

HYDROGEN SULFIDE UPDATED

Rocky Mountain EHS Peer Group
1st Quarter 2013 Meeting



Presented by *LT Environmental, Inc.*

Purpose

- Outline historic and new H₂S prone areas
- Discuss API Recommended Procedures
- Discuss BLM requirements
- Discuss State requirements
- Discuss ACGIH changes



H₂S Prone Areas

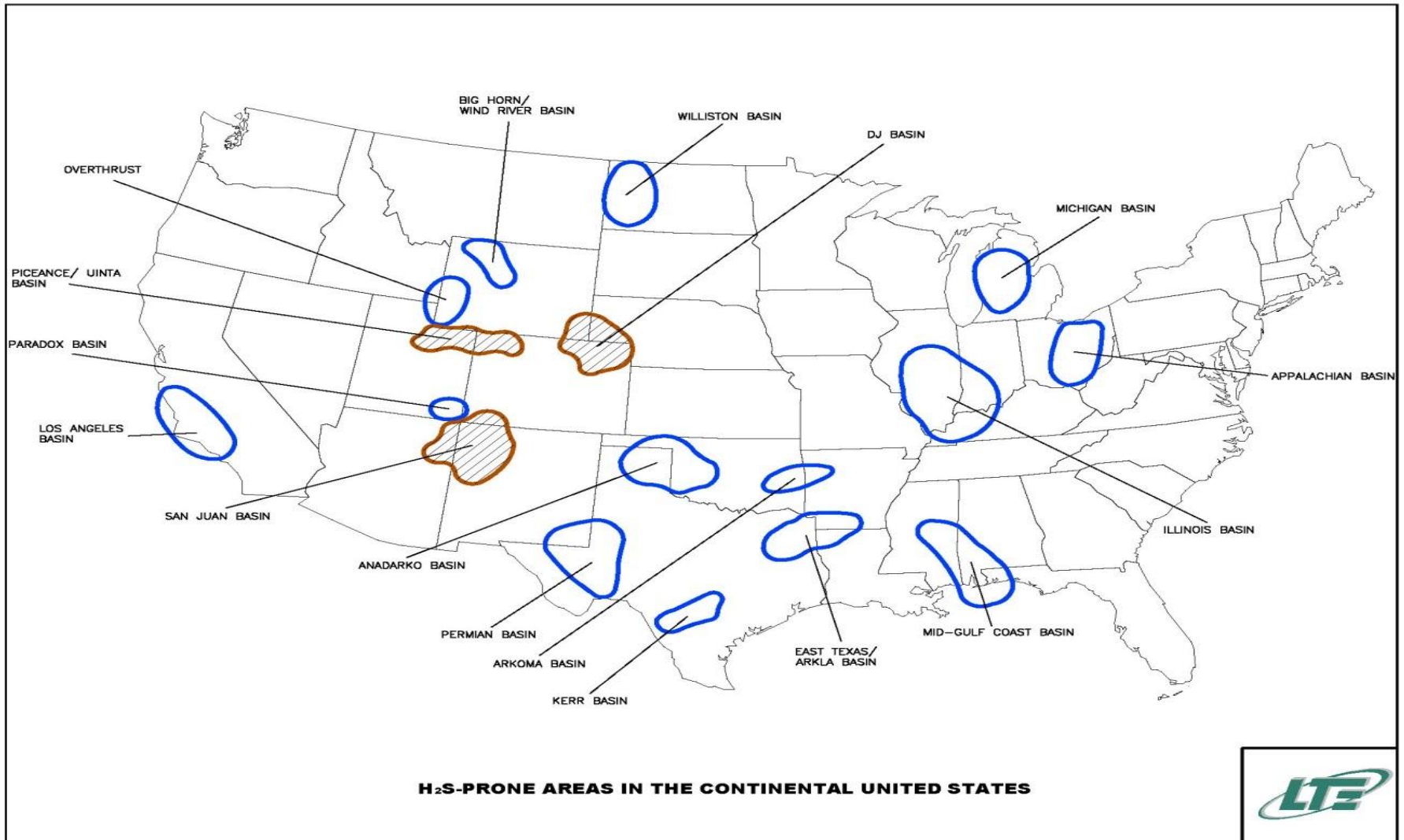
H₂S production historically restricted to specific basins and formations

Recent advances and controls used in drilling and completion technologies seemed to be tied to new areas/formations with H₂S production

Where H₂S is found, SO₂ is also found

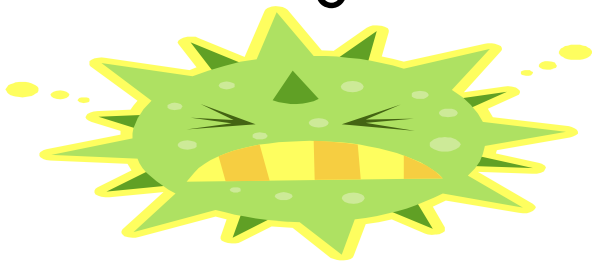


H₂S Prone Areas



Why does H₂S occur?

