



U.S. Chemical Safety and Hazard Investigation Board

CSB Public Meeting

May 4, 2021

Hydrogen Sulfide Release at Aghorn Operating Waterflood Station

Odessa, Texas

October 26, 2019



Executive Director's Introduction

Stephen Klejst, Executive Director of Investigations and Recommendations

Investigation Team

Lauren Grim Supervisory Chemical
Incident Investigator

William Hougland Investigator-In-Charge



U.S. Chemical Safety and Hazard Investigation Board

Investigation Presentation

May 4, 2021

Hydrogen Sulfide Release at
Aghorn Operating Waterflood Station

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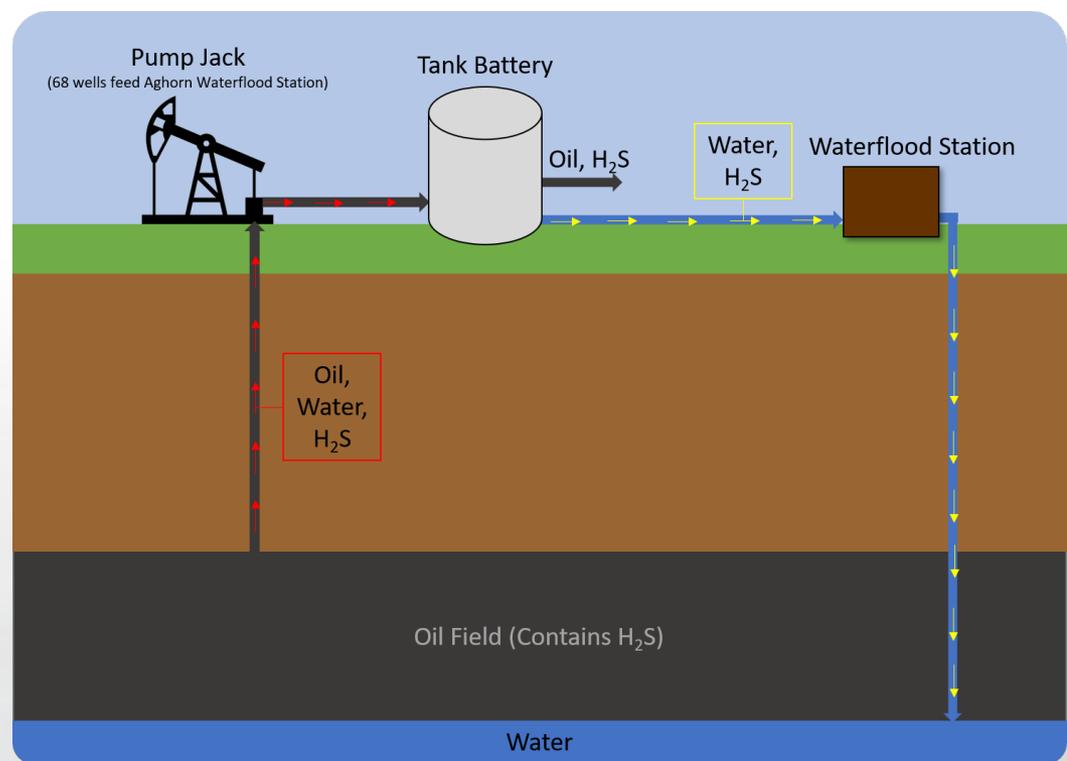
Lauren Grim

Supervisory Chemical Incident Investigator



Aghorn Waterflood Station Background

- Incident occurred at Foster D waterflood station
- Pump jacks extract oil from reservoirs
- In tank battery, oil and produced water separate
- Produced water containing H_2S transferred to waterflood station
- Waterflood station pumps produced water into oil reservoir





Incident Overview

- October 26, 2019
- Aghorn employee Pumper A response to alarm at waterflood station
- Pumper A worked to isolate the pump
- Water containing H₂S released from pump plunger
- Pumper A, and subsequently his spouse, were fatally injured from H₂S exposure



