RRC Report on Natural Gas Facility Weatherization Best Practices

Background

In response to Winter Storm Yuri the Texas Legislature passed Senate Bill 3 (SB 3). One section of SB 3 created the Texas Electricity Supply Chain Security and Mapping Committee comprised of executive leadership from the Public Utility Commission, the Railroad Commission, ERCOT, and the Texas Division of Emergency Management.

SB 3 directs the Committee to "establish best practices to prepare facilities that provide electric service and natural gas service in the electricity supply chain to maintain service in an extreme weather event and recommend oversight and compliance standards for those facilities."

The Texas Railroad Commission's portion of best practices are applicable to different segments of the natural gas supply chain which are 1) Oil and gas Producers, 2) Midstream gas gatherers and processors, 3) Mainline transmission companies, 4) Storage facilities, and 5) Local Distribution Companies.

This report seeks to offer best practices to enhance weather preparedness for the natural gas industry

Introduction

Natural gas production is broadly affected by several circumstances in a cold weather event. In addition to inadequate weatherization measures, loss of power, loss of telecom and inability to access facilities due to icy road conditions can lead to freeze-offs at natural gas facilities.

The natural gas industry depends on electric utilities to power the instrumentation, compression, pumps, and processing equipment that help move gas from the production fields to end users. The temporary loss of electric power can put a gas production, processing, compression, or storage facility out of service, and the resulting gas outages can then contribute to electricity shortages due to reduced fuel supply to gas fired electricity generating plants. Rolling electric blackouts or customer curtailments that can shut down electric pumping units or compressors on gathering lines may also result in prolonged gas production reduction.

Icy roads can prevent maintenance personnel and equipment from reaching wells to haul off produced water which, if left in holding tanks at the wellhead, can cause wells to shut down automatically. Icy roads can also cause an industry stop work order that prevents third party service personnel from driving on icy roads or inclement conditions. Stop work authority

conditions can limit third party service companies from installing, servicing, and maintaining equipment to implement best practices for winter weather conditions.

Keeping gas production facilities in service is critical to maintain an adequate supply of natural gas, while keeping electric-powered compressors running is equally important to maintain adequate pressure in gas transmission lines. Critical load review for gas production and transmission facilities should identify the appropriate priority for power delivery in the event of system stress or load shedding.

Operators of gas supply chain facilities and gas pipeline facilities under the Railroad Commission's jurisdiction are expected to take all necessary measures to prepare to operate in the upcoming winter. The Commission's highest priority is to ensure that should another extreme winter weather event occur, all available natural gas under the jurisdiction of the Commission in the state is available as a reliable energy source for Texans.

Known Risks

Natural gas services, like electric services, can be negatively impacted by extended extreme weather conditions. Extreme weather conditions can trigger temperature related negative direct effects, as well as negative indirect effects that stem from those circumstances directly related to the weather event. During a period of prolonged winter weather conditions, it is critical for the state's electric and natural gas infrastructure systems to function despite the negative effects associated with below freezing temperatures.

Direct effects include icy roads, freezing of products in flow lines and instrumentation, as well as freezing of physical equipment such as compressors, pumps, or separation equipment, along the pathway of natural gas production and transportation. Examples of how these direct effects can impact operations are below:

1. Icy Roads can create unsafe travel conditions for those trained personnel who maintain producing equipment in good working order or to restart an equipment when there is a power outage.
    a. When winter weather conditions remain in an area for an extended period industry field staff may be unable to travel safely on icy roads to well sites, pipelines, or compressor stations to supply and maintain the installed weatherization equipment.
2. Water disposal may be impeded by icy roads, an electrical outage, or inadequate weatherization measures. These circumstances could result in an operator shutting in a well or shutting down a gas treating facility. To maintain stable gas production an operator must, in many instances, be able to dispose of salt water produced from gas wells or dispose of produced water removed at a gas treating facility.
    a. Generally, produced water is temporarily stored in tanks at producing locations and then removed by pumping it through pipes to disposal facilities, or by trucking the produced water from the production site to a disposal facility. If roads are too icy for trucks to operate, and water cannot be moved in other ways when the temporary

on-site storage capacity is full, an operator must temporarily shut-in a well. If the water pumps pushing the water through flow lines are powered by electricity provided by utility companies, an interruption in electrical service can both temporarily cause the operator to shut in the well, and indirectly cause the water lines to freeze up once the water stops moving.

