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EARTHWORKS

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Dedicated to protecting communities and the environment from the adverse impacts of mineral and energy development while promoting sustainable solutions.

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Executive Summary

Hydrogen sulfide gas (H_2S or sour gas) associated with oil and gas production can be quickly lethal to those exposed, corrosive to many metals, and produces additional lethal compounds when burned. In Texas, hydrogen sulfide associated with oil and gas production is predominantly regulated by the Railroad Commission of Texas (RRC), which oversees the oil and gas industry — not railroads. The RRC implements Texas' Rule 36, which obligates operators of certain gas wells to self-report the concentration of hydrogen sulfide in the gas that their wells produce and to comply with more or less stringent rules depending upon that concentration. In this report, Earthworks analyzes this self-reported company data — or lack thereof — using information acquired from the RRC.

The RRC assigns all oil and gas fields in Texas an average concentration of hydrogen sulfide based upon RRC measurements. The RRC considers any oil or gas well drilled in a field with an RRC-assigned average concentration over 100 parts-per-million (ppm) to be "sour gas" and the operator is obligated to test their specific well's concentration and report it through the Commission's H9 form. In RRC District 8 alone — which includes west Texas' Permian Basin — there are more than 1,000 oil and gas fields with hydrogen sulfide concentrations of over 100 ppm.

Key Findings

1. **Analysis of over 19,000 wells in RRC District 8 found over 10,000 thousand wells** — 51% of wells — did not file required H9s to assess and inform the state of the danger their well poses and if it must operate under oversight.

2. **The RRC is not tracking which wells require H9s** — the RRC can't determine who is violating the law because it doesn't bother to keep track of who needs to comply with it.

3. **Among the operators who do file H9s, some operators appear to underreport hydrogen sulfide** gas concentrations in order to avoid accountability measures.

4. **Existing hydrogen sulfide regulations are insufficient to mitigate health risks for both rig workers and the public.**
   - Poor regulation has resulted in numerous deaths due to hydrogen sulfide exposure.
   - Regulations also fail to account for hydrogen sulfide's role in producing sulfur dioxide, a known product of hydrogen sulfide combustion which also poses a major health risk.

Introduction

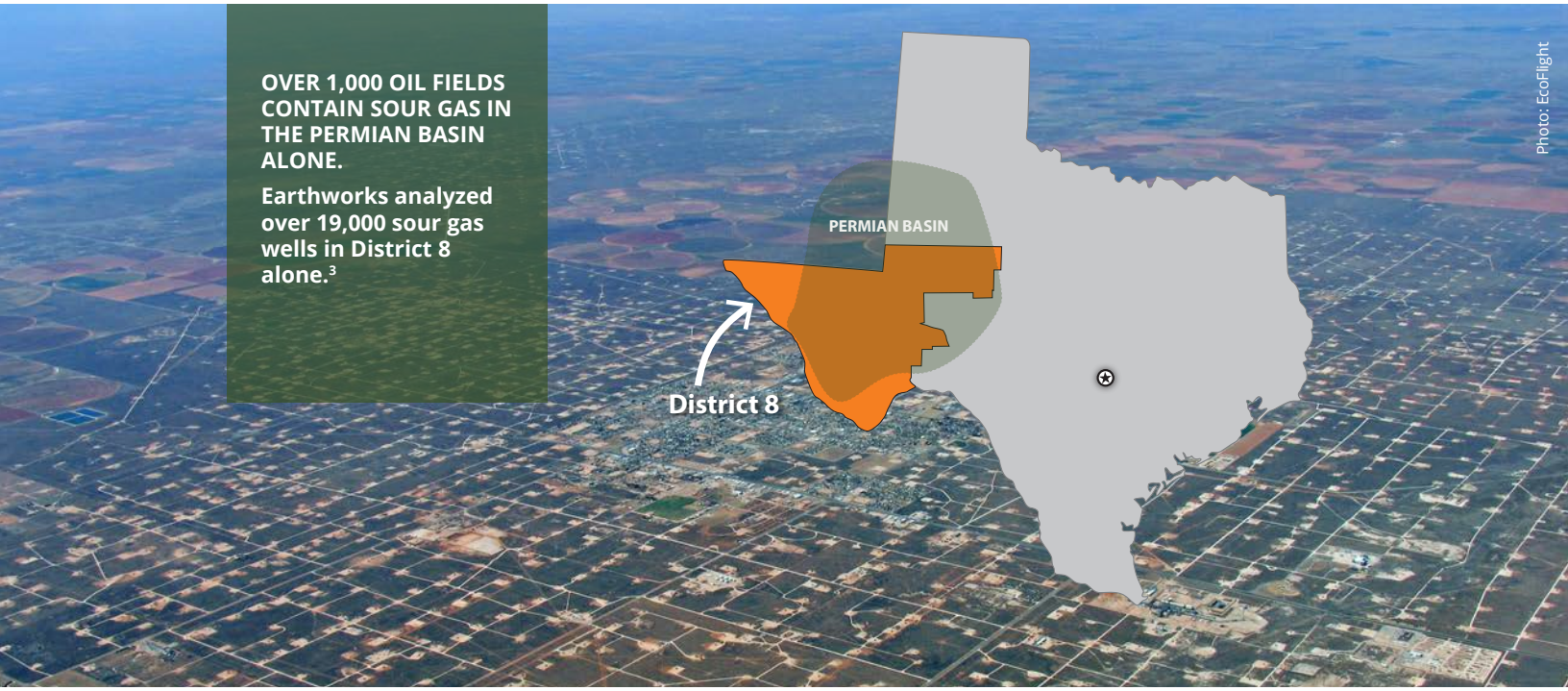
Texas Fails at Regulating Deadly Hydrogen Sulfide Gas

Forty-six years ago, one of the deadliest Texas oil field accidents occurred. In February 1975, an ARCO oil well released hydrogen sulfide gas into the air. The poison gas rapidly engulfed the area, killing nine people. Eight of those deaths were the result of the hydrogen sulfide gas traveling 150 yards to a nearby home. Despite a push from Texas legislators, more than four decades later hydrogen sulfide is still only loosely regulated in Texas.[1]

Not all methane gas ("natural" gas) is equal when it comes out of the ground. There are various characteristics of methane gas that can influence the way the oil and gas industry handles and uses it. One of the most important of those characteristics is the concentration of hydrogen sulfide (H_2S). Gas with a high H_2S concentration is referred to as "sour gas". Gas with a low concentration of H_2S is referred to as "sweet gas".

Sour gas has limited uses because it can be deadly if improperly handled. As the Railroad Commission of Texas (RRC) — which regulates oil and gas, not railroads — makes clear, **"hydrogen sulfide is a very deadly gas that can kill in minutes."**[2] Often sour gas is piped to processing plants that remove the H_2S, a process known as "sweetening" the gas.