Safety Issues

- Nonuse of Personal H₂S Detector
- Nonperformance of Lockout / Tagout
- Confinement of H₂S Inside Pump House
- Lack of Safety Management Program
- Nonfunctioning H₂S Detection and Alarm System
- Deficient Site Security

Nonuse of Personal H₂S Detector

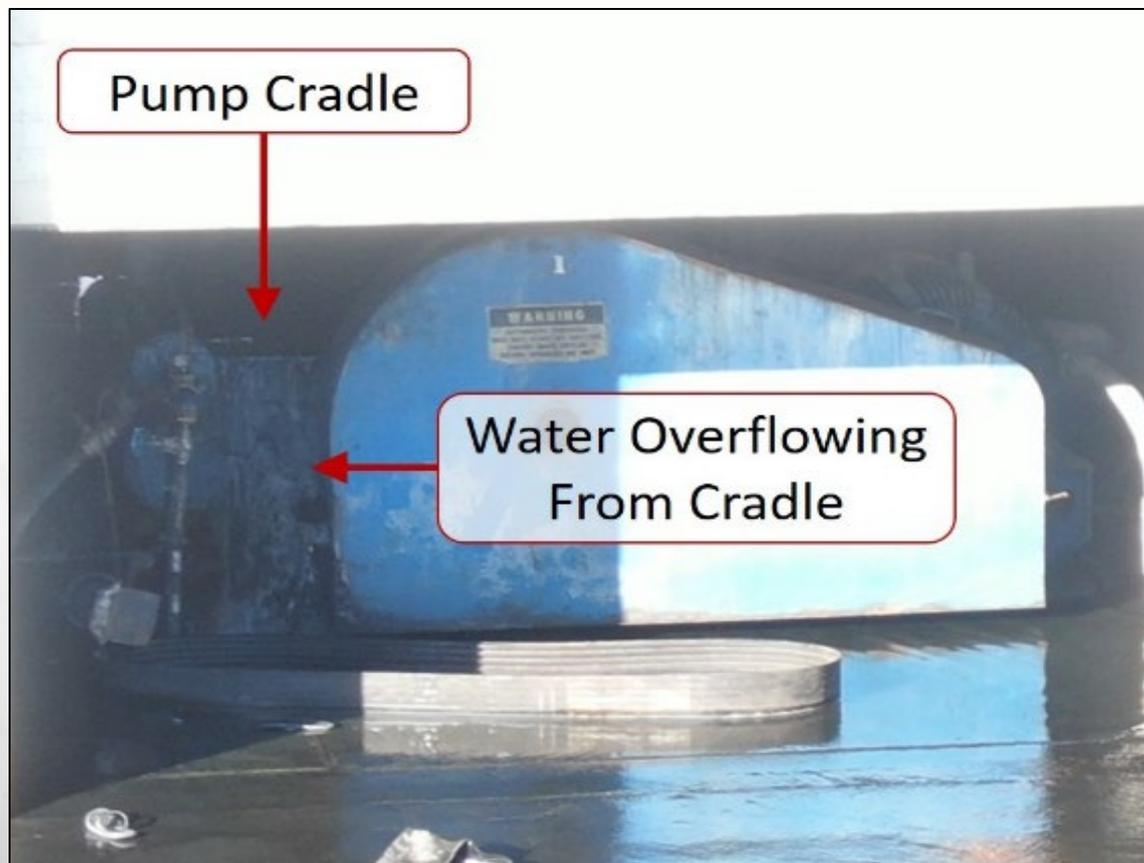
- Aghorn supplied employees with personal H₂S detectors
- Aghorn did not have a formal policy requiring employees to wear H₂S detectors at waterflood stations
- Pumper A's H₂S detector was found in his work truck
- Detector was in an alarm state. It had detected dangerous levels of H₂S
- Staff proposes recommendation to Aghorn





