COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

HYDROGEN SULFIDE OPERATOR GUIDANCE FOR RULES 304.C.(10), 405.Q, 612, AND 903.D

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Purpose of Guidance

This document is intended to clarify Colorado Oil and Gas Conservation Commission (COGCC) requirements for monitoring, measuring, reporting and mitigation of Hydrogen Sulfide (H_2S) gas at oil and gas facilities and oil and gas locations where the Operator knows or reasonably expects to encounter H_2S gas[1]. If any laboratory analysis confirms H_2S in the gas stream[2] of a well at a concentration of 100 parts per million (ppm) or higher, then the well site becomes a "Designated H_2S Location."

Oil and gas operations of particular concern at oil and gas locations with known H_2S gas include:

- a well control event during drilling or well servicing,
- plugging and abandonment
- upset conditions or malfunctions, and
- facility maintenance and replacement operations.

Venting or flaring of H_2S gas at an oil and gas location has the potential to cause risks to the health and safety of workers, the public, and wildlife. H_2S gas can cause death or injury at high concentrations, and flaring gas that contains H_2S produces sulfur dioxide (SO_2), which also has the potential to create a health hazard.

Rule Citations

304.c.(10) [Form 2A] Hydrogen Sulfide Drilling Operations Plan. If operating in zones known or suspected to contain hydrogen sulfide gas ("H2S"), a H2S drilling operations plan consistent with the requirements of Rule 612.d.

[1] For the purpose of compliance with Rule 612, the Director will consider the following when making a determination that the Operator should "reasonably expect to encounter" H_2S gas: 1) the Operator is drilling in a geologic formation or part of a formation that has a previous report of H_2S gas in a nearby well, documented in COGCC's files through Form 4, Form 42, mud logs, geologic reports, or similar information; 2) the Operator is performing well work or facilities maintenance at a "Designated H_2S Location," at a location with existing signs warning of H_2S or potential H_2S, or at a location where H_2S mitigation measures are in place or regularly used.

[2] For samples to be collected "in the gas stream," the sample point will be at a location downstream of the well and upstream of the separator, or at the separator inlet. The well will be in a flowing condition and flowing for a duration such that the gas sample is representative of formation fluids.

405.q. Notice of H2S on an Oil and Gas Location. Within 48 hours after receipt of a laboratory gas stream analysis showing the presence of hydrogen sulfide ("H2S") on an Oil and Gas Location, Operators will provide the Commission written notice of the analysis. Such notice will be provided on a Form 42, Field Operations Notice – Notice of H2S on an Oil and Gas Location. The Commission will provide prompt electronic notice of such analysis to CPW.

612. HYDROGEN SULFIDE GAS

a. General.

(1) Operators will avoid any uncontrolled release or hazardous accumulation of hydrogen sulfide ("H2S") gas. If releases or hazardous accumulations of H2S cannot be avoided, or during upset conditions or malfunctions, Operators will employ mitigation measures to reduce potential harms to safety.

(2) Scope. To protect and minimize adverse impacts to public health, safety, welfare, the environment, and wildlife resources, Operators will comply with this Rule 612 where oil and gas exploration and production occurs in areas known or reasonably expected to contain H2S.

b. Radius of Exposure Calculation. When an Operator is conducting drilling, workover, completion,or production operations in a geologic zone where the Operator knows or reasonably expects to encounter, or a laboratory gas analysis detects, H2S in the gas stream at concentrations at or above 100 parts per million ("ppm"), the Operator will calculate the radius of exposure to any Building Unit, High Occupancy Building Unit, or Designated Outside Activity Area.

(1) Radius of exposure will be calculated pursuant to Bureau of Land Management ("BLM") Onshore Order No. 6 (Jan. 22, 1991). Only the 1991 version of Onshore Order 6 applies to this Rule; later amendments do not apply. All materials incorporated by reference in this Rule are available for public inspection during normal business hours from the Public Room Administrator at the office of the Commission, 1120 Lincoln Street, Suite 801, Denver, CO 80203. In addition, these materials are available from the BLM Colorado State Office, 2850 Youngfield St., Lakewood, CO 80215, and are available online at https://www.blm.gov/sites/blm.gov/files/energy_onshoreorder6.pdf.

(2) If insufficient data exists to calculate a radius of exposure, the Operator will assume the radius of exposure is 3,000 feet.

(3) Operators will perform gas stream laboratory analysis if any concentration of H2S of 20 ppm or greater is detected by using field measurement devices during drilling, completion, or production operations. Operators will report any gas stream laboratory analysis greater than 1 ppm H2S to the Director and the Relevant and Proximate Local Government(s). If the Operator ever detects H2S concentrations greater than 1 ppm, the Operator will repeat gas stream laboratory analysis annually.

c. H2S Public Protection Plan. A public protection plan is required if:

(1) The 100 ppm radius of exposure is greater than 50 feet and there is a Building Unit, High Occupancy Building Unit, or Designated Outside Activity Area within the radius of exposure;

(2) The 100 ppm radius of exposure is equal to or greater than 3,000 feet and includes any publicly-maintained road; or

(3) The Director determines that a public protection plan is necessary to protect and minimize adverse impacts to public health, safety, welfare, the environment, or wildlife resources.

d. H2S Drilling Operations Plan.