Sour gas is common in Texas, with over 1,000 oil fields containing sour gas in the RRC District 8 region alone, which encompasses most of the Permian Basin.[3] That's why today, and in the wake of the ARCO oil well incident, the Railroad Commission of Texas is charged with regulating wells that produce sour gas; to ensure that wells have equipment and processes in place to prevent and to address gas leaks when they occur. This report demonstrates that the RRC has failed to enforce these regulations, resulting in preventable deaths and increasing the likelihood of another large-scale tragedy.



Regulating Sour Gas

Two Texas agencies are responsible for regulating sour gas concerns in Texas: the Texas Commission on Environmental Quality (TCEQ) and the RRC. They do so from different perspectives. The TCEQ is responsible for protecting Texas' air, so they are responsible for preventing operators from releasing sour gas. The RRC is charged with ensuring safe and sustainable practices in the oil and gas extraction process. It sets emergency protocol regulations for sour gas, as well as leak minimization guidelines. While there is considerable overlap between the two agencies' purviews, they do not appear to coordinate effectively.

FOR TCEQ—H_2S IS IMPOSSIBLE TO ENFORCE

The TCEQ considers any site that produces gas with an H_2S concentration higher than 24 ppm to be a sour gas site, and requires them to obtain an air permit for sour gas (independent of the H9 process at the RRC). Based on the concentration of expected H_2S emissions from the site, it may need several different permits.[4] Further, TCEQ limits overall H_2S emissions: sites may not emit such that the public is exposed to higher than 0.08 ppm H_2S for more than half an hour.[5] The TCEQ has a second standard that prevents even land that the public does not regularly use from being exposed to 0.12 ppm H_2S for more than half an hour.

Unfortunately, this overall limit on H_2S is extremely difficult for the TCEQ to enforce, because in areas where multiple wells exist it is virtually impossible to isolate the H_2S emissions to just one site. Moreover, H_2S pollution is so prevalent in Texas' Permian Basin that the TCEQ has found ambient air in some residential areas often exceeds 0.08 ppm H_2S.[6] This effectively prevents the TCEQ from regulating sour gas, because an air monitor could trip at a site with no leaks simply because the ambient air in the area is above the legal limit.

The TCEQ acknowledges that they do not have significant power to limit sour gas in Texas, so in areas where they cannot practically regulate they have created non-binding recommendations. TCEQ's major recommendation for sour gas is that wells be tested for H_2S every two years, because as wells get older the concentration of H_2S in the well's gas increases.[7]

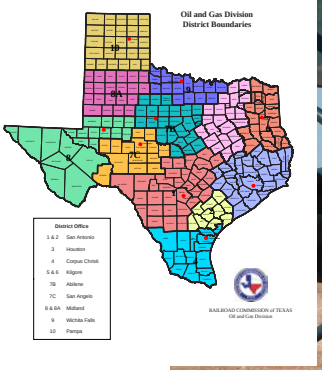
As sour gas wells age, the concentration of H_2S in the well's gas increases.

H_2S pollution is so prevalent in Texas' Permian Basin that the TCEQ has found *ambient* air (not just specific sites or leaks) in some residential areas often exceeds the legal 0.08 ppm H_2S.

Photo: EcoFlight

Regulating Via the RRC

In the wake of the ARCO oil well tragedy, the Texas Legislature passed a law establishing H_2S regulations and charged the RRC with enforcing them. These regulations are outlined in RRC Rule 36. The RRC defines sour gas wells much more loosely than TCEQ: the well must produce gas with an H_2S concentration over 100 ppm[8] (four times higher than the concentration that the TCEQ considers sour and more than 100 time the limit the TCEQ sets for hydrogen sulfide in ambient air). As with TCEQ, the RRC regulates sites differently depending upon H_2S concentration and location. Each regulatory category and what concentration a well must produce in order to be sorted into that category is outlined by Rule 36 (next page). In order to know which regulatory categories different wells fall into, Rule 36 mandates testing of certain wells.



The RRC divides each district in its control into surface locations and formations, a geological description of the formation of shale the well is tapping.[9] These two pieces of information are presented together by the RRC and referred to simply as a field name. For instance, there is a surface location in the Permian Basin referred to by the RRC as "Phantom" and a shale formation referred to as "Wolfcamp". A well that is located in Phantom and tapping the Wolfcamp formation would have its field name listed as "Phantom (Wolfcamp)." This naming system has become more important with the rise in horizontal drilling where several wells, all located close together in one surface location, could each be tapping different formations and thus collecting gas with different properties. H_2S is unevenly distributed across these fields, so the RRC records average concentrations of H_2S in each field. Fields that are above 100 ppm are considered sour gas fields. If the field is beneath the concentration, it is considered a sweet gas field.

Concentrations in some sour gas fields are quite high. For example, in District 8 (which contains the Permian Basin) there are 24 fields with average concentrations of H_2S over 100,000 ppm, 1,000 times what the RRC considers to be sour gas and more than 100 times the rapidly lethal limit.[10]

Rather than requiring every well to test its gas to determine whether it is sour or sweet, the RRC only requires wells that are in sour gas fields to self test and report. If a well is located in a sour gas field, Rule 36 legally obligates the operator to self test the concentration of H_2S in the gas produced by the well and report the results to the RRC via an H9 form[11] along with an assurance of compliance with all other aspects of Rule 36.

These H9 forms are filed with lease numbers so that the RRC knows which specific well the form is tied to. Thus, if a well pad has multiple wells under one lease number, they only need to test one well in order to file their H9. Rule 36 dictates that H9s are non transferable, so if a well changes hands the new operator must refile the H9. Additionally, non-well oil and gas handlers are required to file H9s, so gas plants, waste water treatment and even pipeline/gathering systems all must file with the RRC.[12]

RRC's loose regulations allow unhealthy levels of H_2S.

MORE THAN 100 TIMES THE LETHAL LIMIT
In the Permian Basin there are 24 fields with average concentrations above 100,000 ppm, 100 times the rapidly lethal limit.

RRC's Rule 36 Compliance Requirements

Based on the self tested and self reported H_2S concentrations the operators list on the H9, combined with the presence of receptors near the operation (such as public roads or residences), sites are sorted into one of three "cases" of oversight. These cases are based on Radius of Exposure (R.O.E.). An R.O.E. is the distance from the well that H_2S can be detected at a certain concentration. A well with a higher H_2S concentration in its gas will have a larger R.O.E. Regulations on H_2S are determined by the size of the R.O.E. and what is contained within the R.O.E. (residences, public roads, etc).[13]

Through an unclear process, some RRC districts within the state have mandated more strict parameters than the statewide regulations. For example, RRC Districts 5 and 6 have stronger regulations than other districts; they require some of the higher tiered requirements, like respirators for workers, at sites with lower sour gas concentrations. H_2S is equally dangerous regardless of the district, so the regulatory differences do not appear to be tied to public safety or health.