Nonperformance of Lockout / Tagout

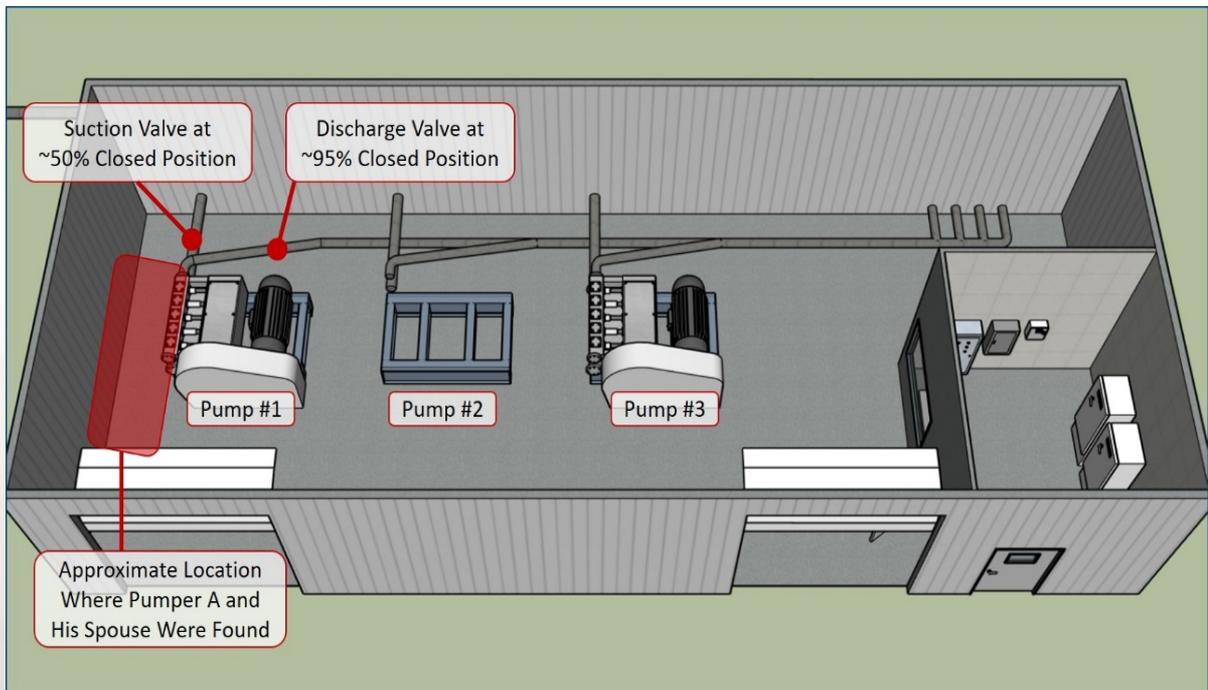
- Incident scene:
 - Pump #1 found running
 - Water spilling from pump
 - Pump #1 configured to be operated by PLC
 - Pump #1 power switch “on”
 - Discharge valve 95% closed
 - Suction valve 50% closed





