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<h2>Hydrogen Sulfide (H<sub>2</sub>S) Protocol</h2>					

## Overview

### Purpose

This Devon Energy EHS Protocol defines what is required to protect workers and the public from the hazards encountered in a hydrogen sulfide (H<sub>2</sub>S) environment.

### Scope

This protocol applies to all Devon operated equipment, facilities and all Devon employees. Contractors will have their own program that meets or exceeds Devon's Hydrogen Sulfide Protocol.

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## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

### 1.0 RESPONSIBILITIES

#### Division/Business Unit Leadership

- Reinforce adherence to this protocol and provide resources for application of the protocol.
- Ensure employees are trained appropriately for working around H<sub>2</sub>S.

#### Line Supervisor

- Understand how this protocol applies to personnel in their area of responsibility.
- Ensure employees have training, skills, knowledge and understanding to comply with this protocol.
- Check periodically to ensure the requirements of this protocol are being met.

#### Environmental, Health and Safety

- Provide technical resources and tools for protocol application.
- Monitor compliance through the audit process.

#### Devon Employees

- Adhere to the requirements of this protocol.
- Identify and report gaps in this protocol.
- Complete required training.

#### Contract Company Representative

- Comply with regulatory requirements and follow the Devon EHS protocols.

### 2.0 TERMS AND DEFINITIONS

#### 2.1 Hydrogen Sulfide Terms and Definitions

**Air Supplying Respirator (ASR)** - a device that provides Grade D breathing air. There are two types of ASR: Supplied Air Respirator (SAR) and Self-Contained Breathing Apparatus (SCBA).

**Ambu Bag** - a hand-held device used to provide positive pressure ventilation to a patient who is not breathing or who is breathing inadequately.

**Contingency Plan** - a written document that contains emergency response procedures which provide an organized plan of action for alerting and protecting the public within an area of exposure, prior to an intentional or accidental release of a potentially hazardous volume of H<sub>2</sub>S.

**Building** - a structure with four sides and a roof (e.g., meter houses, compressor buildings, etc.).

**Escape Pack** - an emergency escape-breathing device providing five, 10 or 15 minutes of breathing for escape from toxic environments, even in concentrations immediately dangerous to life and health (IDLH).

**Grain (one grain 100ft<sup>3</sup> of gas)** - A unit of measure for hydrogen sulfide and is expressed in the following manner:


Grains per 100 cubic feet

¼ grain = 4 ppm      1 grain = 16ppm

**Immediately Dangerous to Life or Health (IDLH)** - exposure to airborne contaminants that is likely to cause death, or may cause immediate or delayed permanent adverse health effects that might prevent escape from such an environment, for H<sub>2</sub>S this concentration is 100 ppm

**Incident Management Team (IMT)** - a group of people assigned to manage an incident under the incident command system. Within Devon, IMTs exist at three levels - local (site), division (DIMT) and corporate (CIMT).

**Iron Sulfide** - a chemical compound consisting of iron and sulfur, commonly found inside piping, vessels and/or other equipment where H<sub>2</sub>S is or has been present, that will ignite and burn in the presence of oxygen in air.

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**Hydrogen Sulfide (H<sub>2</sub>S)** - a gas formed in nature by the decomposition of organic material by bacteria. H<sub>2</sub>S is found in natural gas, oil, sewers, stagnant water, volcanic gases, sulfur springs and anywhere that organic materials may be broken down.

**Hydrogen Sulfide (H<sub>2</sub>S) Facility** - any location where H<sub>2</sub>S concentrations of 10 ppm or greater exist before treatment (oil, gas, water or stream), however; this does NOT include sites impacted by bacterial H<sub>2</sub>S.

**National Association of Corrosion Engineers (NACE)** - a professional organization for the corrosion control industry established in 1943. The main focus of their activities includes cathodic protection, coatings for industry and material selection for specific chemical resistance.

**Parts Per Million (ppm)** - a concentration by volume of one part of a gas (or vapor), or by weight of a liquid or solid, per million parts of air or liquid.

**Public Area** - a dwelling, place of business, church, school, hospital, school bus stop, government building, a public road, all or any portion of a park, city, town, village or other similar area that can be expected to be populated.

**Public Road** - any federal, state, county or municipal street or road owned or maintained for public access or use.

**Radius of Exposure (ROE)** - the distance from a release to where H<sub>2</sub>S concentration in the air will dilute to a specific concentration.

**Self-Contained Breathing Apparatus (SCBA)** - a respirator that has breathing air carried in a tank on the worker's back and supplied through a hose into a full-face respirator with a minimum cylinder rating of 30 minutes under positive pressure/pressure demand.

**Sulfur Dioxide (SO<sub>2</sub>)** - a toxic gas created when hydrogen sulfide is burned. It is heavier than air and forms sulfuric acid when combined with moisture (including perspiration).

**Supplied Air Respirator (SAR)** - a respirator that has compressed air from a stationary source is supplied through a high-pressure hose connected to a full-face respirator under positive pressure/pressure demand with an auxiliary self-contained bottle (rated for a minimum of five minutes).

**Tutwiler Test** - a field test for determining H<sub>2</sub>S in gas mixtures. Mercaptan sulfur and carbonyl sulfide, if present, are determined as H<sub>2</sub>S. The accuracy of this method is not sufficient to obtain reliable results below five grains of H<sub>2</sub>S per 100 ft<sup>3</sup>.

**Working Atmosphere** - the area surrounding a worker that possess a respiratory exposure.

## 2.2 General Terms and Definitions

**Area** - individual operating fields or components that collectively comprise a region, areas normally include an area office.

**Area Office** - a field office with assigned employees that support an area (e.g., Cuero, Artesia, etc.).

**Business Unit** - individual components that collectively comprise a Division. Business Units may also be referred to as Basins.

**Contract Company Representative** - a contractor who is assigned responsibilities and oversight for a specific task that requires adherence to Devon EHS Protocols.

**Division** - the division operations of Devon are Canada, Corporate, Strategic-Services, Facilities and Pipeline and U.S.

**Enterprise Classification Structure** - part of Devon's strategic plan for managing information assets. The ECS is the published list of all records classes, the period of time for retaining each and their designated disposition.

**Field EHS** - a titled position that provides EHS guidance and support within a Division.

**Facility** - a collection of structures, piping, valves, vessels, tanks, compression and processing equipment located in close geographic proximity, that are involved directly in the development,



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

production, processing or delivery of oil and gas to market (e.g., a tank battery, drill-site, well-site, compressor station, pipeline and gas plant).

**Line Supervisor** - a titled position that has assigned authority and responsibility for financials, production, maintenance, projects and personnel for a defined area. In Devon, this could be any supervisor, superintendent, foreman or assistant foreman.

**Person In Charge (PIC)** - a person that has been authorized by Devon to perform specific tasks to comply with this Devon protocol and/or regulatory requirements related to EHS. The PIC is defined in all protocols in the second column of the protocol section.

**Region / District** - individual components that collectively compromise a division.

3.0 PROTOCOL		
3.1 Identification and Communication of Potential H <sub>2</sub> S Hazards H <sub>2</sub> S is a toxic, highly flammable, colorless gas which may be encountered in exploration, production and processing of natural gas, crude oil, associated gas and produced water.		
Step	Person In Charge (PIC)	Action
3.1.1	Line Supervisor	Determine the H <sub>2</sub> S concentrations, prior to treatment, in the gas or liquid stream for new production or acquired assets by sampling or using measurement gas analysis sample results (internal or third party gatherer). Using scavenger to treat the area would not eliminate the need to comply with the monitoring, PPE, signage, etc., requirements identified within the protocol.  <b>Note:</b> Sampling can be conducted using one of the following methods: Tutwiler test, gas chromatograph, gas analysis, colorimetric detector tubes or by electronic detection devices (direct reading instrument).
3.1.2	Line Supervisor	Conduct state and/or agency required sampling when applicable, in accordance with state-specific requirements.  <b>Note:</b> State and agency regulations may require a specific test method.
3.1.3	Line Supervisor	Conduct additional H <sub>2</sub> S sampling as processes change or as conditions warrant at field locations where H <sub>2</sub> S is known or suspected.  <b>Note:</b> Where allowed by state regulations, a representative sample may be used.
3.1.4	Line Supervisor	At H <sub>2</sub> S sites where the presence of H <sub>2</sub> S exists, test the vapor space of one tank of each type (e.g., produced water tank, condensate tank, oil tank, etc.). If gas analysis indicates concentrations above 500 ppm, and required controls are implemented, then additional sampling is not required. <b>Note:</b> Test the concentrations of the tank when levels are at 500 ppm or below. <b>Note:</b> If H <sub>2</sub> S concentrations are unknown and the working atmosphere is 10 ppm supplied air must be used.
3.1.5	Line Supervisor	Record the sample results from Steps 3.1.1 - 3.1.3.  <b>Note:</b> Attachment B - Sampling Results Form can be used to record the results.
3.1.6	Line Supervisor	Create and maintain a list of H <sub>2</sub> S facilities in the area using the H <sub>2</sub> S Facilities List (Attachment C) or equivalent.