Alarmingly, there is no H_2S concentration that causes RRC to deny a permit, even for wells with lethal concentrations in the R.O.E. Instead, RRC simply requires safety measures to decrease the danger of leaks, leaving open the possibility for equipment malfunctions that can result in significant health problems and even death. At sufficient concentrations, H_2S can be lethal in just seconds. When wells are permitted with H_2S concentrations that are hundreds of times the rapidly lethal concentration of 700 ppm, even a contingency plan or alert system would fail to protect people. *Thus, it is unlikely that the regulations outlined in Rule 36 would have been sufficient to avoid the ARCO oil well tragedy, even if they had been in place.*

The Case Number is based on the Radius of Exposure

Differing regulations based on Case Number (1-3) instead of on safety

R.O.E. is Radius of Exposure

The regulations don't appear to be based on safety or health because though H_2S is equally dangerous regardless of the district, they have different regulations.

RULE 36 COMPLIANCE REQUIREMENTS
DRILLING & PRODUCTION

PROVISION	CASE 1	CASE 2	CASE 3
H_2S Concentration Test	X	X	X
H-9	X	X	X
Training	X	X	X
District Office Notification	X	X	X
Drill Stem Tests Restricted	X*	X*	X
BOP Test	X*	X*	X
Materials		X	X
Warning and Marker		X	X
Security		X	X
Contingency Plan			X
Control and Equipment Safety			X
Monitors		X**	X**
Mud (ph Control or Scavenger)			X*
Wind Indicators		X**	X
Protective Breathing Equipment		X**	X
Choke Manifold, Secondary Remote Control, and Mud-Gas Separator			X
Flare Stacks			X*

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

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

CASE 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. Also if 100 ppm R.O.E. is 3000' or greater regardless of public area.

*Requirements in District 5 and 6 only.

**Requirements for Drilling or Workover operations, and gas plant only.

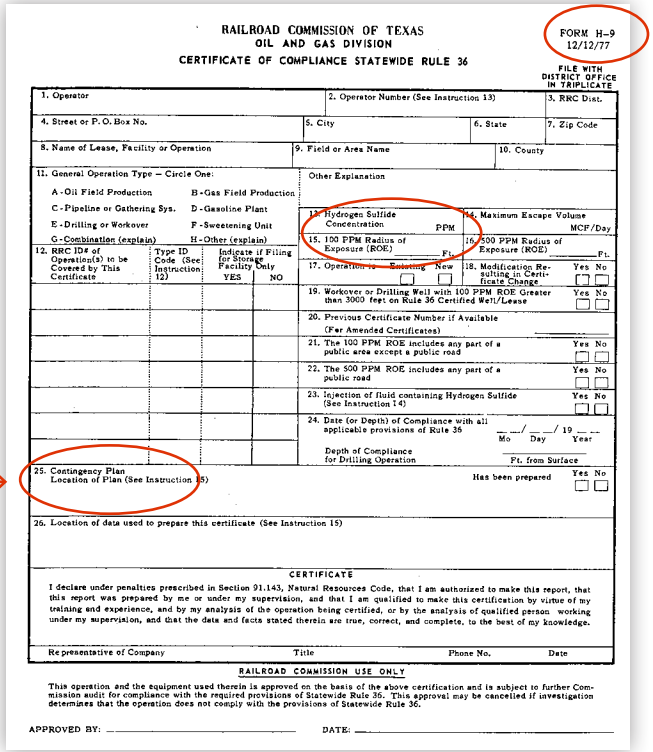
How RRC H_2S Oversight is Supposed to Work

1. The RRC has identified all sour gas fields in the state by determining if an oil and gas field has average H_2S concentration of 100 ppm[14] or greater.

2. RRC sends a letter notifying operators of their legal obligation to test their well for H_2S concentration to every operator applying for a permit to drill (W-1) within one of these sour gas fields.

3. Those test results — whether they exceed 100 ppm or not — are reported to the RRC along with a calculation of an R.O.E. (Radius of Exposure) via form H9 30 days prior to drilling, along with an affirmation that the well will follow Rule 36.

4. Based on the concentration and R.O.E. reported, the operator must agree to the regulatory requirements associated with each "case" (outlined in the form on the previous page).



RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION
CERTIFICATE OF COMPLIANCE STATEWIDE RULE 36

FORM H-9
12/12/77

FILE WITH DISTRICT OFFICE IN TRIPLICATE

1. Operator
2. Operator Number (See Instruction 13)
3. RRC Dist.
4. Street or P.O. Box No.
5. City
6. State
7. Zip Code
8. Name of Lease, Facility or Operation
9. Field or Area Name
10. County
11. General Operation Type – Circle One:
A - Oil Field Production
B - Gas Field Production
C - Pipeline or Gathering Sys.
D - Gasoline Plant
E - Drilling or Workover
F - Sweetening Unit
G - Combination (explain)
H - Other (explain)
Other Explanation
12. RRC ID# of Operation(s) to be Covered by This Certificate
Type ID Code (See Instruction 12)
Indicate if Filing for Storage Facility Only YES NO
13. Hydrogen Sulfide Concentration PPM
14. Maximum Escape Volume MCF/Day
15. 100 PPM Radius of Exposure (ROE) Ft.
16. 500 PPM Radius of Exposure (ROE) Ft.
17. Operation Is Existing New
18. Modification Resulting in Certificate Change Yes No
19. Workover or Drilling Well with 100 PPM ROE Greater than 3000 feet on Rule 36 Certified Well/Lease Yes No
20. Previous Certificate Number if Available (For Amended Certificates)
21. The 100 PPM ROE includes any part of a public area except a public road Yes No
22. The 500 PPM ROE includes any part of a public road Yes No
23. Injection of fluid containing Hydrogen Sulfide (See Instruction 14) Yes No
24. Date (or Depth) of Compliance with all applicable provisions of Rule 36 __ __/ __ __/ 19 __ (Mo Day Year)
Depth of Compliance for Drilling Operation Ft. from Surface
25. Contingency Plan Location of Plan (See Instruction 15) Has been prepared Yes No
26. Location of data used to prepare this certificate (See Instruction 15)

CERTIFICATE

I declare under penalties prescribed in Section 91.143, Natural Resources Code, that I am authorized to make this report, that this report was prepared by me or under my supervision, and that I am qualified to make this certification by virtue of my training and experience, and by my analysis of the operation being certified, or by the analysis of qualified person working under my supervision, and that the data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Representative of Company | Title | Phone No. | Date

RAILROAD COMMISSION USE ONLY

This operation and the equipment used therein is approved on the basis of the above certification and is subject to further Commission audit for compliance with the required provisions of Statewide Rule 36. This approval may be cancelled if investigation determines that the operation does not comply with the provisions of Statewide Rule 36.