Nonperformance of Lockout / Tagout

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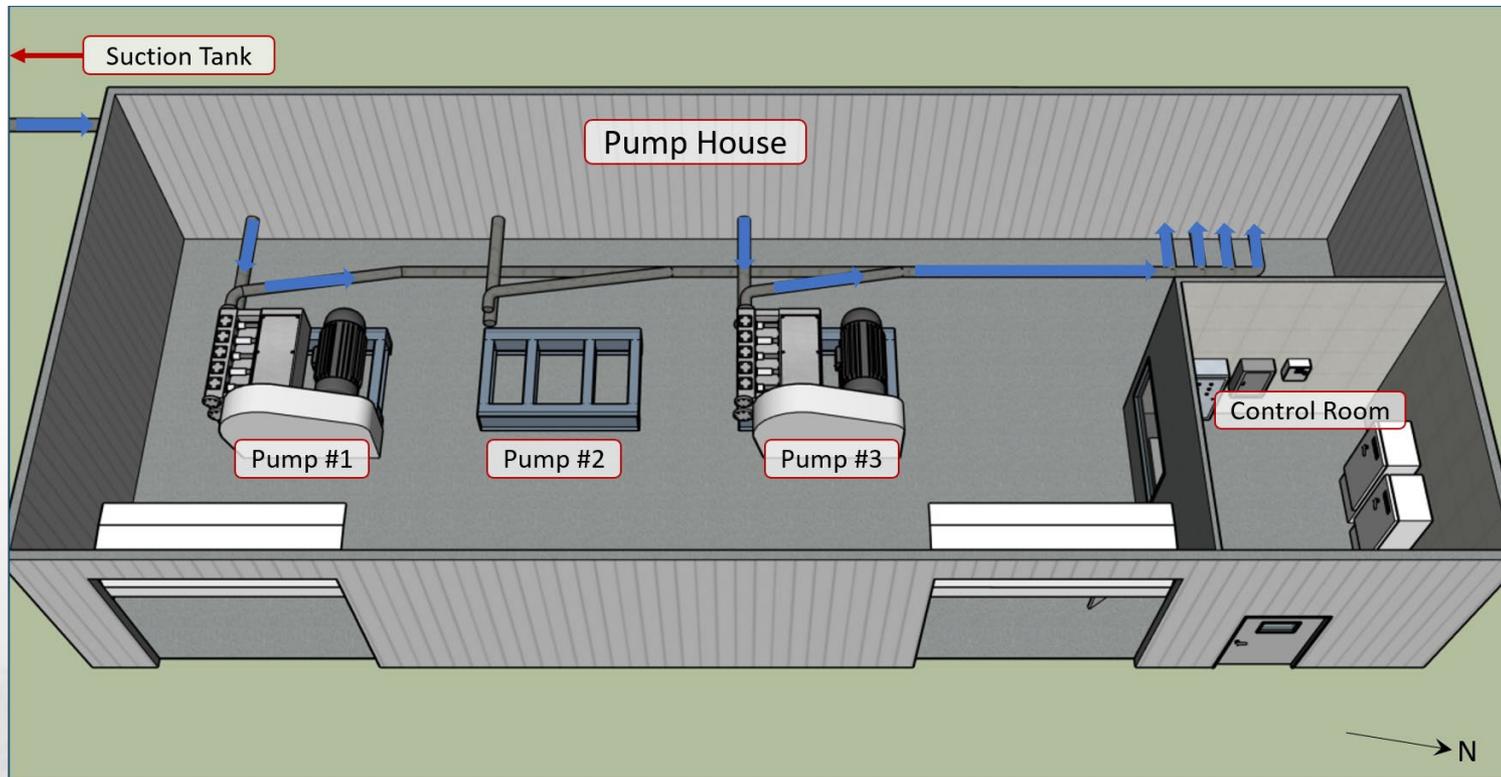


Nonperformance of Lockout / Tagout

- Pumper A did not deenergize or Lockout / Tagout Pump #1 before performing work on it
- The PLC's automatic activation of Pump #1 allowed H₂S-containing water to release from the pump while Pumper A was nearby
- Aghorn did not have written Lockout / Tagout policy
- There was insufficient evidence for CSB to determine to what extent Pumper A was trained on Aghorn's verbal Lockout / Tagout practice
- Staff proposes recommendation to Aghorn