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3.1.7	Line Supervisor/ Engineering	Calculate the Radius of Exposure (ROE) for locations where H <sub>2</sub> S is 100 ppm or greater, located in <b>Appendix A - Radius of Exposure Calculation</b> , using the Pasquill-Gifford method.  <b>Note:</b> ROE calculations for tanks are not required. <b>Note:</b> When calculating ROE on pipelines the calculated distance will run parallel with the pipeline.
3.1.8	Line Supervisor	Communicate H <sub>2</sub> S locations and hazards that may be encountered on-site through initial job planning and prior to arriving on location to the following: <ul style="list-style-type: none"> <li>• Employees</li> <li>• Contractors</li> <li>• Visitors</li> </ul> <b>Note:</b> See <b>Appendix B</b> for Chemical Reactivity Hazards.
<b>3.2</b>	<b>Drilling, Workover and Completion Safe Work Practices</b>	
	<b>H<sub>2</sub>S Site Determination</b>	
<b>Step</b>	<b>Person In Charge (PIC)</b>	<b>Action</b>
3.2.1	Line Supervisor	Based on previous sampling data from surrounding areas and rock formation results, appropriate precautions are required to be followed during drilling: <ul style="list-style-type: none"> <li>• H<sub>2</sub>S Training (<b>Appendix F</b>) of all employees/contractors</li> <li>• Fixed/Personal Monitors</li> <li>• Respirators</li> <li>• Signage</li> <li>• Emergency Action Plans</li> </ul>
	<b>Engineering Controls</b> Engineering controls should be the first line of protection against H <sub>2</sub> S hazards. The control(s) listed below are required.	
<b>Step</b>	<b>Person In Charge (PIC)</b>	<b>Action</b>
3.2.2	Line Supervisor	When H <sub>2</sub> S levels reach 10 ppm evaluate the risk to employees, contractors and nearby communities when determining the appropriate engineering control.  Such controls can include the use of a flare stack or killing the well during drilling, workover or completions. <b>Note:</b> For emergency purposes, an alternate ignition source can be used (e.g., flare gun, etc.).
3.2.3	Line Supervisor	Implement the following work practices and procedures in drilling and workover operations where: <ul style="list-style-type: none"> <li>• the 100 ppm radius of exposure is 50 feet or greater and includes a public area, or is greater than 3,000 feet, regardless of public area (<b>Appendix C</b>): <ul style="list-style-type: none"> <li>◦ Provide a method for igniting the gas if an uncontrollable emergency event occurs.</li> </ul> </li> </ul>



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

		<ul style="list-style-type: none"> <li>o Install a choke manifold, mud-gas separator and flare line, and provide a suitable method for lighting the flare as necessary.</li> <li>o Test drill-stems of H<sub>2</sub>S zones only in daylight hours.</li> <li>o Secondary remote control of blowout prevention and choke equipment to be located away from the rig floor at a safe distance from the wellhead.</li> </ul>
<p><b>Administrative Controls</b> Administrative controls will be implemented as the second line of defense. In some cases, these administrative controls are regulatory requirements, in other cases, administrative controls are implemented when engineering controls are not feasible.</p>		
Step	Person In Charge (PIC)	Action
3.2.4	Line Supervisor	Conduct a Job Hazard Analysis (JHA) before beginning tasks that are non-routine (as defined in the Pre-Job Planning Protocol), activities that are without a procedure, or work on processes where the working atmosphere of H <sub>2</sub> S are greater than 100 ppm. This JHA must include respiratory precautions and stand by person.
3.2.5	Employee	Establish an evacuation plan during the pre-task tailgate when working at H <sub>2</sub> S facilities that includes the following components: <ul style="list-style-type: none"> <li>• Communicate wind direction (i.e., wind indicators on locations)</li> <li>• Identify muster areas and emergency exits</li> </ul>
3.2.6	Employee	Display wind indicators (e.g., windsocks, streamers, etc.) at drilling rigs, workovers and well servicing operations where H <sub>2</sub> S concentrations exceed 100 ppm in the gas or liquid stream. <b>Note:</b> Wind indicators will meet the following requirements: <ul style="list-style-type: none"> <li>• Visible from any location on the site,</li> <li>• Placed where wind movement is unobstructed and</li> <li>• Elevated and rotate freely.</li> </ul>
3.2.7	Employee	Follow state and/or local requirements when posting safety signage to notify employees and contractors of H <sub>2</sub> S. Basic notification by way of signage will start at 10 ppm. If the site levels are 100 ppm or greater, "Danger" signs must be posted instead of "Caution." <b>Note:</b> In Texas, the Texas Railroad Commission requires "Caution" at 100 ppm, therefore basic H <sub>2</sub> S notice will be posted at 10 ppm (see <b>Appendix E</b> , section 2). <b>Note:</b> If there are no state/local requirements, Devon locations will post "Caution" signs at sites where concentrations of H <sub>2</sub> S exceed 10 ppm before treatment. <b>Note:</b> Appropriate caution signs (black on yellow, or equivalent) will be displayed at all location entrances when the atmospheric concentration of H <sub>2</sub> S could exceed 10 ppm. <b>Note:</b> If warning flags or flashing lights are used at sites where concentrations of H <sub>2</sub> S exceed 10 ppm, colors should be displayed according to <b>Appendix E</b> , section one.





## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

3.2.8	Employee	<p>Display danger signs outside all access doorways leading into enclosed facilities, where produced fluids or gases containing 100 ppm H<sub>2</sub>S are being processed or handled.</p> <p><b>Note:</b> Legible danger signs such as, "HYDROGEN SULFIDE OPERATIONS ENTER ONLY WHEN MONITORING SHOWS THE AREA TO BE SAFE" or "RESPIRATORY PROTECTION EQUIPMENT MUST BE WORN BEYOND THIS POINT," should be prominently posted at appropriate locations (e.g., entrance points) for operations where hydrogen sulfide may be encountered (see examples in <b>Appendix E</b>, section two).</p>
3.2.9	Employee	<p>Use the special precautions listed below when iron sulfide is present to minimize the risk of a fire or subsequent ignition of a gas source. Waste materials containing iron sulfide must be handled and disposed of by:</p> <ul style="list-style-type: none"> <li>• Keeping thoroughly wetted with water during handling and storage,</li> <li>• Placing in a safe location away from gas piping and/or process areas,</li> <li>• Monitoring to prevent ignition and re-wetting as needed and</li> <li>• Disposing of iron sulfide in accordance with Waste Management guidelines.</li> </ul>
<p><b>Personal and Fixed H<sub>2</sub>S Monitors</b> Manufacturers' recommendations will be followed for the installation, maintenance, calibration and repair of equipment.</p>		
<b>Step</b>	<b>Person in Charge (PIC)</b>	<b>Action</b>
3.2.10	Line Supervisor	Ensure alarm set points for personal monitors are set at 10 ppm.
3.2.11	Line Supervisor	Fixed monitors will have a low level alarm set at 10 ppm and the high level alarm established by the site's risk assessment, which is not to exceed 100 ppm.
3.2.12	Employee	<p>Protect personnel from exposure to H<sub>2</sub>S when entering buildings, pump rooms or similar areas where H<sub>2</sub>S is greater than 100 ppm in the gas stream or gas phase above produced fluids, by using one OR more of the following methods:</p> <ul style="list-style-type: none"> <li>• Use portable H<sub>2</sub>S detection equipment to test the atmosphere within the enclosure before entry and continuously while within the enclosure.</li> <li>• Use a fixed H<sub>2</sub>S monitoring device that provides audible and/or visible warning.</li> <li>• Use ventilation (i.e., designed to maintain concentrations below 10 ppm), which will be confirmed through fixed monitoring detection system.</li> <li>• Wear an ASR apparatus before entering and while within enclosures.</li> </ul>
3.2.13	Employee	<p>Wear a personal monitor in the breathing zone, not to be placed on the pant leg, belt loop, or the back of the hardhat where H<sub>2</sub>S concentrations in the equipment are known, or suspected to be, greater than 10 ppm.</p> <p><b>Note:</b> All employees, contractors and visitors are expected to comply with this requirement.</p>
3.2.14	Line Supervisor	<p>Monitoring equipment (fixed and portable) will be used during all drilling operations where there is a possibility of hydrogen sulfide exceeding 10 ppm. Fixed alarms will be placed around the drilling site at the following locations:</p> <ul style="list-style-type: none"> <li>• Rig Floor</li> </ul>