- Sulfate-reducing bacteria (SRB) converts SO₄ 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



AMERICAN PETROLEUM INSTITUTE

- 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 (SO₂) requirements

Location Classifications

- No Hazard Area
- Condition 1 Area – low hazard
 - <10 ppm H_2S
- Condition 2 Area – medium hazard
 - >10 ppm, <20 ppm H_2S
- Condition 3 Area – high hazard
 - >20 ppm H_2S

Recommended Actions

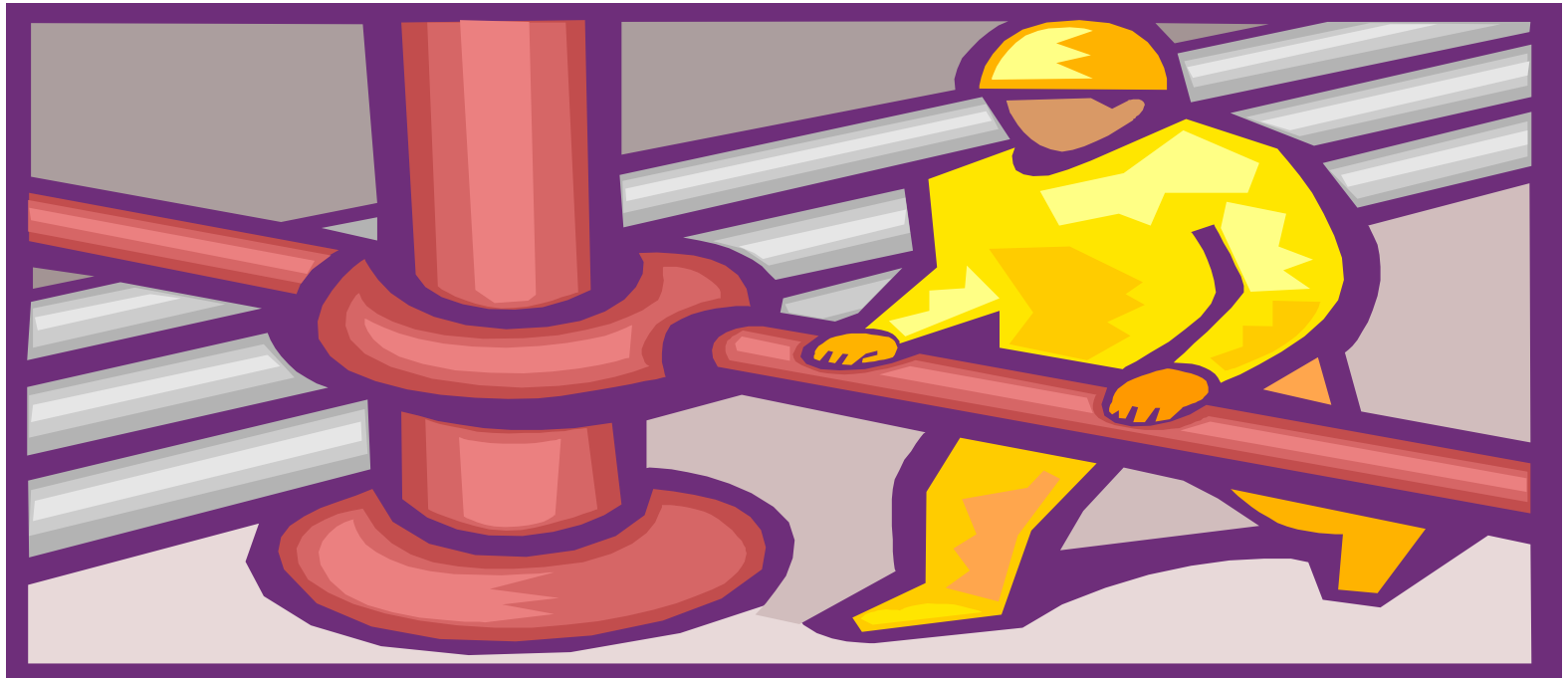
- Warning Systems
 - ▣ Visual and audio dependent upon location classification
- Monitoring Equipment
 - ▣ Manufacturer certified for H₂S and SO₂
 - ▣ Accurate in a range from well below to well above action levels (H₂S = 10 ppm, SO₂ = 2 ppm)
 - ▣ Mixture of fixed and portable monitors as needed to protect 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

BUREAU OF LAND MANAGEMENT

- 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_2S present in concentrations equal to or greater than 100 ppm.