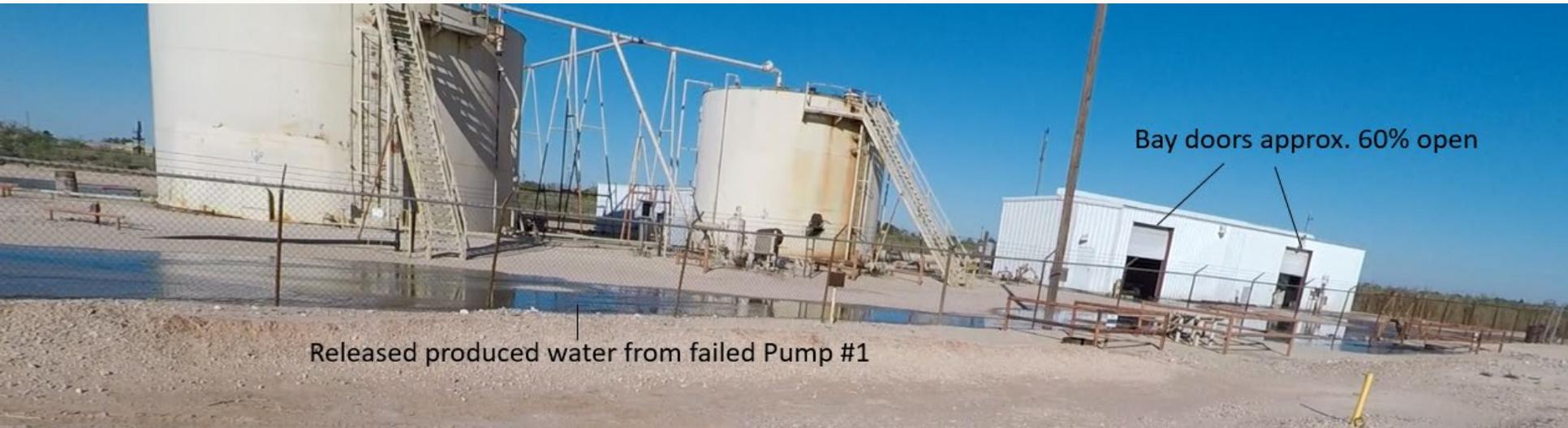
Confinement of H₂S Inside Pump House



Pumps were installed inside of the waterflood station pump house



Confinement of H₂S Inside Pump House



- Pump house's bay doors were found approx. 60% open
- Bay doors did not provide adequate ventilation
- Released H₂S was confined within pump house
- Staff proposes recommendation to Aghorn