(1) When proposing to drill a Well in areas where H2S gas can reasonably be expected to be encountered, Operators will submit a H2S drilling operations plan with their Form 2, unless the plan was already submitted with their Form 2A, pursuant to Rule 304.c.(10).

(2) Operators will prepare the H2S drilling operations plan pursuant to BLM Onshore Order No. 6, as incorporated by reference in Rule 612.b.(1).

e. Designated H2S Locations. If an Operator ever measures H2S gas stream concentrations of 100 ppm or greater at a Well, the Well is a designated H2S location. All designated H2S locations will be designed and operated in accordance with BLM Onshore Order No. 6, as incorporated by reference in Rule 612.b.(1). Designated H2S locations will have:

(1) Signs indicating the presence of H2S not less than 200 feet or more than 500 feet from the entrance of the location;

(2) H2S monitoring with audible and visible alarms at 10 ppm of H2S;

(3) At least one wind indicator; and

(4) With landowner approval, adequate fencing.

f. Operations in Designated H2S Locations.

(1) In a designated H2S location, Operators will employ a secondary means of immediate Well control at all Wells that are known to have H2S through use of a christmas tree or downhole completion equipment. The equipment will allow downhole accessibility (reentry) under pressure for permanent Well control. When the presence of H2S is detected during drilling in formations not tested, completed, or produced, the Operator will report depth intervals, concentrations measured at surface or within drilling Fluid, and the control measures used.

(2) At Oil and Gas Locations producing gas with greater than 100 ppm H2S, Operators will monitor all storage Tanks. Any headspace field measurement or laboratory analysis greater than 500 ppm H2S, or 10 ppm H2S in ambient air, will require mitigation measures to control and minimize accumulation within the storage Tank.

(3) All operations at an Oil and Gas Location with potential H2S concentrations greater than 100 ppm will:

A. Use equipment that can withstand the effects and stress of H2S;

B. Be conducted pursuant to American National Standards Institute ("ANSI")/National Association of Corrosion Engineers ("NACE") Standard MR0175/ISO 15156-2015-SG, Petroleum and natural gas industries – Materials for use in H2S-containing environments in oil and gas production (2015), or some other Director approved standard for selection of metallic equipment. Only the 2015 version of ANSI/NACE Standard MR0175/ISO 15156-2015-SG applies to this Rule; later amendments do not apply. All material incorporated by reference in this Rule are available for public inspection during normal business hours from the Public Room Administrator at the office of the Commission, 1120 Lincoln Street, Suite 801, Denver, CO 80203. In addition, these materials are available from NACE International, 15835 Park Ten Pl, Houston, TX 77084; and

C. If applicable, use adequate protection by chemical inhibition or such other methods that control or limit H2S's corrosive effects.

(4) Operators in designated H2S locations will conduct a laboratory analysis of the gas stream for H2S at least monthly. If the H2S concentration increases by greater than 25%, the Operator will recalculate the radius of exposure and notify the Director and the Relevant and Proximate Local Government(s).

g. Operator Reports of H2S.

(1) Operators will report on a Form 42, Field Operations Notice – Notice of H2S on an Oil and Gas Location any laboratory analysis indicating the presence of H2S gas to the Director within 48 hours. Upon receipt of the Form 42, the Director will notify the Relevant and Proximate Local Government(s).

(2) If a laboratory analysis indicates any concentrations of H2S gas greater than 100 ppm in the gas stream, or headspace field measurement or laboratory analysis greater than 500 ppm H2S, or 10 ppm H2S in ambient air, the Operator will report such findings to the Director on a Form 4, including the information required in Rules 612.b–d, as applicable, within 45 days.

h. Unless deemed an immediate operational need for safety reasons and the release does not pose a risk to public safety, Operators may only intentionally release H2S gas with prior Director approval of a Form 4. The Form 4 will include a proposed air monitoring

plan for H2S. If combustion or Flaring is proposed, the air monitoring plan will include a SO2 by-product detection plan.

i. If an intentional release of H2S gas occurs due to Upset Conditions or malfunctions, the Operator will notify the Director, the Relevant and Proximate Local Government(s), and the local emergency response agency orally within 24 hours, followed by the filing of a Form 4 within 5 days.

j. All H2S monitoring, mitigation, and safety equipment will be maintained and functioning in good working order at all times.

k. Temporary Abandonment of a H2S Well.