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

		<ul style="list-style-type: none"> <li>• Cellar</li> <li>• Bell Nipple</li> <li>• Possum Belly/Shakers</li> <li>• Choke manifold</li> </ul>
3.2.15	Line Supervisor	<p>Monitoring equipment (fixed and portable) will be used during workover, completion and well servicing operations where there is a possibility of hydrogen sulfide exceeding 10 ppm. The monitors will have one or more sensors located at the rig floor at the “open hole” near the wellbore, preferably downwind.</p> <p><b>Note:</b> Where well fluids are flowed to a surface pit, one or more sensors should be installed in the area of the surface pit.</p>
3.2.16	Electrical/ Line Supervisor	<p>Fixed H<sub>2</sub>S monitors shall be designed, installed and operated to meet the following minimum criteria:</p> <ul style="list-style-type: none"> <li>• Provide early detection and allow proper response to protect personnel and the public</li> <li>• Equipped with visual and audible alarms</li> <li>• Located where the alarm can be seen or heard throughout the work area</li> <li>• Maintained in operational status at all times. Superintendent approval is required any time the monitor is bypassed or un-operational</li> <li>• Equipment must be UL listed and intrinsically safe</li> </ul>
3.2.17	Employee	<p>If the audible alarm sounds while on Devon facility and/or right-of-way from either a fixed or personal monitor:</p> <ul style="list-style-type: none"> <li>• Notify any other personnel in the immediate area</li> <li>• Evacuate the area by immediately moving upwind and crosswind</li> <li>• Notify the immediate Supervisor and local EHS</li> </ul>
3.2.18	Line Supervisor	<p>Use one of following methods when testing a facility after a fixed or personal monitor alarms:</p> <ul style="list-style-type: none"> <li>• Test using a monitor, while wearing an ASR and have a stand-by person that meets the requirements listed 3.2.22, or</li> <li>• Specifically for fixed monitors, develop a Job Hazard Analysis (JHA)/Standard Operating Procedure (SOP) that defines the re-entry process and verification that the levels are less than 10 ppm H<sub>2</sub>S.</li> </ul> <p><b>Note:</b> The JHA/SOP must be approved by the local Superintendent.</p>
3.2.19	Employee	<p>Do not re-enter the area without supplied air until the area has been tested and is found to have less than 10 ppm of H<sub>2</sub>S.</p>
<p><b>Respiratory Protection Program</b> Wear respiratory protection in accordance with the Respiratory Protection Program.</p>		





## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

Refer to the definitions section of the EHS Respiratory Protection Implementation Plan for guidelines concerning facial hair growth while using approved respirator.

Step	Person In Charge (PIC)	Action
3.2.20	Employee	Place personal respirators strategically so that the equipment is quickly and easily available to essential personnel. <b>Note:</b> Essential personnel are those required to provide safe operational activities and those required to affect the control of H <sub>2</sub> S.
3.2.21	Employee	Wear an ASR when the working atmosphere is above 10 ppm H <sub>2</sub> S.
3.2.22	Employee	Require at least one stand-by person to be available on-site while working in an H <sub>2</sub> S atmosphere 100 ppm or greater. The stand-by person must meet the following requirements: <ul style="list-style-type: none"> <li>• Be equipped with a fully charged SCBA</li> <li>• Stationed in a safe location,</li> <li>• Trained in rescue operations and</li> <li>• Able to call for help and provide assistance in an emergency situation.</li> </ul> <b>Note:</b> During the pre-task tailgate, the stand-by person will discuss the JHA and determine the appropriate egress during emergency evacuations. A rescue team will be required when appropriate egress routes are not provided with adequate walking/working surfaces. If proper means of egress cannot be achieved during emergency evacuation of the area, a Rescue Team will be required. <b>Note:</b> Rescue training for the standby person should consist of hazard recognition, hazard mitigation, proper use of required PPE and ability to retrieve a downed individual from a hazardous atmosphere from the same work level or fixed-stairway accessed platform by simple extrication of the victim from the hazardous atmosphere. Rescue where a victim would require packaging for extrication or special rescue equipment would require external training and certification (i.e., high angle rescue training for ladder accessed platforms).
3.2.23	Employee	Evacuate the area by immediately moving upwind and crosswind if a personal or fixed monitor alarms, or you begin to feel effects of exposure.

### 3.3 Operation Safe Work Practices

#### H<sub>2</sub>S Site Determination

Step	Person In Charge (PIC)	Action
3.3.1	Line Supervisor	Determine the H <sub>2</sub> S concentrations, prior to treatment (see 3.1.1).
3.3.2	Line Supervisor	Re-test if conditions change.
3.3.3	Employee	At H <sub>2</sub> S sites, where the presence of H <sub>2</sub> S exists, test the vapor space from one tank of each type (e.g., produced water tank, condensate tank, oil tank, etc.). If gas analysis indicates concentrations above 500 ppm, and required controls are implemented, then additional sampling is not required. <b>Note:</b> Test the concentrations of the tank when levels are at 500 ppm or below. <b>Note:</b> If H <sub>2</sub> S concentrations are unknown and the working atmosphere is 10 ppm supplied air must be used.



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Corporate

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## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

<b>Bacterial H<sub>2</sub>S</b> This section specifically addresses infrequent levels of H <sub>2</sub> S found in storage tanks.		
3.3.4	Line Supervisor	<p>Responding to bacterial H<sub>2</sub>S requires specific actions following the sampling and determination process mentioned below:</p> <ul style="list-style-type: none"> <li>Follow the appropriate signage outlined in the protocol</li> <li>Treat the equipment with appropriate material (e.g., scavenger, etc.)</li> <li>Personal monitors shall be worn when working around the affected area until levels can be maintained below 10 ppm</li> <li>Samples must be taken at least once a week. If levels remain at or greater than 10ppm, a subsequent batch treatment will be performed</li> <li>In case of emergency situations, responders will have the appropriate training, respiratory fit testing, and be outfitted with the appropriate respiratory protection prior to responding (refer to Emergency Response section 3.4)</li> </ul> <p><b>Note:</b> Bacterial H<sub>2</sub>S does not constitute the site to be identified as an H<sub>2</sub>S Facility.</p>
<b>Engineering Controls</b> Engineering controls should be the first line of protection against H <sub>2</sub> S hazards. Evaluate and implement those controls that are appropriate to mitigate, if not eliminate, the hazards involved.		
<b>Step</b>	<b>Person In Charge (PIC)</b>	<b>Action</b>
3.3.5	Operations	<p>Install engineering controls that eliminate and/or minimize H<sub>2</sub>S hazards based on risk. Examples include:</p> <ul style="list-style-type: none"> <li>External or remote tank gauges</li> <li>Re-piping tank equalizing/switching valves to ground level</li> <li>Closed drain or vent systems</li> <li>Flare or vent stacks (All flare systems that might contain H<sub>2</sub>S should be of sufficient height and design to minimize the exposure of SO<sub>2</sub> at ground level. All new and refurbished flares that could burn H<sub>2</sub>S will be installed with auto ignition systems.)</li> <li>Chemical treating</li> </ul> <p><b>Note:</b> A scavenger is not an adequate mitigation technique and would still require signage, monitoring, PPE, etc.</p> <ul style="list-style-type: none"> <li>Vapor Recovery Unit (VRU)</li> <li>SCADA systems</li> <li>Use of NACE engineered coatings and materials resistant to H<sub>2</sub>S</li> </ul>
3.3.6	Line Supervisor	<p>Implement the following work practices and procedures in operations where;</p> <ul style="list-style-type: none"> <li>the 100 ppm radius of exposure is 50 feet or greater and includes a public area, or is greater than 3,000 feet regardless of public area (<b>Appendix C</b>):</li> </ul>