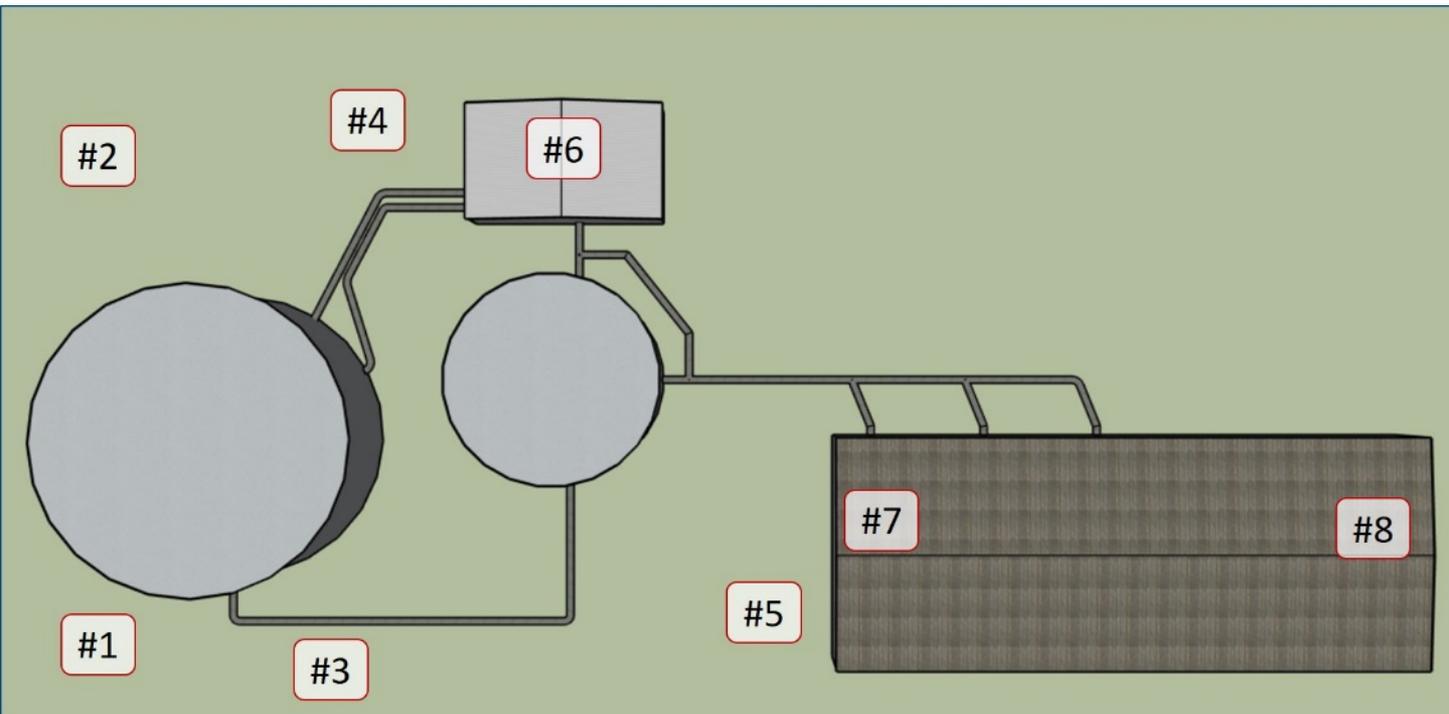


Lack of Safety Management Program

- Aghorn safety policies and procedures were limited to a cell phone use policy, an alarm call-out procedure, and a pamphlet on H₂S hazards
- Safety management programs are important to identify and control site hazards
- Lack of additional formal company safety policies contributed to nonperformance of Lockout / Tagout and nonuse of H₂S detector
- Staff proposes recommendation to Aghorn



Nonfunctioning H₂S Detection and Alarm System





Nonfunctioning H₂S Detection and Alarm System

- Aghorn did not maintain or properly configure H₂S detection and alarm system
- Neither the beacon light nor the phone system alerted Pumper A to dangerous atmosphere
- Staff proposes recommendation to Aghorn



Deficient Site Security





Deficient Site Security





Deficient Site Security



- Gates were typically only locked when an employee was not at the facility
- Gates were open when spouse arrived at facility
- Staff proposes recommendation to Aghorn to improve site security



This Concludes the Staff Presentation



Findings



Findings

- Weather was not a significant factor in the outcome of this incident.
- Due to the limitations of the available evidence, the CSB was unable to determine whether the pump failure and loss of containment of the produced water (1) occurred before Pumper A arrived at the facility, or (2) occurred when the pump energized while Pumper A was closing valves to isolate the pump.
- Due to the limitations of the available evidence, the CSB was unable to confirm whether the pump house exhaust fans were operational at the time of the incident.
- Since the waterflood station equipment contained deadly H₂S, Aghorn should have trained its employees, which should have led to Pumper A being aware, that an equipment malfunction could indicate an H₂S release.
- Pumper A was not wearing his personal H₂S detection device upon entering the facility, and there is no evidence that Aghorn management required the use of these devices.



Findings (continued)

- Regardless of when the pump failed, had Pumper A been wearing his personal H₂S detection device, he could have been alerted of the H₂S danger and potentially been able to escape prior to succumbing to the toxic gas.
- All Aghorn facilities where the potential exists to expose workers or non-employees to H₂S concentrations at or above 10 ppm would benefit from the mandatory use of personal H₂S detection devices as an integral part of every employee or visitor personal protective equipment (PPE) kit prior to entering the vicinity of the facility.
- Aghorn did not comply with OSHA regulation 29 CFR 1910.147 – *The Control of Hazardous Energy (Lockout / Tagout)* to ensure equipment was isolated from energy sources prior to performing work on it.
- Aghorn's lack of a formalized and comprehensive Lockout / Tagout program contributed to Pumper A's failure to deenergize Pump #1 before performing work on it.
- Had Pumper A locked out and tagged out Pump #1 before performing work on it, the significant H₂S release and fatal outcome of the incident may not have occurred.



Findings (continued)

- All Aghorn facilities should have a formalized and comprehensive Lockout / Tagout program, to include policies, procedures, and training, to protect workers from energized equipment hazards, such as exposure to H₂S.
- Aghorn's pump system could operate outdoors, and at the time of the incident, confinement and inadequate ventilation allowed H₂S to accumulate to deadly levels inside the pump house.
- Aghorn did not have sufficient fixtures or facilities to ventilate the pump house, and there is no evidence of Aghorn's assessment of the facility design to ensure proper ventilation.
- All facilities where the potential exists to expose workers to H₂S concentrations at or above 10 ppm would benefit from a comprehensive analysis of the facility design vis-à-vis ventilation and mitigation systems to ensure that workers are not exposed to toxic gas levels.
- Aghorn did not adhere to the OSHA regulatory requirement 29 CFR 1910.1000 – *Air Contaminants* to implement administrative or engineering controls to minimize or eliminate the risk of employees being exposed to air contaminants.