(1) Prior to temporarily abandoning a Well with potential concentrations of greater than 100 ppm H2S in its gas stream, the Operator will file a Form 4, Notice of Temporarily Abandoned Status to obtain the Director's approval.

(2) Operators will install a cast iron bridge plug and maintain H2S monitoring and telemetry equipment when temporarily abandoning a Well with potential concentrations of greater than 100 ppm H2S in its gas stream.

903.d. Emissions During Production.

(2) For any instance of Venting or Flaring permitted pursuant to Rules 903.d.(1).A–E [including Gas Vented during a Bradenhead test pursuant to Rule 419] for a period that exceeds 8 consecutive or 24 cumulative hours, the Operator will submit a Form 4 reporting:

A. The estimated or measured volume and content of gas Vented or Flared;

B. Gas analysis of the gas Vented or Flared, including hydrogen sulfide;

C. Explanation, rationale, and cause for the Venting or Flaring event; and

D. A description of any operational best practices used to minimize Venting during maintenance and repair activity.

(3) At Wells that have Commenced Production Operations prior to January 15, 2021 and that are Venting or Flaring natural gas because they are not connected to a natural gas Gathering Line or putting the natural gas to beneficial use, the Operator may request permission from the Director to Flare or Vent by submitting a gas capture plan via a Form 4 no later than the date the Operator's previously approved Form 4 expires and in no case later than January 15, 2022. If an Operator loses access to a Gathering Line after January 15, 2021, the Operator will submit a gas capture plan via a Form 4 within 30 days of losing the Gathering Line access. The Operator may not Flare or Vent pursuant to this Rule 903.d.(3) unless and until the Director approves the

Form 4. The Director may approve a one-time request to Flare or Vent for a period not to exceed 12 months, if the Director determines that Flaring or Venting is necessary to produce the Well, will minimize waste, and will protect and minimize adverse impacts to public health, safety, welfare, the environment, and wildlife resources. For any such Form 4 submitted prior to January 15, 2022, the Director will not approve the one-time request to Flare or Vent to any date after January 15, 2022. The gas capture plan on the Form 4 will describe:

A. The estimated volume and content of the gas to be Flared or Vented;

B. Gas analysis including hydrogen sulfide for the subject Well;

C. For requests based on lack of available infrastructure, the Operator will state why the Well cannot be connected to infrastructure;

D. When the Well(s) will be connected to infrastructure, why the Operator commenced production of the Well before infrastructure was available, and whether the mineral Owner will be compensated for the Vented or Flared gas; and

E. Options for using the gas instead of Flaring or Venting, including to generate electricity, gas processing to recover natural gas liquids, or other options for using the gas.

Related 100-Series Definitions

BRADENHEAD shall mean the annular space between the surface casing and the next smaller diameter casing string that extends up to the wellhead.

BUILDING UNIT shall mean a Residential Building Unit; and every five thousand (5,000) square feet of building floor area in commercial facilities or every fifteen thousand (15,000) square feet of building floor area in warehouses that are operating and normally occupied during working hours.

DESIGNATED OUTSIDE ACTIVITY AREA: Upon Application and Hearing, the Commission, in its discretion, may establish a Designated Outside Activity Area (DOAA) for:

(i) an outdoor venue or recreation area, such as a playground, permanent sports field, amphitheater, or other similar place of public assembly owned or operated by a local government, which the local government seeks to have established as a Designated Outside Activity Area; or

(ii) an outdoor venue or recreation area, such as a playground, permanent sports field, amphitheater, or other similar place of public assembly where ingress to, or egress from the venue could be impeded in the event of an emergency condition at an Oil and Gas Location less than three hundred and fifty (350) feet from the venue due to the

configuration of the venue and the number of persons known or expected to simultaneously occupy the venue on a regular basis.

The Commission shall determine whether to establish a Designated Outside Activity Area and, if so, the appropriate boundaries for the DOAA based on the totality of circumstances and consistent with the purposes of the Oil and Gas Conservation Act.

DIRECTOR shall mean the Director of the Oil and Gas Conservation Commission of the State of Colorado or any member of the Director's staff authorized to represent the Director.

FLARING means the combustion of natural gas during upstream Oil and Gas Operations, excluding gas that is intentionally used for onsite processes.

FLUID means any material or substance which flows or moves whether in a semisolid, liquid, or gas form or state.

HIGH OCCUPANCY BUILDING UNIT means:

a. Any School, nursing facility as defined in § 25.5-4-103(14), C.R.S., hospital, life care institution as defined in § 12-13-101, C.R.S., or correctional facility as defined in § 17-1-102(1.7), C.R.S., provided the facility or institution regularly serves 50 or more persons;

b. An operating Child Care Center as defined in § 26-6-102(5), C.R.S.; or

c. A multifamily dwelling unit with four or more units.