b. Water removal from gas processing facilities faces similar challenges in extreme weather conditions. Electrically powered water pumps experiencing power outages, can experience problems associated with lubrication oil becoming too viscous due to cold temperatures and non-flowing water in the flow lines freezing. Pump equipment at gas processing facilities often rely on power delivered from the electric grid. If electrical power is impaired and water is not removed, once temporary storage capacity reaches its limit, the operator must shut down a gas treating facility.
c. Saltwater disposal well (SWD) operators often require electricity to power injection pumps. If facilities lose electricity, they are unable to take the salt water, often impacting many producing operators and facilities.

3. Natural gas flows directly from the producing wellhead can experience “freeze-offs” when outside temperatures fall below freezing in producing fields. When water produced entrained with natural gas crystallizes or freezes in surface flow lines, it can block the gas flow and can force the shutdown down of a well. A freeze-off can also occur with mechanical separation equipment at producing locations. Liquid dump valves used on separation equipment can become ineffective when outside temperatures fall below freezing unless the equipment is wrapped and warmed by an independent heat source. When separation equipment malfunctions, oil, gas, and water are not separated properly. An operator must shut-in a well until separation equipment can be restarted.
4. Instrumentation plays a large role in the safe and effective operation of production facilities, compressor stations, and gas processing. Instrumentation is included in an information loop that controls a process. Instruments often relay their information, such as pressure, flow rates, temperatures, or RPMs, to a central processor or directly to a controller via pressurized air lines. Any moisture in these air lines can easily freeze when outside temperatures fall below freezing. Although the volumes of moisture are quite small, the impact on an instrument’s communication with its control device can often require an operator to shut down producing equipment, compressors, or gas processing facilities until a service technician can troubleshoot the blocked air lines.

Indirect effects can happen when electric power demands are shed from segments of the power grid. The loss of electricity can cause critical natural gas production equipment such as compressors, pumps, or separation equipment to experience a temporary interruption beyond the control of the gas producer, transportation company, or treating plant operator. If natural gas producing equipment lacks adequate electric supply, equipment cannot reliably deliver available gas, including gas needed to generate additional electricity. Rolling electricity blackouts or customer curtailments managed by utility companies can inadvertently cause

disruptions in natural gas production. Modern electrically powered equipment at producing facilities, compressors, or processing facilities can be subject to electrical power disruptions during winter storms, which can limit the supply of natural gas to electrical power generating facilities. The interconnected natural gas and electrical power generation facilities are the first link of the supply chain in the state's critical infrastructure during an extreme weather event.

Best Practices

Identifying best practices relies on analysis of the following criteria: effectiveness, efficiency, relevance, sustainability, and the possibility of duplication. Implementing best practices depends on the specific geography and geology of individual well sites. Each operator is expected to take all necessary measures to prepare to operate in extreme weather conditions, given the unique circumstances of their well locations. To ensure upstream and midstream value chain segments operate during extreme weather conditions, the Commission's Oil and Gas Division and Oversight and Safety Division, through experience and research, identified the following best practices for weatherization:

- Submit appropriate critical load designation application forms for the winter season
- Draining all tank battery fluids prior to extreme weather event
- Back up power (3 day minimum)
- Heat trace and insulation
- Instrument filters
- Methanol injection or drip
- Water removal by solids absorption
- Cold weather barriers
- Line heaters
- Glycol contact towers
- Drip pots
- Hot lubricant and circulation heater for engine oil or fuel
- Human Capital (Emergency Response Plan)

This list is not all encompassing, but rather is informative of the practices that exist across the oil and gas industry. Other techniques such as installing instrument covers or heat tracing equipment for critical valves and regulators should be considered as additional preventative measures. Removing sludge and buildup from production and flow lines at a well site or a storage facility will also allow gas to flow unimpeded by frozen water molecules, should be done regularly as preventative maintenance. Keeping additional parts onsite can shorten the down cycle if repairs or replacement are necessary during extreme weather conditions.