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

		<ul style="list-style-type: none"> <li>All flare systems that may contain H<sub>2</sub>S will be designed to minimize the exposure of SO<sub>2</sub> at the ground level. All new and refurbished flares that could burn H<sub>2</sub>S will be installed with auto ignition systems, as specified by <b>Appendix C</b> (Refer to API 49). For emergency purposes, an alternate ignition source can be used (e.g., flare gun, etc.).</li> </ul>
<p><b>Administrative Controls</b> Administrative controls will be implemented as the second line of defense. In some cases these administrative controls are regulatory requirements, in other cases, administrative controls are implemented when engineering controls are not feasible.</p>		
Step	Person In Charge (PIC)	Action
3.3.7	Line Supervisor	Conduct a Job Hazard Analysis (JHA) before beginning with tasks that are non-routine (as defined in the Pre-Job Planning Protocol), activities that are without a procedure, or work on processes where the working atmosphere of H <sub>2</sub> S are greater than 100 ppm. This JHA must include respiratory precautions and stand by person.
3.3.8	Line Supervisor	Implement required controls based on H <sub>2</sub> S concentration and ROE calculations, as specified in <b>Appendix C - H<sub>2</sub>S Compliance Requirements</b> . <b>Note:</b> Additional federal agency and state regulations may apply. Federal and state Regulations can be found on Strata or the hyperlinks in <b>Appendix D</b> .
3.3.9	Employee	Establish an evacuation plan during the pre-task tailgate when working at H <sub>2</sub> S facilities with the following components: <ul style="list-style-type: none"> <li>Communicate wind direction (i.e., wind indicators on locations)</li> <li>Identify muster areas and emergency exits</li> </ul>
3.3.10	Employee	Display wind indicators (e.g., windsocks, streamers, etc.) at facilities where H <sub>2</sub> S concentrations exceed 100 ppm in the gas or liquid stream. <b>Note:</b> Wind indicators will meet the following requirements: <ul style="list-style-type: none"> <li>Visible from any location on the site,</li> <li>Placed where wind movement is unobstructed and</li> <li>Elevated and rotate freely.</li> </ul>
3.3.11	Employee	Follow state and/or local requirements when posting safety signage to notify employees and contractors of H <sub>2</sub> S. Basic notification will start at 10 ppm. If the site levels are 100 ppm or greater, "Danger" signs must be posted. <b>Note:</b> In Texas, the Texas Railroad Commission requires "Caution" at 100 ppm, therefore basic H <sub>2</sub> S notice will be posted at 10 ppm (see <b>Appendix E</b> , section 2). <b>Note:</b> If there are no state/local requirements, Devon locations will post "Caution" signs at sites where concentrations of H <sub>2</sub> S exceed 10 ppm before treatment. <b>Note:</b> Appropriate caution signs (black on yellow, or equivalent) will be displayed at all location entrances when the atmospheric concentration of H <sub>2</sub> S could exceed 10 ppm.



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

3.3.12	Employee	<p>Display danger signs outside all access doorways leading into building, where produced fluids or gases containing 100 ppm H<sub>2</sub>S are being processed or handled.</p> <p><b>Note:</b> Legible danger signs such as, "HYDROGEN SULFIDE OPERATIONS ENTER ONLY WHEN MONITORING SHOWS THE AREA TO BE SAFE" or "RESPIRATORY PROTECTION EQUIPMENT MUST BE WORN BEYOND THIS POINT," should be prominently posted at appropriate locations (e.g., entrance points) for operations where hydrogen sulfide may be encountered (see examples in <b>Appendix E</b>, section two).</p>
3.3.13	Employee	<p>Post signage along the right-of-way of H<sub>2</sub>S pipelines and at public road crossings involving H<sub>2</sub>S concentrations of 100 ppm or greater in the liquid stream.</p> <p><b>Note:</b> Examples can be found in <b>Appendix E</b>, section two.</p>
3.3.14	Employee	<p>Post signage stating "Respiratory Protection Required Beyond This Point" at tank battery stairways and/or ladders where measured H<sub>2</sub>S concentrations are greater than 100 ppm in the vapor space and/or liquid phase of the tank.</p> <p><b>Note:</b> Examples can be found in <b>Appendix E</b>, section two.</p>
3.3.15	Line Supervisor	<p>Provide multiple exits equipped with panic bars, or similar easily operated closures within an enclosed building, located so that emergency escape can be easily accomplished.</p>
3.3.16	Employee	<p>Use the special precautions listed below when iron sulfide is present to minimize the risk of a fire or subsequent ignition of a gas source. Waste materials containing iron sulfide must be handled and disposed of by:</p> <ul style="list-style-type: none"> <li>• Keeping thoroughly wetted with water during handling and storage,</li> <li>• Placing in a safe location away from gas piping and/or process areas,</li> <li>• Monitoring to prevent ignition and re-wetting as needed and</li> <li>• Disposing of iron sulfide in accordance with Waste Management guidelines.</li> </ul>
<p><b>Personal and Fixed H<sub>2</sub>S Monitors</b> Manufacturers' recommendations will be followed for the installation, maintenance, calibration and repair of equipment.</p>		
<b>Step</b>	<b>Person in Charge (PIC)</b>	<b>Action</b>
3.3.17	Line Supervisor	Ensure alarm set points for personal monitors are set at 10 ppm.
3.3.18	Line Supervisor	Fixed monitors will have a low level alarm set at 10 ppm and the high level alarm established by the site's risk assessment, which is not to exceed 100 ppm.
3.3.19	Employee	<p>Protect personnel from exposure to atmospheric concentrations of H<sub>2</sub>S when entering buildings, pump rooms or similar areas where H<sub>2</sub>S is greater than 100 ppm in the gas stream or gas phase above produced fluids, by using one or more of the following methods:</p> <ul style="list-style-type: none"> <li>• Use portable H<sub>2</sub>S detection equipment to test the atmosphere within the enclosure before entry and continuously while within the enclosure.</li> <li>• Use a fixed H<sub>2</sub>S monitoring device that provides audible and/or visible warning.</li> </ul>



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

		<ul style="list-style-type: none"> <li>Use ventilation (i.e., designed to maintain concentrations below 10 ppm), which will be confirmed through fixed monitoring detection system.</li> <li>Wear an ASR apparatus before entering and while within enclosures.</li> </ul>
3.3.20	Employee	<p>Wear a personal monitor in the breathing zone not to be placed on the pant leg, belt loop, or the back of the hardhat where H<sub>2</sub>S concentrations in the equipment are known, or suspected to be, greater than 10 ppm.</p> <p><b>Note:</b> All employees, contractors and visitors are expected to comply with this requirement.</p>
3.3.21	Line Supervisor	<p>Install fixed area H<sub>2</sub>S monitors when required by <b>Appendix C</b>. Consider the following to determine if fixed monitors should be installed when they are not regulatory required:</p> <ul style="list-style-type: none"> <li>Concentration of H<sub>2</sub>S in gas or liquid stream or atmosphere,</li> <li>Volume and/or pressure of the H<sub>2</sub>S gas or liquid in system,</li> <li>Operations involving enclosed facilities containing processing equipment containing H<sub>2</sub>S,</li> <li>Exposure potential for employees (manned vs. unmanned facility),</li> <li>Exposure potential for the public (populated vs. remote area) and</li> <li>Response time to a release.</li> </ul>
3.3.22	Electrical/ Line Supervisor	<p>Fixed H<sub>2</sub>S monitors will be designed, installed and operated to meet the following minimum criteria:</p> <ul style="list-style-type: none"> <li>Provide early detection and allow proper response to protect personnel and the public</li> <li>Equipped with visual and audible alarms</li> <li>Located where the alarm can be seen or heard throughout the work area</li> <li>Maintained in operational status at all times. Superintendent approval is required any time the monitor is bypassed or un-operational</li> <li>Equipment must be UL listed and intrinsically safe</li> </ul>
3.3.23	Employee	<p>If either a personal or fixed monitor alarms at a Devon location:</p> <ul style="list-style-type: none"> <li>Notify any other personnel in the immediate area</li> <li>Evacuate the area by immediately moving upwind and crosswind</li> <li>Notify the immediate Supervisor and local EHS</li> </ul>
3.3.24	Line Supervisor	<p>Use one of following methods when testing a facility after a personal or fixed monitor alarms:</p> <ul style="list-style-type: none"> <li>Test using a portable monitor, while wearing an ASR and have a stand-by person that meets the requirements listed 3.3.28, or</li> <li>Specifically for fixed monitors, develop a JHA/SOP that defines the re-entry process and verification that the levels are less than 10 ppm H<sub>2</sub>S</li> </ul> <p><b>Note:</b> The JHA/SOP must be approved by the local Superintendent.</p>
3.3.25	Employee	<p>Do not re-enter the area without supplied air until the area has been tested and is found to have less than 10 ppm of H<sub>2</sub>S.</p>



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

### Respiratory Protection Program

Wear respiratory protection in accordance with the Respiratory Protection Program.