LOCAL GOVERNMENT means a county, home rule or statutory city, town, territorial charter city or city and county, or any special district established pursuant to the Special District Act, C.R.S. §32-1-101 to 32-1-1807 (2013).

OIL AND GAS LOCATION shall mean a definable area where an Operator has disturbed or intends to disturb the land surface in order to locate an oil and gas facility.

OPERATOR shall mean any person who exercises the right to control the conduct of oil and gas operations.

RESIDENTIAL BUILDING UNIT means a building or structure designed for use as a place of residency by a person, a family, or families. The term includes manufactured, mobile, and modular homes, except to the extent that any such manufactured, mobile, or modular home is intended for temporary occupancy or for business purposes. Each individual residence within a building will be counted as one Residential Building Unit.

TANK shall mean a stationary vessel constructed of non-earthen materials (e.g concrete, steel, plastic) that provides structural support and is designed and operated to store produced fluids or E&P waste. Examples include, but are not limited to, condensate tanks, crude oil tanks,

produced water tanks, and gun barrels. Exclusions include Containers and process vessels such as separators, heater treaters, free water knockouts, and slug catchers.

UPSET CONDITION means a sudden unavoidable failure, breakdown, event, or malfunction, beyond the reasonable control of the Operator, of any equipment or process that results in abnormal operations and requires correction.

VENTING means allowing natural gas to escape into the atmosphere, but does not include:

a. The emission of gas from devices, such as pneumatic devices and pneumatic pumps, that are designed to emit as part of normal operations if such emissions are not prohibited by AQCC Regulation No. 7, as incorporated by reference in Rule 901.b;

b. Unintentional leaks that are not the result of inadequate equipment design; and

c. Natural gas escaping from, or downstream of, a Tank unless: 1) there is no separation occurring at equipment upstream of the Tank; 2) the separation equipment is not sufficiently sized to capture the entrained gas; or 3) the natural gas is sent to the Tank during circumstances when the gas cannot be sent to the Gathering Line or the combustion equipment used to Flare the gas is not operating.

WELL when used alone in these Rules and Regulations, shall mean an oil or gas well, a hole drilled for the purpose of producing oil or gas, a well into which fluids are injected, a stratigraphic well, a gas storage well, or a well used for the purpose of monitoring or observing a reservoir.

Guidance

Personal Air Monitoring

The COGCC suggests the use of personal air monitors for site workers with the capability of detecting H_2S gas in the breathing zone when calibrated and worn in accordance with the device manufacturer's recommendations. For compliance with the reporting requirements of Rule 612.g.(2), alarms should be set at a maximum 10 ppm threshold.

Gas Stream Sampling for Laboratory Analysis

The COGCC recommends that the Operator collect gas stream samples for H_2S laboratory analysis in the following situations:

1. When a field measurement[3] exceeds 10 ppm H_2S gas during any operations other than drilling, completion, and production at an oil and gas location;
2. When a field measurement exceeds 20 ppm H_2S gas during drilling, completion, and production operations, per Rule 612.b.(3);

[3] "Field measurements" include personal air monitors, fixed rig monitors, and colorimetric tubes.

3. When a field measurement exceeds 100 ppm H_2S gas in the gas stream, to verify the field-measured concentration for a Radius of Exposure calculation;
4. When required by the Director, per Rule 209.a;
5. When required by a permit Condition of Approval;
6. During bradenhead pressure diagnostic testing, if the venting period exceeds 8 consecutive or 24 cumulative hours, per Rule 903.d.(2)B;
7. When required by a Rule 419.b bradenhead gas Pressure Management Plan; or
8. When collecting production gas samples for compliance with flaring Rule 903.d.(2)B and Rule 903.d.(3)B.

Form 42, Field Operations Notices for Laboratory Gas Analysis H_2S Detections

When the Operator submits a Form 42 H_2S notice, the Director notifies the local government. The Operator will provide Form 42 notice:

1. For all oil and gas locations, within 48 hours after receipt of a laboratory gas stream analysis showing the presence of H_2S gas[4], per Rule 405.q and 612.g.(1);
2. For Radius of Exposure calculations, when an H_2S gas stream laboratory analysis is greater than 1 part per million (ppm), per 612.b.(3); and
3. For Designated H_2S Locations, when a monthly gas stream laboratory analysis indicates an H_2S concentration that increases more than 25%, when compared to the most recent H_2S Concentration used for a Radius of Exposure calculation.