The Commission will continue to identify best practices as we survey industry experts and other regulators and leverage contracted technical advisory services.

Submit appropriate critical load designation forms for the winter season

The Electric Reliability Council of Texas (ERCOT) provides an application through which a natural gas operator may request its facility be designated as a "Critical Load Serving Natural Gas-Fired Electric Generation." This designation is an important component of extreme weather preparedness. Forms must be filed with the local electric service provider. In 2021, the form needed to be filed no later than November 1, 2021 to allow electric service providers time to complete their winter extreme weather planning. To allow for summer extreme weather planning, the form is generally due in March of each year.

The Railroad Commission sent several notices to operators in 2021 to review the ERCOT application and file, as appropriate, with the local electric service provider(s).

The Railroad Commission new rules adopted on November 30, 2021 specify the criteria and process by which entities associated with providing natural gas in Texas are designated as critical customers or critical gas suppliers during an energy emergency. Upon final approval of the new rules found in 16 TAC §3.65, §3.107, an operator shall submit a bi-annual acknowledgement of its designation as a critical customer in accordance with the new rule.

Drain tank battery prior to weather event

All oil and gas producers, midstream gatherers and pipeline transmission operators should place best efforts to reduce tank levels to increase uptime prior to extreme weather event.

Backup Power

Back up battery power for a minimum of 3 consecutive operating days should be considered in initial basis of design. Design can be wind turbine, on site power generation and on-site battery power.

Heat Trace and insulation

Inlet slug catchers, production separator water dumps, compressor unit dumps, fuel gas dumps should be considered for heat trace and insulation to prevent freeze off.

Instrument filters

Instrument filters are a critical part of natural gas producing systems and should be installed, maintained, and verified to be in good working order, especially during winter weather. If the water in an air system leading to a control panel freezes it could send a false reading with the

potential to cause associated problems, including shutting in equipment. Control of the producing system can often be maintained remotely, even if personnel are unable to reach a facility, if the control panels are receiving high quality responses from their various sensors. Instrument filters generally only clean small volumes of gas or air, and as such tend to work reliably well. They are often installed with redundancy so a filter can be used, shut off and diverted to another filter to allow the filter or desiccant inside the filter to be replaced. A maintenance program is critical for the continuous proper function of inline filters. Filter dryers provide a clean, dry supply of gas to controllers and other instrumentation that functions using instrument gas. Units function under high pressure and can eliminate both liquids and particulates. Filter dryers are in-line devices that hold either a shaped filter made from a material that will collect both fluids—oils and water—as well as solid particles of known sizes, or a dry material bed that acts as a desiccant for collecting moisture and filtering out solids. In-line ensure that control panels receive unimpeded signals from sensors at the well, along the flowlines, or at processing facilities. Proper signals at the control panels ensures that an operator can monitor and manage all equipment regardless of the weather.

Methanol injection or drip

Methanol injection is a well-documented, practical method to reduce the negative impact that hydrates can have on gas flow. Injecting methanol into gas flow streams can lower the freeze point of hydrates, which will effectively inhibit the formation of ice like structures in the flow stream. Hydrates are physical combinations of water and other small molecules found in natural gas that can produce a solid that has an appearance similar to ice. At low ambient temperatures, hydrates can develop a structure able to block normal gas flow in lines and orifices. Liquid methanol can be cost effective to prevent the accumulation of these ice-like structures when injected in a low-pressure point in the gas flow stream. The amount of methanol required to inhibit hydrates is directly related to the amount of water that is found in the gas stream. Methanol injection can replace the need for upstream glycol dehydration in some gas streams, and allow gas to flow until it arrives at a processing facility where the remaining water is removed and gas is conditioned the to meet pipeline specifications. Methanol can also be used in gas reinjection systems installed to assist with gas lift for high-volume liquid (oil and water) horizontal wells.