APPROVED BY: _____ DATE: _____

When wells are permitted with H_2S concentrations that are hundreds of times the rapidly lethal concentration of 700 ppm, even a contingency plan or alert system would fail to protect people.

How RRC H_2S Oversight Actually Works (It Doesn't)

It is unclear — after talking with RRC staff, examining the Rule 36 regulations, and reading the RRC website — how the RRC ensures that operators file these H9s.

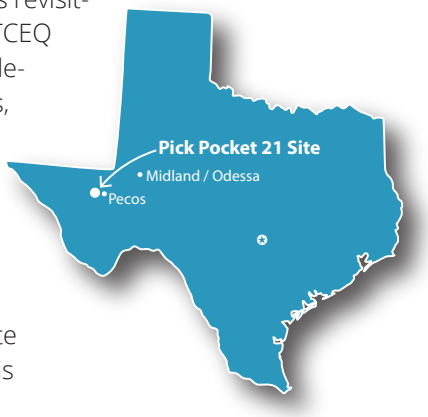
In order to see which operators were asked to file an H9 but had not, Earthworks filed a public information request for a list of all operators that had received an H9 request letter. However, the RRC's public information department responded that, **"After consulting with various staff members, the RRC does not generate a list of H-9 request letters that are sent to operators."[15] This indicates that the RRC has no system to make sure operators file required H9 forms**.

Further, based on conversations with the RRC field operations team, the RRC has dissolved the role of State Coordinator for Hydrogen Sulfide Compliance. This role was held for nearly thirty years by Sam Birdwell who coordinated hydrogen sulfide policy across the state. When he retired the role was not filled. Instead, increased responsibility was placed on the regional and district coordinators for hydrogen sulfide.

CASE STUDY: PICK POCKET 21

Since 2019, Earthworks has visited an MDC Texas Operator LLC site, Pick Pocket 21, seven times. Each time, Earthworks documented pollution and sent it to the TCEQ through a series of formal regulatory complaints. TCEQ failed to act until four separate complaints had been filed.[16] They investigated the site and made recommendations. Earthworks revisited the site after the deadline TCEQ set for the operator to implement those recommendations, and found that pollution continued. After a fifth complaint, Earthworks also contacted the RRC to ensure that the flaring on site was permitted.

The RRC reported that the site was missing an H9 for H_2S. This was odd given that, at the time of the complaint, the site had been permitted to drill for nearly three years in an identified sour gas field.[17] The site should have had an H9 when it was drilled; the RRC had issued a W-1 (drilling permit) and appeared in RRC's databases.



This lax oversight was not exclusive to Pick Pocket 21. In another case, Earthworks submitted a complaint on a site that was less than one mile from a residence and found that the operator had failed to submit an H9 and therefore was operating without proper sour gas precautions.

NO H9 PERMIT AND ONGOING POLLUTION

Earthworks visited the site seven times since 2019, each time detecting pollution with the OGI camera (photo at right).

How Many Sites are Operating Without the Required Forms?

Of the 19,701 well samples of District 8 just 9,695 had the required forms on file at the RRC. Nearly 51% of wells were missing the H9 forms.

Earthworks cross referenced the wells permitted in sour gas fields in District 8 that required H9s with wells that had actually filed H9s to determine if the RRC is systemically failing to ensure that operators file H9s and abide by poison gas health and safety practices.[18]

Initially, Earthworks attempted to determine which wells were in sour gas fields and thus required H9s by sending the RRC a public information request to gain access to all of the H9 letters RRC sent to operators (since these should be automatically generated when a well in a sour gas field applies for a W-1). Additionally, Earthworks requested a list of all H9s on file.

The RRC didn't track their request letters — and didn't track which companies were required to file the H9 hydrogen sulfide compliance forms.

While the RRC did provide a list of all of the H9s on file, they were unable to provide a list of H9 request letters that had been sent out. After Earthworks' initial inquiry, the RRC also published the entirety of their H9 records on the RRC website. Since the RRC was unable to provide a list of H9 request letters that had been sent to operators, Earthworks needed another method to determine which sites were required to file an H9. RRC provides on its website a list of sour gas fields within which wells are required to file H9s.

of **19,701** *wells*

51%

were missing the required permits

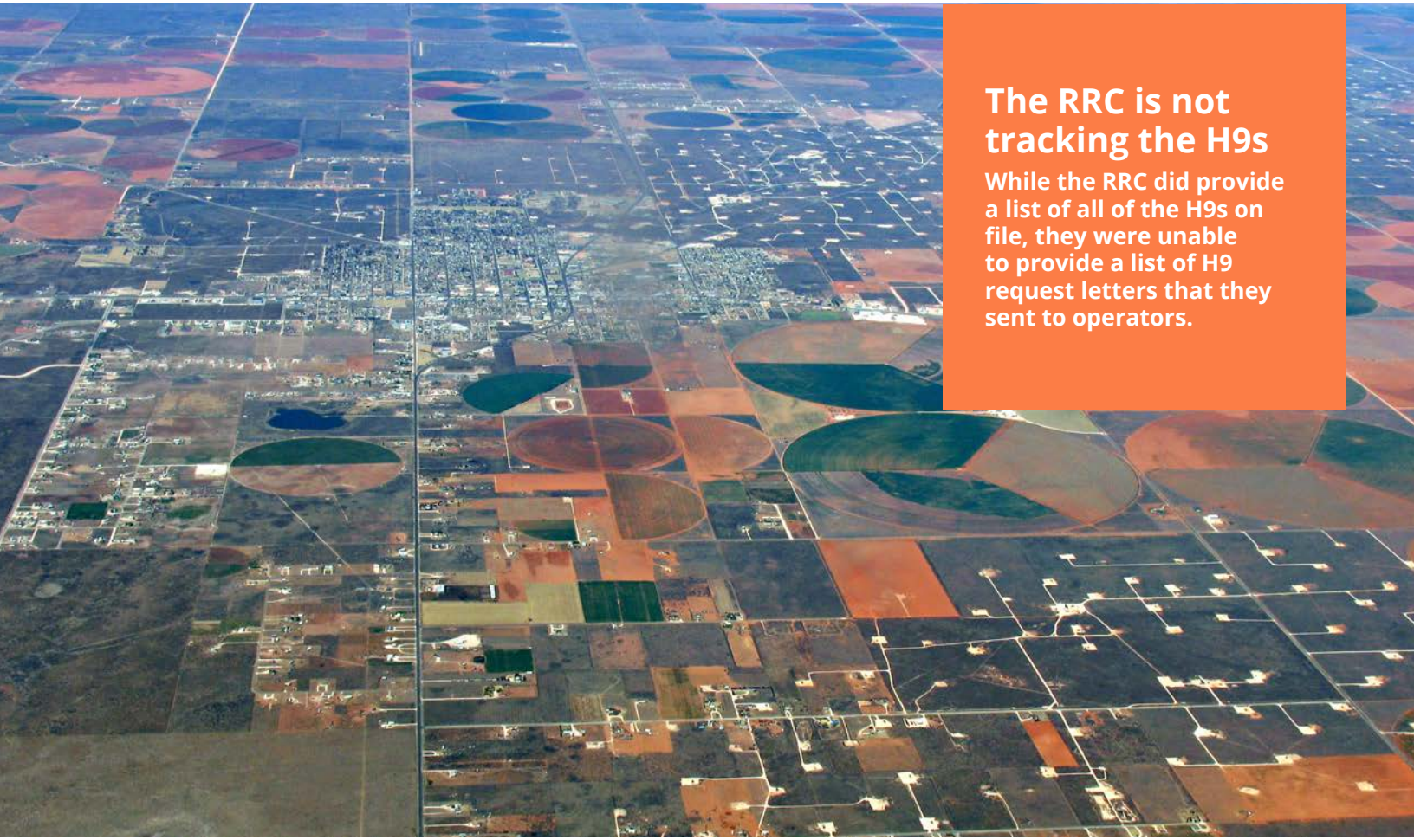
Earthworks sampled over 19,000 wells that required an H9 poison gas permit, only; just 9,695 had H9s forms on file at the RRC.