Form 4, Sundry Notice Reports of H_2S Detections

The Operator will submit a Form 4 within 45 days after the Operator has knowledge of the following, per Rule 612.b and Rule 612.g.(2):

1. When an H_2S gas concentration exceeds 10 ppm in ambient air[5], whether by field measurement or by laboratory analysis;
2. When the Operator is conducting drilling, workover, completion, or production operations in a geologic zone[6] where the Operator knows or reasonably expects to encounter H_2S in the gas stream at concentrations at or above 100 ppm;
3. When an H_2S gas concentration is greater than 100 ppm in the gas stream, as measured by laboratory analysis;
4. When an H_2S gas concentration is greater than 500 ppm in the headspace of a tank, whether by field measurement or by laboratory analysis; or
5. For Designated H_2S Locations, when a monthly gas stream H_2S concentration increases by greater than 25%, as measured by laboratory analysis, when compared to the H_2S concentration used for the most recent Radius of Exposure calculation.

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[4] "Presence of H_2S gas" means a concentration greater than the laboratory detection limit. The COGCC expects that laboratories will be able to achieve a detection limit less than or equal to 1 ppm H_2S gas.

[5] For the purpose of this guidance document, "ambient air" is considered air in a person's breathing zone or air at a measurement device positioned on a rig or at a Designated H_2S Location specifically for the purpose of monitoring for H_2S gas in ambient air. Ambient air is not air in an enclosed space, such as a confined space or tank headspace.

[6] For the purpose of this guidance document, a "geologic zone" is a formation or the member of a formation that is penetrated by the drill bit or completed in the well.

Radius of Exposure

The Radius of Exposure is a calculated distance from the well to a point away from the well where the H_2S gas concentration would be 100 ppm during a well control event, assuming that the well is fully open to the atmosphere (a required assumption for the calculation). During a release, the H_2S gas concentration diminishes with increasing distance from the source as the H_2S gas disperses into the atmosphere. An example Radius of Exposure Calculation is provided in Appendix B.

For a "representative" gas stream sample and flow rate measurement used to calculate a Radius of Exposure, the sampling point and the measurement point should be located between the well and the separator or at the separator inlet. The objective is to collect a sample of raw fluids from the well and to measure the flow rate prior to separation.

H_2S Public Protection Plan

For the purpose of determining the need for an H_2S Public Protection Plan, if insufficient data exists to calculate a Radius of Exposure, the Operator will gather such information or assume the Radius of Exposure is 3,000 feet, per Rule 612.b.(2).

If required, based on the Radius of Exposure calculation and the presence of any potential, nearby pubic points of exposure described below, the Operator will submit an H_2S Public Protection Plan with the Form 4, per Rule 612.c, as follows:

1. The 100 ppm radius of exposure is greater than 50 feet and there is a Building Unit, High Occupancy Building Unit, or Designated Outside Activity Area within the radius of exposure;
2. The 100 ppm radius of exposure is equal to or greater than 3,000 feet and includes any publicly-maintained road; or
3. The Director determines that an H_2S Public Protection Plan is necessary to protect and minimize adverse impacts to public health, safety, welfare, the environment, or wildlife resources.

To assist with preparation of an H_2S Public Protection Plan, the Operator should complete and submit the checklist provided as Appendix C as an attachment to their Form 4.

H_2S Drilling Operations Plan

When drilling a well in areas where H_2S gas can reasonably be expected to be encountered, the Operator will submit an H_2S Drilling Operations Plan with their Form 2A or Form 2, per Rule 304.c.(10) and Rule 612.d and pursuant to Bureau of Land Management ("BLM") Onshore Order No. 6 (Jan. 22, 1991).

BLM Onshore Order No. 6 applies to all onshore Federal and Indian oil and gas leases when drilling, completing, testing, reworking, producing, injecting, gathering, storing, or treating operations are being conducted in geologic zones which are known or could reasonably be expected to contain H_2S or which, when flared, could produce SO_2, in such concentrations that

upon release could constitute a hazard. BLM Onshore Order No. 6 also establishes reporting thresholds for H_2S concentrations for gas streams encountered in geologic zones and production facilities which are referenced in the Order. The requirements and minimum standards set in BLM Onshore Order No. 6 do not relieve an Operator from compliance with any applicable Federal, State, or local requirement(s) regarding H_2S or SO_2 which are more stringent.

When drilling, the H_2S Drilling Operations Plan implementation should commence prior to drilling within 500 feet of the H_2S-bearing formation or at least three (3) days prior to encountering the formation, based on average drilling rates for the production hole, whichever occurs first.

To assist with preparation of an H_2S Drilling Operations Plan, the Operator should complete and submit the checklist provided as Appendix D.