Water removal by solids absorption

In a vapor state all gasses have the capacity to hold water, with drier gas devoid of water molecules that can freeze in low temperatures. Under properly managed conditions, a solid absorption system can reliably work in any weather condition to absorb water as natural gas passes through dry chemical beds. Water removal by solids absorption (desiccant bed) methods can achieve a very dry natural gas stream under certain conditions. On a producing location at the well pad, wet gas is directed into an inlet separator to ensure removal of contaminants and

free water from the original gas stream. After the separator, the gas stream is directed into an adsorption tower where water is adsorbed—the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface—by the desiccant. When the adsorption tower approaches maximum loading, the gas stream is automatically switched to another tower allowing the desiccant in the first tower to be regenerated. This method usually requires at least two desiccant towers to ensure that a tower is always full of a dry desiccant, rather than a water saturated desiccant. When the equipment is designed and installed properly, and the desiccants are systematically replenished, the removal of water by mechanical and solids absorption is an effective method for creating a dry steam of natural gas with little potential to freeze downstream of the separators. Care must be taken to analyze the amount of water remaining in the gas stream after leaving the separator.

Cold weather barriers

In extreme weather environments locating critical equipment underground or inside heated buildings is required for much of the year and provides necessary safeguards for points along the path of natural gas flow. Cold weather barriers, although effective, are generally not temporary or short-term solutions, and are not as prevalent in all climates. Cold weather barriers, such as wind walls, may be installed around certain compressors to block cold winds which could exacerbate freezing conditions. Wrapping and insulating surface equipment, injection lines, supply valves, water lines, and other equipment may also help to prevent freezing and stoppage of both natural gas and produced water flow. The methods for installing weather barriers and insulating natural gas equipment from cold air temperatures are diverse. Burying flow lines is an effective method to control flowline temperatures. Insulated wrapping can be effective for some equipment, while forced air heating inside buildings as well as small pumps to circulate compressor lubricants can maintain equipment temperatures above the freezing point. Cold weather barriers need to be systematically reviewed, designed, and implemented based on weather conditions that are known to exist at a specific natural gas facility.

Line heaters

Line heaters are a common form of equipment in the production of natural gas and a best practice for some geographic areas, specifically for gas wells that are being choked back at the wellhead, often earlier in a well's producing life. Line heaters heat the gas to avoid freezing immediately downstream of the wellhead. They are commonly used in wells that flow predominantly gas and small amounts of water, with no appreciable oil. The equipment uses a gas fired flame to heat a fluid filled chamber inside the body of the line heater. Gas passes through a coil that is immersed in a chamber of warmed fluid, which increases the temperature of the natural gas as it passes. Line heaters can be sized for high or low pressured wells that pass natural gas through a wellhead choke, which can cool gas to the point of freezing—a Joule-

Thompson effect that functions much the same as a conventional refrigeration system. This type of cooling can create an ice formation, particularly when ambient temperatures around the choke are at or below freezing. Line heaters, when sized appropriately for the volume of gas being produced, effectively heat gas in the vicinity of the wellhead before it reaches downstream separation or treating equipment. Downstream of a line heater the potential still exists for freezing with low ambient temperatures, but a line heater can effectively mitigate freezing at the first potential point of freezing off the wellhead.