To determine which wells were in the sour gas fields outlined on the RRC website, Earthworks used the Enverus well[19] database for District 8. The Enverus well database is a third-party system that lists every well along with its field name and lease number. Enverus separates the surface location name from the formation, so Earthworks divided each sour gas field from the RRC website into its surface location name and formation name, then cross referenced both of those data points with the Enverus well data. The Enverus data unfortunately does not include formation information on every well, so any wells that did not have both formation and field name matches in the RRC sour gas field list were not evaluated.

This process yielded 75,546 wells in District 8 that are located in sour gas fields and thus required H9s. However, many of those wells shared lease numbers. Since H9s apply to every well on a lease, Earthwork removed duplicate leases which yielded a list of 19,701 leases that corresponded to wells that needed H9s.

Earthworks then cross referenced those lease numbers with the H9 database acquired via the above public information request.[20] ***Of the 19,701 well samples of District 8 that required an H9, just 9,695 had H9s on file at the RRC. Nearly 51% of wells were missing H9s.***

Aerial view near Midland, Texas. Photo by EcoFlight.



The RRC is not tracking the H9s

While the RRC did provide a list of all of the H9s on file, they were unable to provide a list of H9 request letters that they sent to operators.

The Consequences: Worker and Resident Risks

RRC's failure to require H9 forms and enforce sour gas regulation has created numerous risks to both residents and workers.

- **RRC is unaware of poison gas.** Such widespread failure to acquire H9s from operators has numerous consequences. Without H9s the RRC has no way of knowing which wells belong in stricter regulatory "cases" that would require precautions including contingency plans and alarm systems to protect the public. This is concerning because H_2S is incredibly dangerous. It can be lethal in relatively low concentrations and when burned produces other toxic chemicals. Every site that is over 100 ppm is supposed to require training for those working on site in order to ensure the safety of workers and the public,[21] but without H9s on file there is no way for the RRC to know which sites need training.

- **Impacted residents are unaware of poison gas.** Without H9s on file, sites that should have a sign notifying the public about the presence of H_2S may not do so. Earthworks has directly observed this problem. The Primexx Red Unit, where Earthworks has documented pollution multiple times, was found to be missing an H9. At the time, residents were living less than one mile away from the site. After long term exposure suffering from respiratory problems, the family living near the site was forced to move in order to protect their health. The residents were there before the well was ever drilled. Without notification to the public it is easy to see how a tragedy could occur.

The RRC's lack of oversight of H_2S is threatening workers and resident's health.

- **Poison gas is flared improperly.** H9 information is required when operators wish to flare on site. Operators that wish to flare must file a request for a Rule 32 exception (a flaring permit) from the RRC. That request form requires operators to provide H9 information[22] because when flared, sour gas releases sulfur dioxide (SO_2), which can be deadly.

  Of the nearly 10,000 sites missing H9s, about 1,950 had been granted flaring permits. Either those operators lied to the RRC by leaving the H_2S section of the flaring application blank, or were unaware that they were required to have an H9 in the permit. In both of these cases, the RRC fails to enforce the law.

  Whatever the cause, widespread failure by operators to file H9s makes flaring substantially harder to properly regulate and increases the risk that members of the public are exposed to H_2S — and fall ill as a result.

- **Workers are at risk.** If an operator doesn't file an H9, oil and gas workers are also at higher risk in the event of an H_2S gas release. H9 training requirements may not be implemented so workers may not take appropriate steps to resolve problems; or due to a lack of monitoring equipment, they may realize too late that the poisonous gas is releasing.

H_2S CONCENTRATIONS ARE ARTIFICIALLY LOW

H_2S Concentrations are Under Reported

Even among the operators that do file H9s, very few report sour gas concentrations high enough to be regulated. RRC District 8 has 49,031 H9s on file, based on Earthworks' initial public information request. Of those H9s, only 948 reported concentrations higher than 100 ppm. All 49,031 H9s were filed in fields where average concentration across the field is over 100 ppm. It begs credulity that oil wells drilled in 100 ppm+ average H_2S concentration sour gas fields are pulling above average concentration only 0.2% of the time (948÷49,031 = 0.0193).

Many fields have average H_2S concentrations higher than 100 ppm. H9 forms filed show most operators reporting lower than 100 ppm concentrations — indicating possible underreporting, one of the main risks of allowing companies to self report data.

Moreover, many fields have average concentrations much higher than 100 ppm. For instance, the field in District 8 with the highest concentration of sour gas is Sand Hills (Ellenburger) with 49 W-1s (drilling permits). Here, the average H_2S concentration in the field is over 236,000 ppm, yet only ten H9s were filed in the District; and only three of those H9s report concentrations of over 100 ppm. Only two wells report concentrations of over 500 ppm.

This information is consistent with an anonymous account given to Earthworks by a Primexx employee who stated that Primexx regularly under-reports sour gas in order to avoid regulation. Such action on a larger scale may explain the seemingly low number of H9s that show sour gas levels of over 100 ppm, especially since concentrations are self-reported.

Aerial view near Midland, Texas. Photo by EcoFlight.

The gas associated with many oil wells is treated as a nuisance to be flared whether it is sour or not. Operators are not paying to sweeten it for sale.