Findings (continued)

- Aghorn did not employ sound safety management principles in addressing the risks associated with H₂S at the Foster D waterflood station facility.
- Aghorn lacked operational, training, testing, and maintenance procedures and records.
- Comprehensive safety management practices include risk identification, assessment, mitigation and monitoring of design, procedures, maintenance and training, and are an essential element of protecting workers and non-employees from toxic gases at chemical plants.
- All facilities where the potential exists to expose workers or non-employees to H₂S concentrations at or above 10 ppm should be governed by a safety management program that includes a focus on protecting workers and non-employees from toxic H₂S gas.
- Improved communication of the hazards that contributed to this incident, as well as the regulatory requirements to control those hazards, could help prevent future similar incidents.



Findings (continued)

- Aghorn did not maintain or properly configure its Foster D waterflood station facility H₂S detection and alarm system.
- Without the alarm panel receiving any signals from the detectors, neither the beacon light nor the phone system alerted Pumper A to the dangerous atmosphere.
- Had Aghorn properly maintained and configured the H₂S detection and alarm system, and if produced water and H₂S released prior to his arrival, Pumper A would have been notified of the presence of toxic levels of H₂S in and around the pump house.
- At all facilities where the potential exists to expose workers to H₂S concentrations at or above 10 ppm, the H₂S detection and alarm system should be properly maintained and configured, and companies should have a program and process that addresses installation, calibration, inspection, maintenance, training, and routine operations.
- Aghorn's H₂S detection and field alarm system was not designed with multiple layers of alerts, leading to the opportunity for a single-point failure. Had the chemical release occurred after Pumper A arrived on-scene, the one alerting device remaining would only have been evidenced from outside the pump house.



Findings (continued)

- Regardless of when produced water and H₂S released, had there been multiple layers of alerts in the H₂S detection and alarm system design at the facility, such as through both visual and audible alerts both internal and external to the pump house, Pumper A would have been warned of pending danger.
- Even if the field H₂S alert system had been tested and operational, as designed, it was highly unlikely to have deterred the spouse from entering the facility or provided her with warning of released hazardous chemicals that might threaten her life or those of her children.
- Audible alarms provide additional warning of toxic gas hazards.
- All facilities where the potential exists to expose workers or non-employees within the perimeter of the facility to H₂S concentrations at or above 10 ppm would benefit from H₂S detection and alarm system designs that employ multiple layers of alerts unique to H₂S, such as with the use of both audible and visual mediums, so that workers and non-employees in all locations would be alerted to a significant release.



Findings (continued)

- Pumper A's spouse likely did not see the H₂S warning signs because they were corroded, and she arrived during night conditions. If she did see the H₂S warning signs, she may not have known that she could have been in danger.
- Aghorn's site security did not meet industry guidance and standards, to include *ANSI/API Standard 780 – Security Risk Assessment Methodology for the Petroleum and Petrochemical Industries*, and *API RP 781 – Facility Security Plan Methodology for the Oil and Natural Gas Industries*.
- Had Aghorn designed the facility according to these guidelines, the gates would have been secured, preventing Pumper A's spouse from entering the facility.
- All facilities where the potential exists to expose workers or non-employees to H₂S concentrations at or above 10 ppm would benefit from formal, written, site-specific security programs that require employees to lock access gates upon entering and departing the facility.



Probable Cause



Probable Cause

The CSB determined that the probable cause of the incident was Aghorn's failure to enforce operator use of personal H₂S detectors when in the vicinity of equipment or facilities with the potential to release H₂S, and Aghorn's failure to develop, train on, and enforce Lockout / Tagout procedures that led to Pumper A performing work on a pump while it was still energized. Contributing to the incident was Aghorn's facility physical and operational design, which did not allow for adequate ventilation of the toxic H₂S gas inside the pump house, and Aghorn's deficient safety management program. Likely also contributing to the incident was Aghorn's failure to maintain and properly configure the site H₂S detection and alarm system. Contributing to the severity of the incident was Aghorn's poor site security that allowed Pumper A's spouse to gain access to the facility.