Designated H_2S Locations

Designated H_2S Locations are well locations where H_2S gas is present in the gas stream from the well at or above a concentration of 100 ppm. For all Designated H_2S Locations, the Operator will perform the following:

1. Commence H_2S operations, per Rule 612.e:
    - Operate the oil and gas location in accordance with the requirements of BLM Onshore Order 6 (Jan. 22, 1991)
    - Install signs, alarms, at least one wind indicator, and with landowner approval, adequate fencing
2. Implement mitigation measures to control the source of H_2S gas per Rule 612.f.(2) at the following thresholds:
    - When an H_2S gas concentration exceeds 10 ppm in ambient air, whether by field measurement or by laboratory analysis
    - When an H_2S gas concentration exceeds 500 ppm in the headspace of a tank, whether by field measurement or by laboratory analysis
3. Perform the following, per Rule 612.f.(4):
    - Implement proper well control measures using equipment that can withstand the effects and stress of H_2S and materials that meet the requirements of American National Standards Institute (“ANSI”)/National Association of Corrosion Engineers (“NACE”) Standard MR0175/ISO 15156-2015-SG
    - Monitor storage tank headspace H_2S concentrations,
    - Conduct a gas stream laboratory analysis at least monthly

H_2S Gas Prevention and Mitigation

As a preventative measure, the COGCC recommends that Operators treat water and recycled fluids that are intended for use in the well, to minimize the potential for the introduction of conditions conducive for growth of sulfate reducing bacteria in producing zones and injection zones. Surface equipment should be treated as soon as practicable if H_2S is observed and its source is isolated to surface equipment to reduce the potential for continued growth of sulfate reducing bacteria.

Temporary Abandonment of Wells at Designated H_2S Locations

Before the Operator submits a Form 4 request to temporarily abandon a well that has the potential for H_2S in the gas stream at concentration greater than 100 ppm in the gas stream, the COGCC recommends that the Operator confirm the gas stream H_2S concentration by laboratory analysis and submit the laboratory analytical report with their Form 4.

For unplanned operations, the Director may provide verbal approval to temporarily abandon the well. In that case, the Operator will submit the Form 4 within two business days with the temporary abandonment procedure.

For planned or unplanned operations, the Operator will install a cast iron bridge plug (or other Director approved wellbore isolation method) within 100 feet of the top perforation and maintain H_2S monitoring and telemetry equipment, per Rule 612.k.

Gas Venting, Flaring, and Other Considerations

For any venting that is otherwise allowed by Rule 903, COGCC may require that the gas be flared for safety reasons to reduce the potential for exposure to H_2S gas as a Condition of Approval for an H_2S Public Protection Plan or an H_2S Drilling Operations Plan.

When combusted, H_2S gas produces SO_2 gas, which either remains in gaseous form (through atmospheric dispersion from the flare stack); or, it may combine with water to form sulfurous acid in the gas phase or sulfuric acid in the liquid phase. SO_2 can be noxious at low concentrations, and it can cause negative health effects. Both H_2S and SO_2 gas are heavier than air and therefore appropriate precautions should be taken in regards to confined spaces, cellars, containment structures and low lying areas.

H_2S is sometimes removed from gas streams using iron sulfide, which generates spent iron sponge. Spent iron sponge is flammable and subject to spontaneous combustion in dry conditions.

