HYDROGEN SULFIDE
UPDATED

Rocky Mountain EHS Peer Group
1st Quarter 2013 Meeting

Presented by LT Environmental, Inc.
Outline historic and new H$_2$S prone areas
Discuss API Recommended Procedures
Discuss BLM requirements
Discuss State requirements
Discuss ACGIH changes
H$_2$S Prone Areas

H$_2$S production historically restricted to specific basins and formations

Recent advances and controls used in drilling and completion technologies seemed to be tied to new areas/formations with H$_2$S production

Where H$_2$S is found, SO$_2$ is also found
$H_2S$ Prone Areas
Why does $\text{H}_2\text{S}$ occur?

- Sulfate-reducing bacteria (SRB) converts $\text{SO}_4$ from cellulosic material and some hydrocarbons
- SRB uses carbon food sources that are typically found in the majority of drilling mud systems
- SRB introduced into the mud system during drilling activities, and are activated during re-use and storage of mud
- SRB introduced into the well stimulation fluids, and are activated during re-use and storage of fluids
Recommended Practice 49 - Recommended Practice for Drilling and Well Servicing operations Involving Hydrogen Sulfide

- Applies to well drilling, completion, servicing, workover, downhole maintenance and plug & abandonment procedures.
- Establishes location classifications
- Addresses personnel training, monitoring equipment, personal protective equipment, contingency planning and emergency procedures.
- Also establishes Sulfur Dioxide (SO$_2$) requirements
Location Classifications

- No Hazard Area

- Condition 1 Area – low hazard
  - <10 ppm $\text{H}_2\text{S}$

- Condition 2 Area – medium hazard
  - >10 ppm, <20 ppm $\text{H}_2\text{S}$

- Condition 3 Area – high hazard
  - >20 ppm $\text{H}_2\text{S}$
Recommended Actions

- **Warning Systems**
  - Visual and audio dependent upon location classification

- **Monitoring Equipment**
  - Manufacturer certified for $H_2S$ and $SO_2$
  - Accurate in a range from well below to well above action levels ($H_2S = 10$ ppm, $SO_2 = 2$ ppm)
  - Mixture of fixed and portable monitors as needed to protect workers

- **Personnel Training**

- **Contingency Plans**
Contingency Plan

- May be required by certain federal, state or local agencies.

- Must contain:
  - Facility specific description and maps
    - Monitoring equipment locations
    - Safety equipment locations
    - Safe breathing area locations
    - Evacuation routes
  - Training and drill requirements
  - Emergency response procedures
Onshore Oil and Gas Order No. 6, Hydrogen Sulfide Operations
Applicability

- All onshore Federal and Indian oil and gas leases.
- Drilling, completing, testing, reworking, producing, injecting, gathering, storing, or treating operations.
- Involving zones which are known or could reasonably be expected to contain H$_2$S present in concentrations equal to or greater than 100 ppm.
Requirements

- Written H$_2$S Drilling Operations Plan submitted with APD
- Written Public Protection Plan submitted with APD, notification of production or when radius of exposure criteria are met
- Training Program available for review upon request
- All plans and programs available at site
Radius of Exposure

- Pasquill-Gifford derived equation:
  \[ X = [1.589](H_2S \text{ concentration})(Q)]^{0.6258} \]

  \[ X = \text{radius of exposure} \]

  \[ H_2S \text{ concentration} = \text{decimal equivalent of the volume fraction of } H_2S \text{ in the gas stream} \]

  \[ Q = \text{maximum volume of gas determined to be available for escape in cubic feet per day} \]
State Requirements

- Colorado Oil & Gas Conservation Commission Rule 607
  - An operator must file an H$_2$S drilling operations plan when working in geologic zones known or reasonably expected to encounter H$_2$S in the gas stream at concentrations at or above 100 ppm.
  - Any field measurement of H$_2$S during oil and gas operations detected by using colorimetric tubes, hand-held personal monitors, fixed gas monitors or other field instrumentation at a concentration equal to or greater than 20 ppm shall be verified by a subsequent sampling of the source gas by laboratory gas analysis for H$_2$S concentration.
  - All subsequent gas analysis which report concentrations above non-detect at a subject location shall be reported to COGCC and the Local Governmental Designee (LGD).
ACGIH is a private, not-for-profit, nongovernmental organization whose members are industrial hygienists or other health & safety professionals.

Composed of committees that review existing published, peer-reviewed literature to develop a conclusion on the level of exposure that workers can experience without adverse health conditions.

Threshold Limit Values (TLVs) = 8-hour time-weighted average recommendations (NOT REGULATION)
Existing Exposure Limits for H$_2$S

- OSHA ceiling (10 min) = 20 ppm
- OSHA peak (10 min) = 50 ppm
- IDLH = 100 ppm
- NIOSH ceiling (10 min) = 10 ppm
- ATSDR MRL (24 hour) = 0.07 ppm (acute), 0.03 ppm (intermediate)
- WHO community exposure limit (24 hour) = 0.003 ppm
ACGIH

- Changed the threshold limit value (TLV) and the short-term exposure limit (STEL) recommendation for \( \text{H}_2\text{S} \) in February 2010.
Changes based on the potential neurological effects of prolonged exposure to H$_2$S published in several peer-reviewed articles.

Effects include mental capacity reduction similar to Alzheimer’s Disease.
ACGIH

- TLV - Revised from 10 ppm to 1 ppm
- STEL - Revised from 15 ppm to 5 ppm
Problems

- **Monitoring equipment** –
  - A Canadian Department of Governmental Services Study determined that the majority of intrinsically safe personal H2S detectors on the market are not accurate in the ppb range
  - A report issued by detector manufacturers indicated that problems will occur with false positives when alarms set below 1 ppm
Problems

• Several published standards incorporate ACGIH TLVs by reference
  - NFPA 306 – Control of Gas Hazards on Vessels
  - US Coast Guard regulations (OSHA PEL or TLV, whichever is lower)
  - US Army (OSHA PEL or TLV, whichever is lower, or specific Army OEL)
  - Some individual state health and safety plans (e.g. California)
  - Many international standards and regulations (e.g. Canada)
  - Many consensus standards (e.g. ANSI, NFPA)
  - Many corporate health and safety plans
  - Mine Safety and Health Administration (MSHA) regulations
Problems

- American National Standards Institute (ANSI) committee on Hydrogen Sulfide Safety stated that they believe there is insufficient data justifying the ACGIH reduction.
- Canadian Department of Governmental Services determined that inadequate study of the economic and scientific feasibility of the reduction has been performed.
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