Health Impacts of Hydrogen Sulfide

Failure to effectively regulate H_2S makes frontline communities and oil field workers more critically unsafe. H_2S is particularly sinister due to a few characteristics that make it stand out from other air pollutants associated with oil and gas.

- **H_2S is lethal.** According to the Agency for Toxic Substances and Disease Registry (a subdivision of the Centers for Disease Control and Prevention), death can occur quickly.[23] When the ppm exceeds 700 it can kill someone in as little as a few breaths.

- **H_2S is a system asphyxiant.** This means that unlike simple asphyxiants which displace air from the lungs, H_2S interferes with the body's ability to use the oxygen that the lungs take in (that trait is shared by cyanide and carbon monoxide).[24]

- **H_2S attacks the nervous system.** Those who survive initial exposure may have permanent nerve damage.[25] Or they might suffer from the "slaughterhouse sledgehammer effect": surviving initial exposure only to fall unconscious and thus continue to breathe the gas, worsening exposure until death.[26] This phenomenon can occur so quickly that many workers on drilling operations refer to it as being "knocked down."[27] It is particularly dangerous for workers on site at oil and gas wells because they may be standing on catwalks or equipment, so when they lose consciousness, they fall off and die from complications related to the fall.[28] This effect is so severe that it often affects those who attempt to rescue the person initially exposed resulting in additional fatalities. The speed with which H_2S can become lethal, along with the slaughterhouse sledgehammer effect, nullifies many of the RRC's required sour gas safeguards. The time it takes for operators to enact the contingency plans that the RRC has in place can be the difference between life and death. Alarm systems presuppose that people have time to escape which is not always true.

H_2S is so potent a toxin that OSHA considers the permissible exposure limit to be just 20 ppm

—a fifth of the RRC's sour gas designation.

- **Death can occur at lower concentrations of H_2S.** The lower the concentration the longer the amount of time exposure can continue before it becomes fatal. However, even at lower concentrations, the time to lethal exposure is relatively short. According to the federal Occupational Safety and Health Administration (OSHA) prolonged exposure for as little 100 ppm for 48 hours can prove fatal.[29] At concentrations at and above 200 ppm, severe impacts are felt in just one hour and can result in pulmonary edema (wet lung). H_2S is so potent a toxin that OSHA considers the PEL (permissible exposure limit) to be just 20 ppm which is only a fifth of the RRC's sour gas designation.[30]

- **H_2S exposure results in multiple oil field worker deaths each year.** In fact, according to OSHA, hydrogen sulfide is one of the leading causes of workplace inhalation deaths.[31] Many of these deaths are from workers who do not appear to have been properly trained, accidentally exposing themselves. The RRC obligates operators to train workers on H_2S if they will be working at a sour gas well, but without H9s on file the RRC has no way to know which workers need training.

Partial List of H_2S Fatalities in Texas Over the Past Decade

Gregory Claxton
Died in 2015 from exposure to H_2S while opening a thief hatch on a tank for a test. The H_2S killed him so rapidly that his body was found standing up. The site was in a "sweet gas" field and thus did not have an H9 nor any sign warning of possible H_2S exposure. Despite an autopsy isolating H_2S as the cause of death, the RRC claimed the well produces only 2 ppm H_2S, far below a lethal concentration.[32]

Jacob and Natalee Dean
Jacob died in 2019 from exposure to H_2S due to an onsite release at the Aghorn Operating Waterflood Station. His wife, Natalee, concerned that he had not returned home, went to the site and also died from exposure to H_2S.[33] A subsequent OSHA investigation found that Aghorn Operating was not requiring employees to wear personal H_2S detectors. They also found that the onsite H_2S detectors were not functional. Moreover, they found that security onsite was insufficient which allowed Natalee access to the site. Depending on the concentration of H_2S on site, every one of those issues should have also been a Rule 36 compliance issue at the RRC.[34]

Employee of Enbridge G&P (name not public)
In 2010, four workers were exposed to H_2S from a boiler at an Enbridge G&P gas processing plant. One worker died and another was left in critical condition. An OSHA investigation resulted in seven violations including one for failing to provide respirators for workers.

Employee of Big Lake Gas Plant (name not public)
In 2018 an employee was replacing a pump at the Big Lake Gas Plant and was overcome by H_2S and died. OSHA found five different safety violations at the gas plant.[35]

Electrical engineer (name not public)
In 2015 an electrical engineer was killed while repairing electrical equipment on a tank battery. The engineer was overcome by H_2S causing him to lose consciousness. When he lost consciousness, he fell and landed on a pipe, resulting in a fatal head injury.[36]

Two employees of Cubic Water LLC (names not public)
In 2014, an employee was adjusting a pipe in the pump room at a Cubic Waste Water facility. The employee discovered a leak, so they left the pump room to inform the Water Utility. The employee then went back into the pumproom to attempt to fix the leak. They were overcome by H_2S. A second employee entered the pumproom to attempt to save the initial employee and was also overcome. Neither was able to exit and they both died.[37] Cubic Water does not have H9s for any of their facilities.

Employee of Bopco, LP (name not public)
In 2013 an employee climbed a tank in order to measure the water level in the tank. When he opened the tank hatch, he was overcome with H_2S. Exposure knocked him down and he fell 24 feet off the tank to his death.[38]

Employee of Hatchett Roustabout, Inc (name not public)
An employee was trying to close a valve in a pumpjack cellar at the Mts 611fasken Oil site. H_2S from the pipe overcame him and he died. Hatchett Roustabout was issued only $8,000 in fines for the incident from OSHA.[39] Hatchett Roustabout, Inc., is not listed as an operator in any of the RRC's databases (even in legacy information that would still show the operator if they no longer exist) nor does the site at which the employee died appear to have an H9.

Continued next page

Partial List of H_2S Fatalities in Texas Over the Past Decade — CONTINUED

Enbridge Pipeline Incident (name not public)

In January of 2010, at a facility for the Enbridge G&P pipeline, five employees were injured and a sixth died from H_2S exposure. The employees were working to relight a boiler on site. During the process they discovered that a valve had seized. Under direction from onsite management the employees removed the valve without proper precautions in order to start repairs. This caused the employees to be exposed to significant quantities of H_2S. All six were poisoned. Two were hospitalized and one of them died from exposure. OSHA found seven different violations at the site and levied a fine of nearly $200,000.[40] Enbridge has numerous H9s on file for different aspects of their pipeline infrastructure, but apparently the training mandated by RRC due to the site having substantial concentrations of H_2S was insufficient as even on-site management instructed employees to act in a dangerous manner.