Refer to the definitions section of the EHS Respiratory Protection Implementation Plan for guidelines concerning facial hair growth while using approved respirator.

Step	Person In Charge (PIC)	Action
3.3.26	Employee	Place personal respirators strategically so that the equipment is quickly and easily available to essential personnel. <b>Note:</b> Essential personnel are those required to provide safe operational activities and those required to affect the control of H <sub>2</sub> S.
3.3.27	Employee	Wear an ASR when working in concentrations above 10 ppm H <sub>2</sub> S
3.3.28	Employee	Require at least one stand-by person to be available on-site while working in an H <sub>2</sub> S atmosphere 100 ppm or greater. The stand-by person must meet the following requirements: <ul style="list-style-type: none"> <li>• Be equipped with a fully charged SCBA</li> <li>• Stationed in a safe location,</li> <li>• Trained in rescue operations and</li> <li>• Able to call for help and provide assistance in an emergency situation.</li> </ul> <b>Note:</b> During the pre-task tailgate, the stand-by person will discuss the JHA and determine the appropriate egress during emergency evacuations. A rescue team will be required when appropriate egress routes are not provided with adequate walking/working surfaces. If proper means of egress cannot be achieved during emergency evacuation of the area, a Rescue Team will be required.  <b>Note:</b> Rescue training for the standby person should consist of hazard recognition, hazard mitigation, proper use of required PPE and ability to retrieve a downed individual from a hazardous atmosphere from the same work level or fixed-stairway accessed platform by simple extrication of the victim from the hazardous atmosphere. Rescue where a victim would require packaging for extrication or special rescue equipment would require external training and certification (i.e., high angle rescue training for ladder accessed platforms).
3.3.29	Employee	Evacuate the area by immediately moving upwind and crosswind if a personal or fixed monitor alarms, or you begin to feel effects of exposure.

### 3.4 Emergency Preparedness, Response & Rescue

Step	Person In Charge (PIC)	Action
3.4.1	Line Supervisor	Sites with 100 ppm in the gas stream shall include specific actions relating to H <sub>2</sub> S emergencies (e.g., responding to releases, addressing emergency response and rescue, etc.) in their Emergency Response Plan.  This plan will include a section verifying the following requirements regardless of whether the rescue team is internal/contract: <ul style="list-style-type: none"> <li>• Training specific to H<sub>2</sub>S</li> </ul>



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

		<ul style="list-style-type: none"> <li>• Location and proper inspection of SCBA's</li> <li>• Emergency responder requirements</li> <li>• Proper personal monitoring</li> </ul>
3.4.2	Employee/Contractor Company Representative	Notify the Line Supervisor prior to opening any equipment at locations with 100 ppm or greater in the gas or liquid stream to review the JHA and emergency rescue plan.
3.4.3	Employee/Emergency Response Personnel	Verify the SCBA is working properly and then don the SCBA prior to entering the area. <b>Note:</b> Emergency escape packs must never be used for rescue; they are only intended for escape purposes.
3.4.4	Employee/ Emergency Response Personnel	If the stand-by person responds to an unconscious individual, they are responsible for calling in the Emergency Response Team prior to entering the area. Perform rescue with a fully charged SCBA and remove unconscious individual to a safe location, if it is safe to do so.
3.4.5	Employee/ Emergency Response Personnel	If the stand-by person is unsuccessful removing the unconscious employee, the stand-by individual will provide lifesaving support (e.g., ensure the patient's airline is not kinked, facemask is secured on the patient's face, etc.) until the Emergency Response Team arrives.
3.4.6	Employee/ Emergency Response Personnel	Stop rescue and leave the area immediately if: <ul style="list-style-type: none"> <li>• The conditions become unsafe,</li> <li>• There is a failure with your SCBA or it alarms,</li> <li>• The rescue cannot be performed safely.</li> </ul>
3.4.7	Employee/ Emergency Response Personnel	Perform first aid and/or CPR as needed. Do not provide artificial breathing unless using an ambu-bag. <b>Note:</b> Mouth-to-mouth on an exposed individual can lead to secondary exposure to H <sub>2</sub> S.
3.4.8	Employee	Activate the site H <sub>2</sub> S Contingency Plan if required.
<b>3.5</b>	<b>H<sub>2</sub>S Contingency Plans</b>	
<b>Step</b>	<b>Person in Charge (PIC)</b>	<b>Action</b>
3.5.1	Field EHS	Develop an H <sub>2</sub> S Contingency Plan when required per <b>Appendix C</b> . <b>Note:</b> The contingency plan will be available upon request and will be on-site where the plan would be activated and discussed during the pre-task discussion. See <b>Appendix I - Sample Contingency Plan</b> .
3.5.2	Field EHS	Include the following elements within the H <sub>2</sub> S contingency plan: <ul style="list-style-type: none"> <li>• Procedures for activation of the contingency plan</li> <li>• Characteristics of H<sub>2</sub>S</li> <li>• Responsibilities of employees</li> <li>• Process for alerting personnel</li> <li>• Process for assisting distressed employees</li> <li>• Measures for identifying, alerting, assisting and evacuating the general public within the area of exposure</li> </ul>





## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

		<ul style="list-style-type: none"> <li>Emergency contacts</li> <li>A diagram or map of the area of exposure</li> <li>Required safety equipment and supplies</li> <li>Process for accounting for evacuated employees</li> <li>Established public awareness of plans</li> <li>A liaison with emergency responders and public officials</li> </ul> <p><b>Note:</b> Use the H<sub>2</sub>S Contingency Plan sample found in <b>Appendix I</b> or equivalent.</p>																												
3.5.3	Field EHS	Review and update the H <sub>2</sub> S contingency plan annually, or as needed.																												
<b>3.6</b>	<b>Regulatory Permitting for Operations and Drilling</b>																													
<b>Step</b>	<b>Person in Charge (PIC)</b>	<b>Action</b>																												
3.6.1	Line Supervisor	Obtain any necessary permits that may be required to operate H <sub>2</sub> S facilities, or drill in a zone with H <sub>2</sub> S. If required, permits must be in place prior to beginning operations.																												
3.6.2	Line Supervisor	Notify the Environmental Department 60 days prior to construction for state-specific air permitting evaluations. Some states may require that an air permit be submitted and authorization received prior to construction.																												
<b>4.0</b>	<b>RECORDKEEPING</b>																													
<b>Step</b>	<b>Person in Charge (PIC)</b>	<b>Action</b>																												
4.1.1	Employee/Contract Company Representative	Forward all H <sub>2</sub> S records to Line Supervisor for filing.																												
4.1.2	Line Supervisor	File the records from Section 4.1 as noted below:																												
	<table border="1"> <thead> <tr> <th>Record</th> <th>File Location &amp; Number</th> <th>Retention Period</th> <th>Enterprise Classification Code</th> </tr> </thead> <tbody> <tr> <td>H<sub>2</sub>S Contingency Plan</td> <td>See Field Office File Directory</td> <td>CY + 3 CY = Current Year</td> <td>EH45</td> </tr> <tr> <td>ROE Calculator</td> <td>See Field Office File Directory</td> <td>CY + 3 CY = Current Year</td> <td>EH45</td> </tr> <tr> <td>H<sub>2</sub>S Facilities List</td> <td>See Field Office File Directory</td> <td>CY + 3 CY = Current Year</td> <td>EH45</td> </tr> <tr> <td>Sample Results Form</td> <td>See Field Office File Directory</td> <td>CY + 3 CY = Current Year</td> <td>EH45</td> </tr> <tr> <td>Personal and Fixed Monitor Form</td> <td>See Field Office File Directory</td> <td>CY + 3 CY = Current Year</td> <td>EH45</td> </tr> <tr> <td>Sampling Equipment Form</td> <td>See Field Office File Directory</td> <td>CY + 3 CY = Current Year</td> <td>EH45</td> </tr> </tbody> </table>	Record	File Location & Number	Retention Period	Enterprise Classification Code	H <sub>2</sub> S Contingency Plan	See Field Office File Directory	CY + 3 CY = Current Year	EH45	ROE Calculator	See Field Office File Directory	CY + 3 CY = Current Year	EH45	H <sub>2</sub> S Facilities List	See Field Office File Directory	CY + 3 CY = Current Year	EH45	Sample Results Form	See Field Office File Directory	CY + 3 CY = Current Year	EH45	Personal and Fixed Monitor Form	See Field Office File Directory	CY + 3 CY = Current Year	EH45	Sampling Equipment Form	See Field Office File Directory	CY + 3 CY = Current Year	EH45	
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Sampling Equipment Form	See Field Office File Directory	CY + 3 CY = Current Year	EH45																											
<p><b>Note:</b> The Records Management Enterprise Classification Structure Code is listed as a reference, which should be used when records are sent to stored records.</p>																														