Glycol contact towers

Glycol units are an accepted industry standard practice and are effective at removing water from a stream of natural gas typically to meet typical pipeline and process specifications. Dry gas that leaves a glycol unit has little propensity to freeze. Relatively low-cost glycol absorption towers can be installed quickly, with a single skid able to service more than one well. This allows a range of options and flexibility to configure systems to address a broad range of gas flow rates and water volumes. While operational costs are generally proportional to the flowing natural gas volumes, such systems can vent releases of both steam and a measurable quantity of hydrocarbon gases. Used as a liquid desiccant, glycol can be introduced through a series of trays, or stages within a unit placed downstream of the wellhead before gas enters a commercial pipeline. Wet gas enters at the bottom of an absorber tower and ascends through a mist extractor where water is removed. As the gas rises through the tower's packing or bubble cap trays water is absorbed by the descending lean glycol, which is continually pumped to the top of the tower. Drier gas exits the top of the tower and passes through a heat exchanger to the gas outlet. The removal of water by glycol is an effective method for creating dry natural gas with little potential to freeze downstream of the separators.

Drip pots

Drip pots are a best practice for most producing systems that can be incorporated along with other winterization practices. Drip pots and coalescers can eliminate or reduce the amount of water when there is a slug of liquid in a gas supply used for instrumentation, or other severe liquid issues. Drip pots come in many shapes that are made primarily from the same materials as the flowlines carrying natural gas. They are located immediately after pressure changes, abrupt increases in flow area, or the lowest elevations in a continuous producing system. Drip pots work by allowing gravity to separate water from gas where the temperature of gas decreases following a significant pressure change. The cooling effect of a notable pressure change can cause liquids to fall out of the gas stream into the drip pot. The natural effects of gravity can cause water to drop from gas at low spots in a flow line. These low spots in flow lines can be an ideal place to locate a drip pot where water is likely to collect. A manual valve or collection system can pull water from the gas stream; a collection system on a timer with servo controls can also automatically dump accumulated water. Drip pots primarily remove larger

volumes of water that collect in flow lines, which can cause a hydraulic impedance increasing the pressure drop along a flowline. Drip pots do not generally dry gas or winterize a producing system, but they can reduce the amount of water that reaches downstream natural gas separation or treating facilities. The removal of water will reduce the potential for freezing at points along the gas producing system.

Hot lubricant and circulation heater for engine oil or fuel

Large pieces of oil and gas field equipment, such as pumps or compressors, rely on lubricants to move under pressure, as they are designed to reduce metal on metal contact. Lubricants keep these large pieces of equipment from overheating using fluids that are much more viscous than standard engine oils. When equipment is running lubricant is warmed by the mechanical action of the moving parts. At operating temperatures apparent viscosity can be relatively low, but when ambient temperatures drop to near freezing, viscosity can increase causing lubricants to begin to appear as a solid. When machinery is shut down the lubricant temperature can drop increasing its viscosity. At freezing temperatures pumps designed to circulate lubricant have difficulty functioning. Installing external block heaters with an external energy source such as a gas fed flame or electricity can maintain lubricants at an appropriate temperature, even when the equipment is not operational, making it easier to restart the equipment by keeping the oil/fuel in the engine at an elevated temperature. Using these techniques can keep pumps and compressors functional and prevent freeze-offs.

Human Capital (Emergency Response Plan)

While weather specific technologies, including those discussed above, are critical to sustain natural gas production during cold weather conditions, the maintenance and operation of these technologies begins with human capital—the people trained and able to ensure natural gas continues to serve its essential function in the electricity supply chain despite adverse conditions. Human capital and experience of employees, along with appropriate safety and technical training specific to extreme weather events is an essential component of reliability and resiliency planning. Increasing staffing levels in advance of an extreme weather event ensures that appropriately trained employees are readily available, if they're not pre-positioned on-site, to resolve any equipment or instrumentation failures should temperatures fall below an acceptable operating temperature for sensitive equipment or instruments.

Conclusions

For new installations, careful planning during the design stage for measurement and regulating systems can reduce the chances of freezing. Any steps that reduce restrictions or prevent areas where liquids can collect will minimize the possibility of freezing. For existing installations, the best practices detailed above, along with any other practices not detailed in this report, should be implemented, as appropriate to the site-specific geography and geology, to prepare facilities providing natural gas critical to the electricity supply chain to maintain service in an extreme weather event.