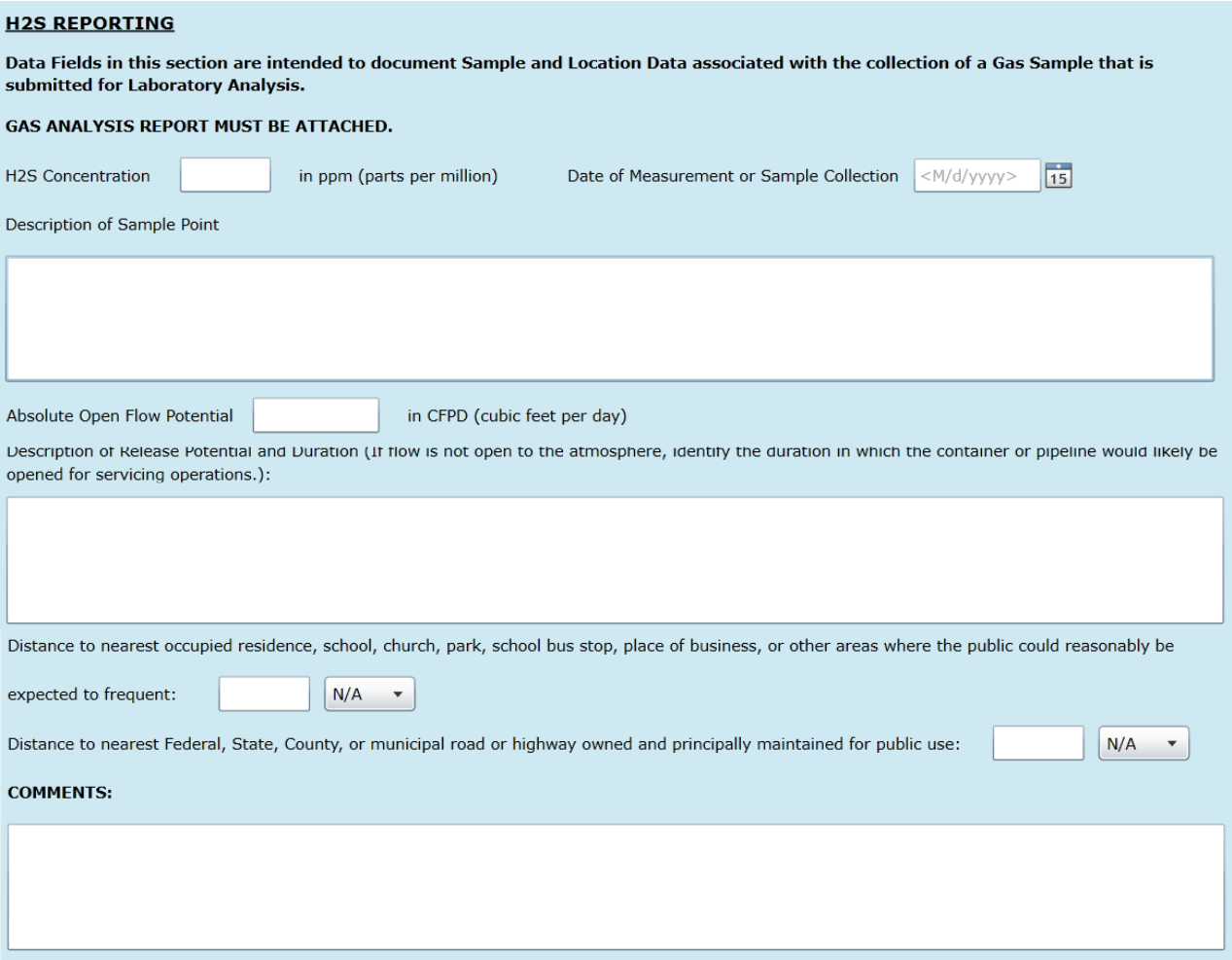
Document Change Log

Change Date	Description of Changes
3/30/2021	Document created and finalized

Appendix A

Form 4 Requirements

When a Form 4 is required by Rule 612.g.(2), the Operator should provide information needed to complete the form, as shown below for the eForm H_2S Reporting tab:



For the Comments section shown above, the Operator should include the following information on the Form 4:

1. A description of the type of feature for the Operator's distance measurement and whether the feature is a Building Unit, High Occupancy Building Unit, or Designated Outside Activity Area, or "other feature"
2. If the feature is and "other feature," then provide the distance in feet to the nearest Building Unit, High Occupancy Building Unit, or Designated Outside Activity Area, if less than 3,000 feet
3. Name of the road or highway for the Operator's distance measurement
4. A description of operation underway or circumstances at the time of detection or sample collection

5. For drilling, well servicing, or plugging operations, a description of well control equipment
6. For wells that are not otherwise on a Designated H_2S Location, a description of the Operator's planned H_2S mitigation and management equipment and materials, if any
7. For H_2S gas detections that are not in the gas stream, a statement indicating that the Radius of Exposure is zero feet.
8. For H_2S gas detected in the gas stream, the geologic formation name(s) and gross completed interval depths of the known or suspected sources of the H_2S gas

The Operator will provide Radius of Exposure calculations (see Appendix B) as an attachment to the Form 4.

Appendix B

Radius of Exposure

For H_2S concentrations greater than 10% (100,000 ppm), do not use the Pasquill-Gifford Equation shown below, and instead, refer to BLM Onshore Order No. 6

Hydrogen Sulfide Conversions

Percent H_2S is taken from either the mole or volume fraction of H_2S in the total mixture of gases.

Example, assuming a 10% H_2S concentration:
- 10% H_2S = 0.10 volume or mole fraction of total gas mixture
- 0.10 = 100,000 ppm H_2S in a 1,000,000 ppm total mixture of gases
- 0.10 = 100 ml in 1,000 ml (1 liter) mixture of gases
- 0.10 = 100 cu ft in 1,000 cu ft mixture of gases

Pasquill-Gifford Equation

100 ppm Radius of Exposure

$$\mathbf{R = ((1.589) \cdot (H_2S \text{ mole fraction}) \cdot (Q))^{0.6258}}$$

500 ppm Radius of Exposure

$$\mathbf{R = ((0.4546) \cdot (H_2S \text{ mole fraction}) \cdot (Q))^{0.6258}}$$

Where:
- R = radius of exposure in feet
- H_2S mole fraction = concentration in ppm divided by 1 million
- Q = cubic feet per day gas flow rate against atmospheric pressure or Absolute Open Flow Potential taken from a conventional four point back pressure test

Assumptions:
- Pressure = 14.7 psig
- Temperature = 60 °F

Example Calculations

<u>100 ppm Radius of Exposure</u>
H_2S concentration = 3,900 ppm, Flow Rate = 500 MCFD

$$R = ((1.589) \cdot (3{,}900/1x10^6) \cdot (500 \cdot 1{,}000))^{0.6258}$$
$$R = 153 \text{ feet}$$