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## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

5.0 TRAINING REQUIREMENTS		
Step	Person in Charge (PIC)	Action
5.1	Line Supervisor/Field EHS	Provide H <sub>2</sub> S Awareness training for all Devon employees visiting H <sub>2</sub> S facilities (≥10 ppm). The training will meet the following requirements: <ul style="list-style-type: none"><li>• H<sub>2</sub>S Awareness training</li><li>• Hazards of H<sub>2</sub>S (in the protocol training)</li><li>• Applicable alarms and monitoring systems (site/location specific)</li><li>• Safe exit routes and assembly areas (site/location specific)</li><li>• How to respond if an emergency occurs (site/location specific)</li></ul>
5.2	Line Supervisor/Field EHS	Provide operations training annually to employees working in or around H <sub>2</sub> S facilities (≥10 ppm). <b>Note:</b> See <b>Appendix F</b> for H <sub>2</sub> S operations training requirements.
5.3	Line Supervisor/Field EHS	Provide emergency response training to employees who are designated to perform rescue or stand-by person duties.
5.4	Line Supervisor/Field EHS	Provide H <sub>2</sub> S Contingency Plan training to employees responsible for sites requiring an H <sub>2</sub> S Contingency Plan.
5.5	Line Supervisor/Employee	Notify contractors working in H <sub>2</sub> S areas that they must have completed required regulatory training that meets or exceeds Devon's minimum requirements.
6.0 REFERENCES		
		American National Standards Institute (ANSI), Standard Z390.1 - 2006 American Petroleum Institute (API) RP 49, Recommended Practice for Drilling and Well Service Operations Involving Hydrogen Sulfide RP 55, Recommended Practices for Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide. National Institute for Occupational Safety and Health, (NIOSH), 77-158, Criteria for a Recommended Standard for Occupational Exposure to Hydrogen Sulfide Texas Railroad Commission, State Rule 36

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### Appendix A - Radius of Exposure Calculation

#### H<sub>2</sub>S Radius of Exposure Calculations Worksheet

Ambient Temperature: 60 F

Atmospheric Pressure: 14.65 (Normally 14.65)

Gas Volume, Q: 1,000 cft<sup>3</sup>

ppm H<sub>2</sub>S: 1,300 ppm

Q - "Q" in the equation is the escape rate for a system or facility expressed in cubic feet per day. Q for a gas well will either be the well's adjusted open-flow potential, or if you feel that it is too high, your estimate of the well's capacity to flow against a zero back-pressure. Q is corrected to standard temperature and pressure.

**For the 500 ppm Radius of Exposure:**

$$X = [(0.4546)(\text{H}_2\text{S Concentration})(\text{Rate of Escape, Q})]^{0.6258}$$

X= 55 feet

**For the 100 ppm Radius of Exposure:**


$$X = [(1.589)(\text{H}_2\text{S Concentration})(\text{Rate of Escape, Q})]^{0.6258}$$

X= 119 feet

[Radius of Exposure Calculation Sheet.](#)

H<sub>2</sub>S concentration is the decimal equivalent of the mole or volume fraction of hydrogen sulfide in the gaseous mixture.

Escape rate is expressed in cubic feet per day (corrected for standard conditions of 14.65 psia and 60 F).

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## Appendix B - Chemical Reactivity Hazards

### H<sub>2</sub>S Reactivity with Other Chemicals

H<sub>2</sub>S gas may produce dangerous chemical reactions in the presence of incompatible substances. When mixing chemicals where H<sub>2</sub>S gas may be present:

- consult SDS's
- take appropriate precautions

**Note:** Oilfield acids commonly used in downhole clean-up and stimulation treatments are capable of reacting with iron sulfide pipe scale to generate high concentrations of H<sub>2</sub>S gas at the surface during well work.

H<sub>2</sub>S gas readily dissolves in both water and liquid hydrocarbons. Sudden changes to these mixtures may cause the sudden release of high concentrations of H<sub>2</sub>S gas. These changes include, but are not limited to:

- pressure or temperature increases or decreases
- severe agitation or mixing and
- the addition of other chemicals to a mixture.

### Iron Sulfide

Iron reacts with H<sub>2</sub>S to form a substance called iron sulfide. This material is typically a dark brown to black powder material or a sludge:

- found inside piping, vessels, iron sponge and/or other equipment where H<sub>2</sub>S is, or has been present, and
- will ignite and burn in the presence of oxygen in air (pyrophoric).

**Note:** Special precautions must be taken where iron sulfide is present to minimize the risk of a fire or subsequent ignition of a gas source.

Waste materials containing iron sulfide must also be handled and disposed of by:

- keeping thoroughly wetted with water during handling and storage,
- placing in a safe location away from gas piping and/or process areas,
- monitoring carefully to prevent ignition and re-wetting as needed and
- determining if transportation and disposal requires permits.

**Note:** Consult EHS Department for additional guidance on handling and disposal issues.



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

### Appendix C - H<sub>2</sub>S Compliance Requirements

SCENARIO 1 -100 ppm R.O.E. is less than 50'

SCENARIO 2 -100 ppm R.O.E. is 50' or greater, but less than 3000' and contains no public area.

SCENARIO 3 -100 ppm R.O.E. is 50' or greater and includes a public area, or 500 ppm R.O.E. includes a public road, or if 100 ppm R.O. E. is 3000' or greater regardless of public area.

SCENARIO 4 - stock tank vapor space >500 ppm

**Note:** Section 10 of API RP 55 contains guidance on installation of gas monitors in gas plants and production facilities

#### **PRODUCTION**

This table does not include scenarios with drilling and operations containing less than 100 ppm H<sub>2</sub>S.

PROVISION	Scenario 1	Scenario 2	Scenario 3	Scenario 4
<b>Training</b> - operations containing >100 ppm H <sub>2</sub> S will train its employees working in affected areas	X	X	X	X
<b>Agency Notification</b> - immediate notification of any accidental release of H <sub>2</sub> S of sufficient volume to present a hazard and of any H <sub>2</sub> S related accident	X	X	X	
<b>Drill Stem Tests</b> - permitted only during daylight hours and drill stem meets requirements of NACE		X	X	
<b>BOP Test</b> - will be done nearest to the bit change prior to reaching compliance depth		X	X	
<b>Materials</b> - must meet requirements of ANSI NACE standard MR0175 and API-RE-14E		X	X	
<b>Warning and Marker Provision</b> - there must be signs at the facility and on all access roads	X	X	X	X
<b>Security</b> - unattended fixed surface facilities will be protected by fencing when within ¼ mile of public access - at least two exits for escape capable of opening from inside must be provided		X	X	X
<b>Contingency Plan</b> - an organized plan of action for alerting and protecting the public following an accidental release of a potential hazardous volume of H <sub>2</sub> S			X	
<b>Control and Equipment Safety</b> - operators will install safety devices and maintain them in an operable condition or will establish safety procedures designed to prevent the undetected, continuing escape of H <sub>2</sub> S			X	
<b>Wind Indicators</b> - will be installed at strategic locations at or near the site and be readily visible			X	
<b>Monitors</b> - fixed detection and alarm equipment that will warn of the presence of H <sub>2</sub> S gas in concentrations that could be harmful			X	
<b>Flare Stacks</b> - operator must provide a suitable method for lighting the flare. Use an automatic ignition source, ignition system or a flare gun to light the stack.		X	X	



## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

### Appendix C - H<sub>2</sub>S Compliance Requirements (Continued)

SCENARIO 1 -100 ppm R.O.E. is less than 50'

SCENARIO 2 -100 ppm R.O.E. is 50' or greater, but less than 3000' and contains no public area.

SCENARIO 3 -100 ppm R.O.E. is 50' or greater and includes a public area, or 500 ppm R.O.E. includes a public road, or if 100 ppm R.O.E. is 3000' or greater regardless of public area.

SCENARIO 4 -stock tank vapor space >500 ppm

**Note:** Section 10 of API RP 55 contains guidance on installation of gas monitors in gas plants and production facilities.