Employee of Onyx Contractors (name not public)

In March of 2020, several employees of Onyx Contractors were working at the Stratco A. G. Hill well. Information on the incident is sparse since investigation from OSHA is ongoing.[41] A contractor was overcome by H_2S. A second contractor attempted to rescue the first. The first one survived but the prospective rescuer succumbed to H_2S exposure. OSHA's initial investigation found two safety violations. The site is in a sour gas field and thus should have been required to file an H9. The site was originally drilled in the 70s, and has changed hands multiple times. Only the original operator from the 1970s filed an H9. Since the H9s do not transfer with changes in ownership, the site has been in violation of Rule 36 for over a decade. Even now, 15 months after the initial incident, the site still does not have an H9 on file. Moreover, based on the W-1 that Stratco had on file it appears that they lied to the RRC about whether the site was in a sour gas field.[42] There is a box on the W-1 form that asks if the well is in a sour gas field. Stratco marked the answer to that as "no" despite giving a sour gas field name. Disconcertingly, the RRC noted that the site was in a sour gas field in their database, but still failed to obligate the operator to file an H9 or act on the fact that W-1 filed was inaccurate.

Risks to the Public

Beyond its toxicity, H_2S threatens workers and frontline communities (such as in the case of the ARCO well incident) due to three properties.

1. **H_2S is heavier than air.** When H_2S is released on site it does not rise into the atmosphere like other common oil and gas pollutants.[43] When it is released, clouds of it can stay close to the ground and travel long distances downwind, threatening frontline residents even if they are a considerable distance from the site. This phenomenon played a large part in the ARCO well tragedy.

2. **Relying on odor can be dangerous.** Despite its characteristic rotten egg odor, relying on smell to assess H_2S's danger can be fatal due to olfactory fatigue and olfactory paralysis. Prolonged exposure to H_2S even at low concentrations can cause olfactory fatigue (colloquially known as going nose blind), meaning the body loses the ability to detect H_2S.[44,45] Unlike other strong smells in which the odor becomes less perceivable over time as the body stops viewing it as novel, loss of smell due to H_2S occurs because the gas itself actively attacks the ability to smell. Additionally, there is a lack of expertise on this phenomenon among some frontline communities which can create dangerous situations in which a resident may believe that H_2S is dissipating when in fact they are experiencing olfactory fatigue. Even more dangerous is olfactory paralysis. At higher concentrations, H_2S can cause someone to lose their sense of smell instantaneously rather than fade over time as with olfactory fatigue.

   Loss of smell due to H_2S occurs because the gas itself actively attacks the ability to smell.

   The unreliability of a person's ability to smell H_2S is why employees of oil and gas companies are recommended to carry H_2S sensors by OSHA.[46] Due to this phenomenon and the risk that sites without H9s may not even have signs warning about H_2S, frontline residents may never realize they are exposed until they succumb to the symptoms of exposure.

   Lack of information for frontline communities is further complicated by the oil and gas industry's use of odorants. When gas is processed to be sent to end use consumers, an odorant is often added so that the otherwise odorless processed gas can be detected in homes in the event of a leak. Many odorants are sulfur based and thus smell similarly to sour gas.[47] Even if a resident doesn't succumb to olfactory fatigue or paralysis, they may not realize that the rotten gas smell is poisonous and more dangerous than normal ordorized methane (aka "natural") gas that fuels their stove, furnace, etc.

   Even lower, non-lethal H_2S concentrations can significantly harm health. Frontline communities near sour gas wells often report irritated eyes and lungs.[48] Eye irritation from sour gas exposure is so common around oil and gas production that it is referred to as "gas eye". Further, it can make breathing difficult and cause dizziness. **According to OSHA, sour gas can exacerbate asthma when exposed to concentrations as low as 2 ppm,[49] which is 50 times lower than the RRC's sour gas designation.**

3. **Even when H_2S is combusted before being released it still poses a threat to human health.** H_2S, when burned, breaks down into sulfur dioxide (SO_2) which is another toxic compound.[50] Just like H_2S, SO_2 is heavier than air and can travel long distances on the ground. According to the National Institute of Health:

> *Briefly, the major health effects of exposure to sulfur dioxide at less than 25 ppm (for various durations) are irritation of mucous membranes, throat, esophagus, and eyes; reflex cough; increase in respiratory rate associated with decrease in depth of respiration; decrease in nasal mucus flow; variable effects on tracheal and bronchial mucus flow; decrease in forced expiratory volume and flow; decrease in airway conductance; and increase in airway resistance.*[51]

According to the Canadian Centre for Occupational Health and Safety, sulfur dioxide is:

> *VERY TOXIC, can cause death. Can cause severe irritation of the nose and throat. At high concentrations: can cause life-threatening accumulation of fluid in the lungs (pulmonary edema). Symptoms may include coughing, shortness of breath, difficult breathing and tightness in the chest. A single exposure to a high concentration can cause a long-lasting condition like asthma. If this occurs, many things like other chemicals or cold temperatures can easily irritate the airways. Symptoms may include shortness of breath, tightness in the chest and wheezing. {Reactive Airways Dysfunction Syndrome (RADS)}.*[52]

SO_2 has health impacts at concentrations as low as 5 ppm. Due to this, the National Institute for Occupational Safety and Health (NIOSH), a part of the CDC, recommends that respirators are worn in any condition where someone may be exposed to SO_2.[53] SO_2 is generated in an equal number of molecules when combusted from H_2S. **Thus, a perfect combustion from a flare in which all H_2S is burned still produces SO_2 at a ppm that is approximately equivalent to the initial H_2S ppm. Given the life-threatening characteristics of SO_2, proper flaring of sour gas may not mitigate the danger of the gas.**

The risk of SO_2 from H_2S puts frontline communities in a difficult position, because any gas coming from a sour gas site — even gas from a lit flare that is operating properly — may pose a health risk to them and their family.

FLARING DOES NOT MAKE H_2S SAFE

After H_2S is combusted it breaks down into sulfur dioxide (SO_2), another toxic compound that has health impacts at low levels—another risk for neighboring families.

H_2S — CORROSION AND RUST

When exposed to water, H_2S forms a potent acid that can quickly eat away at certain types of metal.[54] Due to the prolific use of water in fracking and exposure to the elements, corrosion and rust associated with H_2S and the sulfuric acid it produces is a common risk at sour gas sites. In fact, H_2S along with CO_2 are two of the leading causes of corrosion in oil and gas equipment.[55]

That rust can cause numerous problems. Primarily it risks compromising the structural integrity of equipment, causing cracks or splits that result in leaks of sour gas and risk of exposure to the public. In addition to the increased risk of leaks from rusty equipment, rust also poses a direct danger to field workers. Rust absorbs oxygen from the air, thus in confined spaces (such as tanks) oxygen levels can be so low that workers may suffocate and die.