<u>500 ppm Radius of Exposure</u>
H_2S concentration = 3,900 ppm, Flow Rate = 500 MCFD

$$R = ((0.4546) \cdot (3{,}900/1x10^6) \cdot (500 \cdot 1{,}000))^{0.6258}$$
$$R = 70 \text{ feet}$$

Appendix C

Public Protection Plan Checklist
When an H_2S Public Protection Plan is required by Rule 612.c, the Operator will make copies of the plan available at the oil and gas location during drilling, completion, or production operations, or any other operations that have the potential for a release of H_2S gas, including well plugging, flowline abandonment, well servicing, facility maintenance, equipment replacement, and any other operations that have the potential for a release of H_2S gas during the work. The Operator will also maintain a copy of the Public Protection Plan at the Operator's local field office and provide copies of the plan to the local emergency dispatch office and the Local Government Designee.

Public Outreach and Communication
Items to be discussed with the COGCC personnel and considered as an integral part of the plan include:

- Public education
- Seminars
- Mass alert systems
- Use of sirens
- Telephones on site
- Radio on site

Minimum items required to present and discuss in public education, meetings, & seminars:

- Hazards of H_2S and SO_2
- Necessity for a plan
- Possible sources of H_2S and SO_2
- Instructions for reporting a leak to the Operator and/or rescue and safety personnel
- Manner of public notification
- Steps to be taken in an emergency
- Evacuation plan and drills

Plan Contents

- Site Identification
- Operator Name
- Well Name or Facility Name
- Latitude-Longitude
- Legal Location
- API Number

Operator's Key Personnel

Names
Titles
Responsibilities, duties, and jobs
Telephone numbers

Rescue & Management Personnel (include jurisdictional law enforcement, fire, hospital, COGCC, BLM)

Organization
Phone numbers
Address

Public Potentially Present within the Radii of Exposure

Names
Phone numbers
Addresses

Area Maps, including:

Radius of Exposure where 100 ppm could potentially be encountered (use 3,000 feet if insufficient data is available to calculate the Radius of Exposure)
Radius of Exposure where 500 ppm could potentially be encountered
Likely locations that public may be present within the Radii of Exposure

Description of Warning Systems and Administrative Controls

Monitors (activated)
Site security
Access control

Appendix D

Drilling/Operations Plan Checklist
When an H_2S Drilling Plan is required by Rule 612.d, the Operator will make copies of the plan available at the oil and gas location during drilling. This checklist also serves as a reference when preparing an H_2S Operations Plan for completion operations, production operations, well plugging, flowline abandonment, well servicing, facility maintenance, equipment replacement, and any other operations that have the potential for a release of H_2S gas during the work.

The Operator will also maintain a copy of the Drilling/Operations Plan at the Operator's local field office and provide copies of the plan to the local emergency dispatch office and the Local Government Designee.

Personnel Training
- Description of training plan

Site Identification
- Operator Name
- Well Name or Facility Name
- Latitude-Longitude
- Legal Location
- API Number

Operator's Key Personnel
- Names
- Titles
- Responsibilities, duties, and jobs
- Telephone numbers

Rescue & Management Personnel
(include jurisdictional law enforcement, fire, hospital, COGCC, BLM)
- Organization
- Phone numbers
- Address

Well Site Diagram
- Rig orientation
- Pits
- All other equipment
- Gathering lines
- Prevailing wind direction
- Surrounding terrain
- Briefing areas
- Primary briefing area, based on prevailing wind direction
- Access/Egress roads
- Flare line
- Caution & danger signs
- Wind socks

Access, Egress and Roads

At least one access road
At least one egress (exit) road
Security
Traffic control
Attendance Roster
Fencing where public access is likely

Protective Equipment for Essential Personnel

Location; type; storage and maintenance of all working monitors and escape packs
Means of communication when using breathing equipment
Testing, calibration, & maintenance records

H_2S Detection and Monitoring Equipment

Location of H_2S sensors
Location of audible alarms
Location of visual alarms
Portable H_2S monitors
Portable SO_2 monitors
Testing, calibration, & maintenance records

Visual Warning Systems

Wind direction indicators
Caution signs
Danger signs (easily seen within 50’ of storage vessel or potential point of exposure)

Metallurgy

Metallurgical properties of all temporary and fixed tubular goods
Metallurgical properties of well control equipment potentially exposed to H_2S (Drilling Operations)
Metallurgical properties of production and gathering equipment
Inspection and maintenance schedules to check for corrosion, cracks or leaks; records should be maintained by the Operator for COGCC inspection upon request

Well Control (Drilling Operations)

Flare line and means of ignition
Remote controlled choke
Flare guns/flares
Mud-gas separator
BOP & Flow Control

Mud Program (Drilling Operations)

Mud system and additives
Mud degassing system
H_2S scavengers