Proposed Recommendations



Proposed Recommendations

To Aghorn Operating Inc.

2020-01-I-TX-R1

For all waterflood stations where the potential exists to expose workers or non-employees to H₂S concentrations at or above 10 ppm, mandate the use of personal H₂S detection devices as an integral part of every employee or visitor personal protective equipment (PPE) kit prior to entering the vicinity of the facility. Ensure detector use is in accordance with manufacturer specifications.



Proposed Recommendations (continued)

To Aghorn Operating Inc.

2020-01-I-TX-R2

For all Aghorn facilities, develop a site-specific, formalized and comprehensive Lockout / Tagout program, to include policies, procedures, and training, to protect workers from energized equipment hazards, such as exposure to H₂S. Ensure the program meets the requirements outlined in 29 CFR 1910.147 and includes energy control procedures, training, and periodic inspections.



Proposed Recommendations (continued)

To Aghorn Operating Inc.

2020-01-I-TX-R3

For all waterflood stations where the potential exists to expose workers to H₂S concentrations at or above 10 ppm, commission an independent and comprehensive analysis of each facility design vis-à-vis ventilation and mitigation systems to ensure that, in the event of an accidental release, workers are protected from exposure to toxic gas levels.



Proposed Recommendations (continued)

To Aghorn Operating Inc.

2020-01-I-TX-R4

For all waterflood stations where the potential exists to expose workers or non-employees to H₂S concentrations at or above 10 ppm, develop and demonstrate the use of a safety management program that includes a focus on protecting workers and non-employees from H₂S. This program should include risk identification, assessment, mitigation, and monitoring of design, procedures, maintenance and training related to H₂S. This program must be in compliance with 29 CFR 1910.1000 – *Air Contaminants* and 29 CFR 1910.147 – *The Control of Hazardous Energy (Lockout / Tagout)*.



Proposed Recommendations (continued)

To Aghorn Operating Inc.

2020-01-I-TX-R5

For all waterflood stations where the potential exists to expose workers to H₂S concentrations at or above 10 ppm, ensure the H₂S detection and alarm systems are properly maintained and configured, and develop site-specific detection and alarm programs and associated procedures based on manufacturer specifications, current codes, standards, and industry good practice guidance. The program must address installation, calibration, inspection, maintenance, training and routine operations.



Proposed Recommendations (continued)

To Aghorn Operating Inc.

2020-01-I-TX-R6

For all waterflood stations where the potential exists to expose workers or non-employees within the perimeter of the facility to H₂S concentrations at or above 10 ppm, ensure that the H₂S detection and alarm system designs employ multiple layers of alerts unique to H₂S, such as with the use of both audible and visual mediums, so that workers and non-employees within the perimeter of the facility would be alerted to a significant release. The system design must meet manufacturer specifications, current codes, standards, and industry good practice guidance.



Proposed Recommendations (continued)

To Aghorn Operating Inc.

2020-01-I-TX-R7

For all waterflood stations where the potential exists to expose non-employees to H₂S concentrations at or above 10 ppm, develop and implement a formal, written, site-specific security program to prevent unknown and unplanned entrance of those not employed by Aghorn, starting with a requirement for employees to lock access gates upon entering and departing the facility.



Proposed Recommendations (continued)

To Occupational Safety and Health Administration (OSHA)

2020-01-I-TX-R8

Issue a safety information product (such as a safety bulletin or safety alert) that addresses the requirements for protecting workers from hazardous air contaminants and from hazardous energy.



Proposed Recommendations (continued)

To Railroad Commission of Texas

2020-01-I-TX-R9

Develop and send a Notice to Operators to all oil and gas operators that fall under the jurisdiction of the Railroad Commission of Texas that describes the safety issues described in this report, including:

1. Nonuse of Personal H₂S Detector
2. Nonperformance of Lockout / Tagout
3. Confinement of H₂S Inside Pump House
4. Lack of Safety Management Program
5. Nonfunctioning H₂S Detection and Alarm System
6. Deficient Site Security



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