<b>Gas Plants</b>				
This table does not include scenarios with gas plants containing less than 100 ppm H <sub>2</sub> S.				
PROVISION	Scenario 1	Scenario 2	Scenario 3	Scenario 4
<b>Training</b> - operations containing >100 ppm H <sub>2</sub> S will train its employees working in affected areas	X	X	X	X
<b>Agency Notification</b> - immediate notification of any accidental release of H <sub>2</sub> S of sufficient volume to present a hazard and of any H <sub>2</sub> S related incident	X	X	X	
<b>Materials</b> - must meet requirements of ANSI NACE standard MR0175 and API-RE-14E.		X	X	
<b>Warning and Marker Provision</b> - there must be signs at the facility and on all access roads	X	X	X	X
<b>Security</b> - unattended fixed surface facilities will be protected by fencing when within ¼ mile of public access		X	X	X
<b>Contingency Plan</b> - an organized plan of action for alerting and protecting the public following an accidental release of a potential hazardous volume of H <sub>2</sub> S			X	
<b>Control and Equipment Safety</b> - operators will install safety devices and maintain them in an operable condition or will establish safety procedures designed to prevent the undetected, continuing escape of H <sub>2</sub> S			X	
<b>Monitors</b> - fixed detection and alarm equipment that will warn of the presence of H <sub>2</sub> S gas in concentrations that could be harmful		X	X	
<b>Wind Indicators</b> - will be installed at strategic locations at or near the site and be readily visible		X	X	
<b>Protective Breathing Equipment</b> - will be maintained at two or more locations at the site		X	X	X
<b>Flare Stacks</b> - operator must provide a suitable method for lighting the flare. Use an automatic ignition source, ignition system or a flare gun to light the stack.			X	



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## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

### Appendix C - H<sub>2</sub>S Compliance Requirements (Continued)

SCENARIO 1 -100 ppm R.O.E. is less than 50'

SCENARIO 2 -100 ppm R.O.E. is 50' or greater, but less than 3000' and contains no public area.


SCENARIO 3 -100 ppm R.O.E. is 50' or greater and includes a public area, or 500 ppm R.O.E. includes a public road, or if 100 ppm R.O.E. is 3000' or greater regardless of public area.

SCENARIO 4 -stock tank vapor space >500 ppm

**Note:** Section 10 of API RP 55 contains guidance on installation of gas monitors in gas plants and production facilities.

<b>Work Over and Drilling</b>				
This table does not include scenarios with gas plants containing less than 100 ppm H <sub>2</sub> S.				
PROVISION	Scenario 1	Scenario 2	Scenario 3	Scenario 4
<b>Training</b> - operations containing >10 ppm H <sub>2</sub> S will trained on the Hazards of H <sub>2</sub> S	X	X	X	X
<b>Agency Notification</b> - immediate notification of any accidental release of H <sub>2</sub> S of sufficient volume to present a hazard and of any H <sub>2</sub> S related incident	X	X	X	
<b>Materials</b> - must meet requirements of ANSI NACE standard MR0175 and API-RE-14E.		X	X	
<b>Required Rig Package</b> - Warning and Marker Provision, color coded warning flags or lights (at the facility and on all access roads), portable /fixed monitors	X	X	X	X
<b>Contingency Plan</b> - an organized plan of action for alerting and protecting the public following an accidental release of a potential hazardous volume of H <sub>2</sub> S			X	
<b>Control and Equipment Safety</b> - operators will install safety devices and maintain them in an operable condition or will establish safety procedures designed to prevent the undetected, continuing escape of H <sub>2</sub> S			X	
<b>Monitors</b> - fixed detection and alarm equipment that will warn of the presence of H <sub>2</sub> S gas in concentrations that could be harmful		X	X	
<b>Wind Indicators</b> - will be installed at strategic locations at or near the site and be readily visible		X	X	
<b>Protective Breathing Equipment</b> - will be maintained at two or more locations at the site		X	X	X
<b>Flare Stacks</b> - operator must provide a suitable method for lighting the flare. Use an automatic ignition source, ignition system or a flare gun to light the stack.		X	X	



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Appendix D - Federal and State Requirements


[EHS Bureau of Land Management Order 6](#)

[EHS New Mexico](#)

[EHS Oklahoma](#)

[EHS Texas](#)

[EHS Wyoming](#)

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### Appendix E - Hydrogen Sulfide Warning Signs Section One - Drilling and Workover Signs

The first section of this appendix is for drilling and workover sites. Refer to API 49, 'Recommended Practice for Drilling and Well Service Operations Involving Hydrogen Sulfide,' for more information.

Appropriate caution signs (black on yellow, or equivalent) will be displayed at all location entrances when the atmospheric concentration of hydrogen sulfide could exceed 10 ppm, so as to indicate a potential danger might be encountered. If danger flags or flashing lights are used, colors should be displayed in accordance with the following conditions:

Legible warning signs, such as, "HYDROGEN SULFIDE OPERATIONS ENTER ONLY WHEN MONITORING SHOWS THE AREA TO BE SAFE" or "RESPIRATORY PROTECTION EQUIPMENT MUST BE WORN BEYOND THIS POINT," should be prominently posted at appropriate locations (e.g., entrance points) for operations where hydrogen sulfide may be encountered.



**CONDITION I: Potential Danger To Life and Health:** Well Operations Under Control.  
Warning Device: **Green** (hydrogen sulfide concentration < 10 ppm).  
Characterized By: Routine well operations in zones containing hydrogen sulfide. Hydrogen sulfide may be present at concentrations below 10ppm.

General Action:

- a. Check safety equipment for proper functioning. Keep it available.
- b. Be alert for a condition change.
- c. Follow instructions of on-site operator representative.

**CONDITION II: Moderate Danger To Life and Health:** Critical Well Control Operations.  
Warning Device: **Yellow** (hydrogen sulfide concentration > 10 ppm and < 30 ppm). Characterized By: Hydrogen sulfide is or potentially may be present up to 30 ppm on the well location.


General Action:

- a. Stay in the SAFE BRIEFING AREA if not working to correct the situation.
- b. Follow instructions of the on-site operator representative.
- c. The on-site operator representative will follow community warning and protection plan procedures.

**CONDITION III: Extreme Danger To Life and Health:** Loss Of Well Control  
Warning Device: **Red** (hydrogen sulfide concentration > 30 ppm). Characterized By: Hydrogen sulfide concentration is above, or potentially may be above, 30 ppm.

General Action:

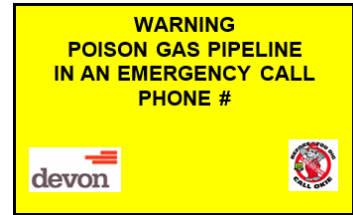
- a. Stay in the SAFE BRIEFING AREA if not working to correct the situation.
- b. Follow instructions of the on-site operator representative.
- c. The on-site operator representative will make appropriate notifications, activate the audible alarm and initiate the community warning and protection plan.
- d. If the well is ignited, the burning hydrogen sulfide will be converted to sulfur dioxide, which is also dangerous to life and health. Therefore, DO NOT assume that the area is safe after the gas is ignited. Continue to observe applicable emergency and safety procedures and follow the instructions of the on-site operator representative.

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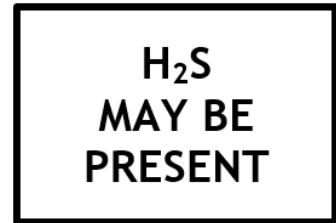
**Appendix E - Hydrogen Sulfide Warning Signs (Continued)  
Section Two - Production Operations and Midstream Signs**

Examples of hydrogen sulfide warning signs are provided in the second section of this appendix, these can be used when a state does not have specific sign requirements.

Post signage similar to the examples below along the right-of-way of H<sub>2</sub>S pipelines and at public road crossings involving H<sub>2</sub>S concentrations of 100 ppm or greater.



Display basic notice signs at sites in Texas where concentrations of H<sub>2</sub>S exceed 10 ppm before treatment.

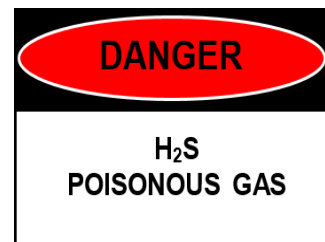


Display 'CAUTION' signs at sites where concentrations of H<sub>2</sub>S exceed 10 ppm before treatment.

In the state of Texas, the 'Caution' sign is required by the Texas Railroad Commission where concentrations exceed 100 ppm.




Display 'DANGER' signs at sites where concentrations of H<sub>2</sub>S exceed 100 ppm.