Requirements

- Written H₂S 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:

$$X = [1.589)(\text{H}_2\text{S concentration})(Q)]^{0.6258}$$

X = radius of exposure

H₂S concentration = decimal equivalent of the volume fraction of H₂S in the gas stream

Q = 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 H₂S drilling operations plan when working in geologic zones known or reasonably expected to encounter H₂S in the gas stream at concentrations at or above 100 ppm
 - ▣ Any field measurement of H₂S 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 H₂S 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)



AMERICAN CONFERENCE of GOVERNMENTAL INDUSTRIAL HYGIENISTS

- 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)

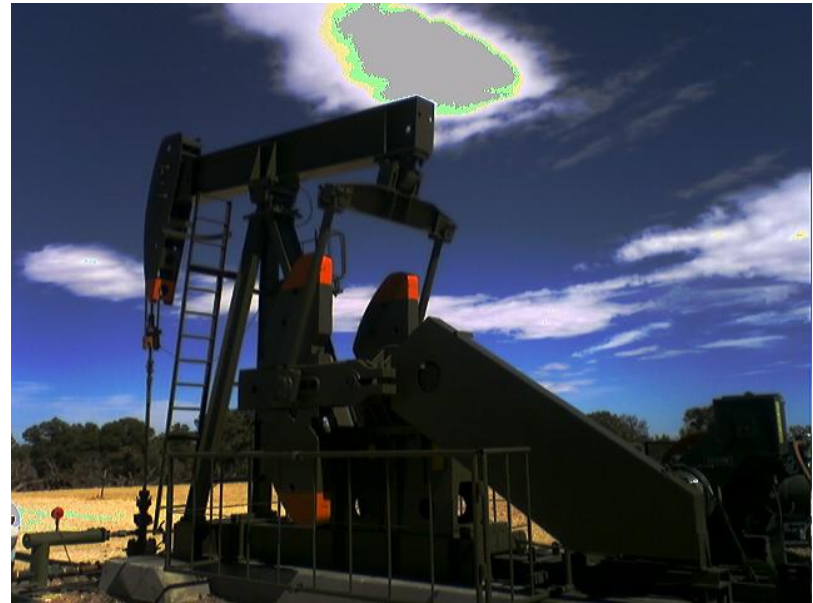


Existing Exposure Limits for H₂S

- 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

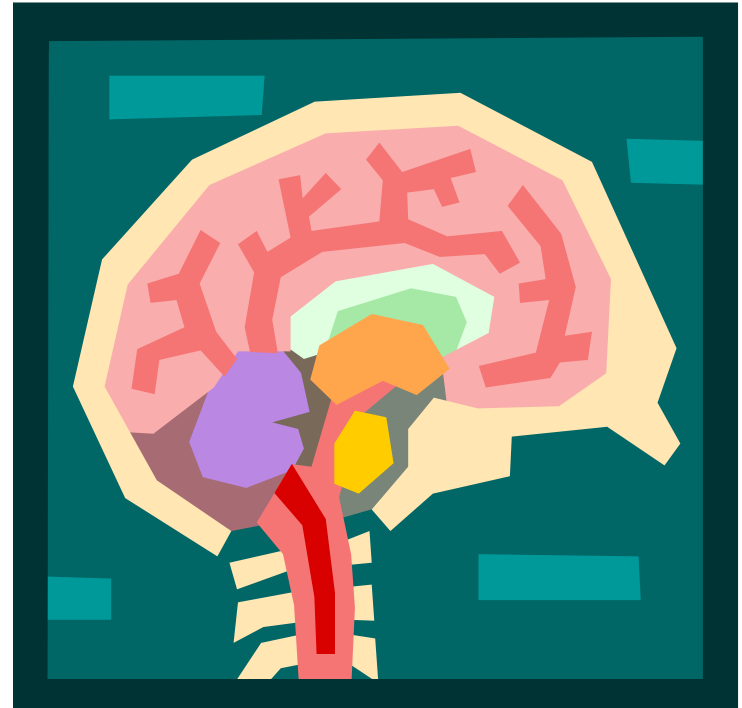
ACGIH

- Changed the threshold limit value (TLV) and the short-term exposure limit (STEL) recommendation for H₂S in February 2010.



ACGIH

- Changes based on the potential neurological effects of prolonged exposure to H_2S 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



Contact:



LT Environmental, Inc.

4600 West 60th Ave
Arvada, CO 80003
303-433-9788

Jeff Citrone, CIH, CSP, REA

jcitrone@ltenv.com

303-962-5494



Compliance, Remediation, Engineering