Further, equipment that is not properly protected from corrosion is in some cases used on abandoned and plugged wells. Over time the rust builds up and can compromise the plug or cause a collapse. This happened on rancher Ashley Watt's land. She has dozens of wells plugged and abandoned on her ranch, none of which appear to have an H9 despite being located in a sour gas field. In June of 2021, one of the plugs on a well failed. This resulted in contaminated water entering her water supply. The well, which was required to file an H9 but did not have one, was so corroded that the company responsible for it, Chevron, was unable to replug it. Currently, Chevron is attempting to determine what to do.

These rust problems from H_2S are avoidable. The RRC mandates that wells whose H9 shows an H_2S concentration above 100 ppm must use rust resistant materials. Operators who fail to provide an H9 then can skirt these regulations and use non-rust resistant materials.

"H_2S is highly corrosive and causes metals to thin or to become brittle...National Association of Corrosion Engineers (NACE) standard MR 0175 includes recommendations for selection of specific materials when H_2S is present. ...Metal fatigue, including hydrogen embrittlement, or sulfide stress cracking, can result in equipment failure, which can release H_2S gas, and lead to H_2S exposure and injury."

— Text and photo by OSHA.[58]

Recommendations

The systematic failure of operators to file H9s must be resolved

- **The RRC should begin tracking which operators need H9s based on the location of the well, when each operator is sent a request letter, and when the RRC receives the H9s.** It is unacceptable that this system is not already in place. If an H9 is not received from a well within 30 days of the request, the well's drilling permit should be revoked. In order to resolve the current backlog of missing H9s, every operator who has wells in a sour gas field across the state should be sent a new H9 request. Those who do not respond within 30 days and do not already have necessary H9s on file should have their P-5 revoked (the form that registers an operator with the RRC and allows them to continue to operate) and their wells severed so that they cannot bring oil or gas to market.

- **Severance is a more aggressive enforcement action than the RRC typically takes to resolve violations, but the RRC's current practices have clearly failed.** H_2S is so dangerous that it merits much more aggressive regulation in order to fix, and unlike flaring there is no emergency situation in which an operator could justify not filing an H9.

The RRC should require these additional procedures

- **The RRC should require operators to file an H9 for every site in the state, rather than just those operating in sour gas fields.** There are two reasons for this. First, if every site required an H9, it would make tracking H9s much easier because operators would not be able to hide behind the complications of whether the site needs an H9. Second, the determination of whether a field is sweet or sour is based on average concentrations in the field, therefore when a site is tested as part of an H9 the site despite being in a sweet gas field may in fact meet the definition of a sour gas well. Moreover, this practice may have potentially saved Gregory Claxton's life. He was exposed to a lethal concentration of sour gas at a well in a sweet gas field, presumably because that specific well was substantially above the average concentration for the field.

Apache Corp. Cheyenne Central Processing Facility.

- **All H9 tests should be conducted by a third party in order to ensure accurate results.** Current testing is self submitted. This allows operators leeway to manipulate or even falsify data.

- **All sites should be required to refile their H9 with updated test results every two years.** The TCEQ acknowledges that over time the concentration of H_2S produced by a well may change and is likely to increase. As such, the TCEQ recommends that operators test sites every two years. It does not make sense for the RRC to only require one initial test, because that test could quickly become inaccurate, resulting in unnecessary danger to workers and the public.

- **Sour gas site regulations should be strengthened to meet the health threats posed by H_2S, and made uniform across the state.** RRC districts should not have different requirements. There is no justifiable health explanation for why District 5 and 6 have stricter H_2S regulation than other districts. All of the other districts should be brought in line with those regulations. Further, the R.O.E. that result in operators being sorted into the three different categories need to be reevaluated. A warning marker and a contingency plan should be required at every sour gas site. A fourth category should be created, where no well can be drilled at a location if the R.O.E. for 100 ppm includes a public area. As outlined above, OSHA acknowledges that 100 ppm exposure to H_2S can be lethal even over a relatively short period of time. The public should not be put at risk by the mere presence of these wells, particularly since most H_2S regulation is focused on mitigating the fallout of accidents rather than actually preventing them.

- **TCEQ and RRC should use the same sour gas site definition as the Society of Petroleum Engineers.** The TCEQ defines a sour gas site to have a concentration of 24 ppm H_2S in 30 TAC Chapter 101.1 (96) and the RRC defines it to be 100 ppm. At a minimum both agencies should be using the TCEQ's definition. Neither of those is consistent with widely agreed on standards. The Society of Petroleum Engineers considers any gas with an H_2S concentration above 4 ppm to be sour.[56] Ideally, both the TCEQ and the RRC would move their standard for sour gas to be 4 ppm.

- **The RRC should mandate state wide adoption of American Petroleum Institute (API) Standard 21.** Standard 21 requires that oil and gas tanks be equipped with electronic measuring equipment and spigots for sampling so that measurements and samples do not need to be taken by opening up hatches on top of tanks and risking exposure. Adoption of this standard would decrease the threat to workers and neighbors from H_2S exposure and would help to avoid other deaths related to exposure to tank contents. It would also help to minimize emissions that occur during tank thieving.

- **The RRC should require that all materials used in the extraction and processing of oil and gas be compliant with NACE MR0175/ISO 15156.** Created by the National Association of Corrosion Engineers, this set of standards outlines what materials should be used in the production of oil and gas in order to prevent corrosion in the presence of H_2S. All production — regardless of whether it is in a sour or sweet field — should be expected by the RRC to follow these standards. Corrosion is the leading cause of equipment failure throughout oil and gas operations, so preventing corrosion both decreases equipment failure more broadly and helps protect workers and the public from potential sour gas exposure. Moreover, since testing of wells can't occur until some infrastructure is in place, requiring the infrastructure be corrosion resistant before the well is tested makes it less likely that sour wells use materials that easily corrode.

The RRC should declare an emergency and cease permitting of new wells

- **It is clear that the RRC cannot handle existing sour gas wells.** RRC's current oversight recklessly permits new wells even though they increase the sour gas health threat to communities' and workers' lives.

The RRC should reevaluate flaring at sour gas sites and disincentivize its use

- **The fact that even properly combusted flaring of sour gas results in toxic sulfur dioxide air pollution should force the RRC to more aggressively act to reduce flaring at sour gas sites**. A new standard should be established that sets a R.O.E. of 25 ppm for sulfur dioxide. If a site has a public road or residence in that R.O.E. the site should not under any circumstances be granted a Rule 32 exception. Doing this would largely stop flaring at sites where sulfur dioxide is a threat to the public without compromising the operation of the site, because Rule 32 has a separate provision that allows for emergency flaring. Further, the RRC should not allow any sour gas site to have a flaring permit approved administratively (where RRC bureaucrats approve the permit). Instead, flaring at sour gas sites should require a final order from the commissioners

Diamondback Energy Longfellow site in Reeves County, Texas. 2019.

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