Post signage at tank battery stairways and/or ladders where measured H<sub>2</sub>S concentrations are greater than 100 ppm in the vapor space of tanks when gauging or opening equipment, or when concentrations in the breathing zone exceed 10 ppm.



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### Appendix F - H<sub>2</sub>S Training Requirements

H<sub>2</sub>S training instructors/administrators will include the following material:

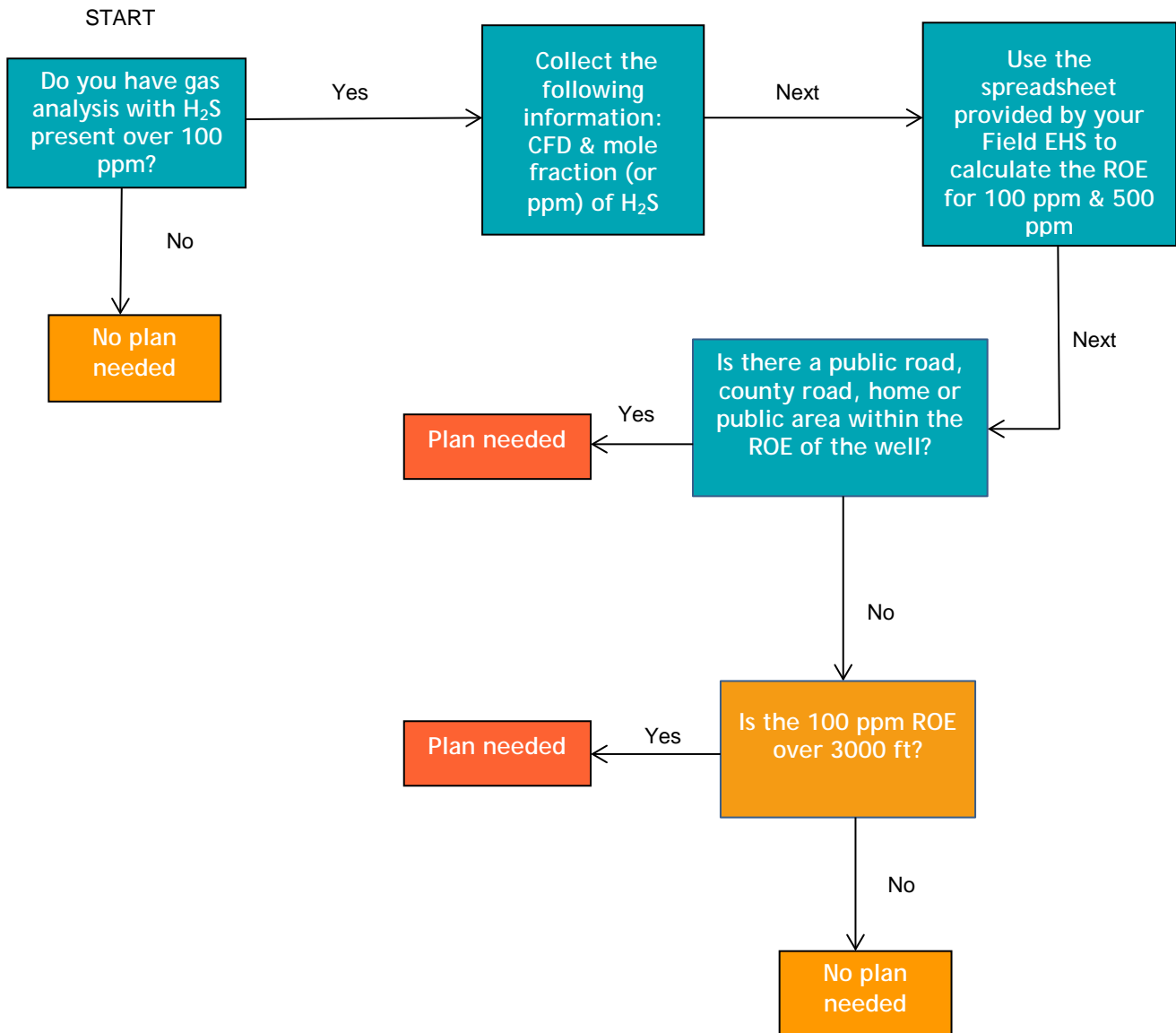
1. Instructor will train all employees who work in and around H<sub>2</sub>S Facilities (≥10 ppm).
2. Instructor will require contractors and service companies to use trained personnel actually working on H<sub>2</sub>S systems or wells and where such work could allow the escape of H<sub>2</sub>S gas.
3. Train all personnel in:
  - a. Hazards, characteristics and properties of H<sub>2</sub>S and SO<sub>2</sub>
  - b. Sources of H<sub>2</sub>S
  - c. Safety precautions, detection methods
  - d. Proper use of breathing equipment - Safety and Support
  - e. Symptoms of H<sub>2</sub>S exposure
  - f. Rescue techniques and first aid/CPR
  - g. Wind direction awareness and routes of egress
  - h. Emergency response procedures
4. Train onsite supervisory personnel in:
  - a. Effects of H<sub>2</sub>S on metals
  - b. Corrective actions and shutdown procedures
  - c. Well control - If a drilling operation
  - d. Knowledge of the contingency plan

# Hydrogen Sulfide (H<sub>2</sub>S) Protocol

## Appendix G - Contingency Plan Flowchart

Determine the need for a Production Hydrogen Sulfide (H<sub>2</sub>S) Contingency Plan. If the state has more stringent requirements, follow the state requirements for developing a contingency plan.

How to determine if an H<sub>2</sub>S Contingency Plan is required:




Legend

ROE: radius of exposure

CFD: cubic feet per day

H<sub>2</sub>S: hydrogen sulfide

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### Appendix H - Sample Contingency Plan

Use the hyperlink below to find an example of an H<sub>2</sub>S Contingency Plan.

[EHS Template Hydrogen Sulfide Field Contingency Plan](#)

[EHS Template Hydrogen Sulfide Drilling Contingency Plan](#)



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## Hydrogen Sulfide (H<sub>2</sub>S) Protocol

### Attachment A - Approval, Review and Modification History

Revision Number	Approved/Revised/Reviewed By	Approval/Revision/ Review Date	Description (Initial Approval, Revision or Review along with further details of revision if needed)
00	Richard Luedecke	02/27/14	Initial Approval
01		07/30/14	<ol style="list-style-type: none"> <li>Added new definition, Working Atmosphere - the area surrounding a worker that possess a respiratory exposure.</li> <li>Provided additional clarification around tank sampling for H<sub>2</sub>S (3.1.4 and 3.3.3).</li> <li>Modified JHA requirements to address the need for both respiratory protection and a stand-by person (3.2.4 and 3.3.7).</li> <li>Simplified language regarding when to wear an ASR (3.3.21 and 3.3.27).</li> <li>Provided additional clarification regarding the responsibilities of the stand-by person and when a formal rescue team is required on location (3.2.22 and 3.3.28).</li> <li>Specified the level of training required for H<sub>2</sub>S awareness and H<sub>2</sub>S specific rescue (Appendix F).</li> </ol>
02	Richard Luedecke	4/7/16	Updated the language of step 3.2.14. Additionally the number and location of required H <sub>2</sub> S monitors on a drilling rig were modified.
03	Jason Nieuwenhuis	10/19/16	Administrative change made to include rescue-training language from Respiratory Protection Protocol to steps 3.2.22 and 3.3.28. Additionally, updated examples listed for Field Office Definition. The definition of Division was updated to align with the current organization. Lastly, links to state H <sub>2</sub> S rule summaries have been removed for states that no longer have Devon Operations.



### Attachment B - Sample Results Form

Follow state testing requirements if no testing requirements are listed. Test the tank when liquid levels are at a level to obtain the maximum H<sub>2</sub>S exposure (e.g., ¾ full).

VAPOR SPACE TESTING RESULTS							
Manufacturer:		Serial No.:			Instrument:		
H <sub>2</sub> S	Location	Location	Location	Location	Location	Location	Location
1 ft above thief hatch							
At thief hatch							
1 ft below thief hatch							
1 ft above thief hatch							
At thief hatch							
1 ft below thief hatch							
Printed Name of Person Performing Atmospheric Tests:					Date & Time:		

GAS STREAM TESTING RESULTS							
Manufacturer:		Serial No.:			Instrument:		
Location	H <sub>2</sub> S	Location	H <sub>2</sub> S	Location	H <sub>2</sub> S	Location	H <sub>2</sub> S
Printed Name of Person Performing Atmospheric Tests:					Date & Time:		

