors have the capability to run simultaneous alarm types (low, high, TWA, STEL), but if the monitor being used does not, consider the most relevant alarm for the work.
    - Example: Change the Low and High alarm to correspond with PPE worn.
    - Note: Changing the alarm settings for every employee, based on every job may not be feasible. In these cases, develop a plan to respond appropriately to the changing conditions.
- Alarm setpoints on monitors, if changed, should be set based on a thorough risk assessment of task, duration, location, PPE, and any other influential aspects of the job. This assessment should be documented in the site-specific Hazardous Gas Program.
    - When monitors have setpoints that differ from others onsite, there should be a method to easily differentiate and track these monitors so they are used for their intended purpose. Each site should identify these methods in the site-specific program.
        - Examples include:
            - Different color monitor, different case, labeling, etc.

- Custom start-up message on these monitors, which must be accepted to fully turn on
    - "For use w/ respirator ONLY", “Maint Area ABC users - custom alarms"
- Dedicated docking stations that apply preset settings upon docking

PPE

- Alarm setpoints can be modified to account for PPE worn, as the alarm is intended to alert employees to unacceptable exposures.
- When considering PPE, alarms (for evacuation) cannot exceed the Max Use Concentration (MUC).
    - Max Use Concentration = Respirator Assigned Protection Factor (APF) x Exposure Limit
    - If the MUC exceeds the IDLH level for a hazardous gas, or the performance limits of the cartridge, then the MUC & alarm need to be set at a lower limit.
- Air purifying respirators are not to be used in IDLH conditions, so an MUC & alarm cannot facilitate their use for sustained work at the IDLH.
    - The IDLH level for a hazardous gas should be known to determine appropriate respiratory protection.
- NIOSH uses TWA values as the exposure limit to calculate Maximum Use Concentration. These are suitable for determining alarms for sustained work with respiratory protection. This is appropriate for setting TWA alarms.
- Ceiling limits can also be used to calculate MUC for an instantaneous level. This is appropriate for setting low/high evacuation alarms.

Note: Air purifying respirators do not mitigate oxygen deficiency or displacement for gases such as arsine, carbon monoxide, nitrogen dioxide, and oxygen. Alarm settings for these gases should only be changed with the proper use of atmosphere supplying respiratory protection. Stench gas, such as Ethyl Mercaptan, is utilized in underground mines as a warning system in the event of an emergency or system test. This gas is introduced into the ventilation system and or the compressed air systems. Organic vapor cartridges will hinder the wearer ability to detect the stench gas.

SENSOR FUNCTION

- When sensors are subjected to situations where they become over-ranged, over-saturated, or any other scenario that may provide an accurate reading, they may need to be bump tested, calibrated, or replaced, based on manufacturer’s recommendations.
- Sudden increases/decreases in gas levels, temperature, or pressure may cause sensor drift or provide inaccurate readings.
- Cross-sensitivities of potential gases present in the workplace might interfere with accurately alerting employees to a present hazard – Reference manufacturer’s recommendations for sensor cross-sensitivities. These can change based on type of calibration gas used for each instrument.
    - Some common cross-sensitives for FCX are listed below, but do not include all potentials. Be aware what is possible at each location.

Table 1. Common Cross-sensitivities (based on Industrial Scientific using Pentane Gas).

Actual Exposure	Cross Interference Alarm
Acetylene	SO_2, CO, HCL
Chlorine	CO, H_2S, SO_2, NO_2, NH_3
Hydrogen Sulfide	NO_2, HCL, PH_3, NH_3, Ethyl & Methyl Mercaptan
Sulfur Dioxide	HCN, HCL, NH_3
Nitrogen Dioxide	H_2S, SO_2, CL_2, CLO_2, HCN

Table 2. Common gas generation scenarios.

Ammonia (NH_3)	Blasting agents, misfire in muck, manufacture of ammonium-moly products
Arsine (AsH_3)	Electrowinning/electrorefining under unfavorable voltage or electrolyte conditions
Carbon Dioxide (CO2)	Calcite ores with acid (some carbonate ores can release CO_2 under low pH)
Carbon Monoxide (CO)	Blast smoke, oxy/acetylene torches in confined or unventilated areas, oil breakdown in kilns, incomplete combustion, gasoline engines
Carbon Disulfide (CS2)	Stagnant PAX or D8
CH_4 (explosive)	Fermentation of organics/decay of sewage
Chlorine (Cl_2)	Mixing bleach with a strong acid, water treatment systems
Chloramine gases	Mixing bleach with ammonia
Hydrogen (H_2)	Electrowinning/electrorefining under unfavorable voltage, strong acid reacting with metal
Hydrogen Sulfide (H_2S)	Breakdown of NaHS or P_2S_5/Nokes when mixed with pH < ~10.5, fermentation of organics/decay of sewage, sulfur shipments, stagnant PAX or D8, ground water with exposure to sulfide ore bodies or oil deposits
Nitrogen Dioxide (NO_2)	Arc welding, released from impure sulfuric acid (nitrosysulfuric acid is very unstable and readily releases large volumes of NO_2), blast smoke
Oxygen Deficiency	Stagnant air in confined area (decay of organics, oxidation of metals, consumed by sulfide ores, etc.)
Ozone (O_3)	Arc welding
Radon	Enclosed area with exposure to granite or similar geology
Sulfur Dioxide (SO_2)	Sulfuric acid, reactive sulfide ore, often after blast increases surface area available, seems to be catalyzed by moisture, hot work on steel with concentrate contamination, overheated concentrate dryers

REFERENCES

- 29 CFR 1910.134; Respiratory protection
- CDC/NIOSH Immediately Dangerous to Life or Health Values
- Industrial Scientific Cross-Sensitivity
- A Practical Guide for Use of Real Time Detection Systems for Worker Protection and Compliance with Occupational Exposure Limits, May 2019