



August 23, 2019

U.S. Department of Energy
Attention: Office of Electricity
Guidance for Enhancing Oil and Natural Gas Resilience
1000 Independence Avenue, SW
Washington, DC 20585-0121

Re: Codes, Standards, Specifications, and Other Guidance for Enhancing the Resilience of
Oil and Natural Gas Infrastructure Systems Against Severe Weather Events

U.S. Department of Energy,

Pursuant to the Notice of Request for Information (“RFI”) issued by the U.S. Department of Energy (“DOE”), Office of Electricity and published in the Federal Register on July 9, 2019,¹ the Natural Gas Council² respectfully submits these comments. The RFI seeks public input on relevant consensus-based codes, specifications, standards and less formal forms of guidance for improving the resilience of oil and natural gas infrastructure against cyber and physical threats as well as severe weather events.³ The Natural Gas Council appreciates the opportunity to provide DOE with feedback on the RFI.

Over the past few years, the Natural Gas Council has produced various reports regarding the reliability and resiliency of the natural gas system. Specifically, the reports analyze the natural gas system’s performance during severe weather events and highlight effective practices

¹ *Codes, Standards, Specifications, and Other Guidance for Enhancing the Resilience of Oil and Natural Gas Infrastructure Systems Against Severe Weather Events*, 84 Fed. Reg. 32731 (July 9, 2019).

² The Natural Gas Council was formed in 1992, uniting all sectors of the natural gas industry to work together toward common goals. The five full members of the Natural Gas Council - the American Gas Association, the American Petroleum Institute, the Interstate Natural Gas Association of America, the Independent Petroleum Association of America, and the Natural Gas Supply Association - collectively represent nearly all the companies that produce, transport and distribute natural gas consumed in the United States. www.naturalgascouncil.org.

³ RFI at p. 32731.

operators use to protect against physical and cyber events on oil and natural gas infrastructure. Below is a brief summary of the reports.

The July 2017 report, “Natural Gas Systems: Reliable and Resilient”⁴ provides a practical guide to the operational measures, physical characteristics, and contractual underpinnings of the natural gas system’s exceptional record of reliability and resilience. Notably, the July 2017 report determined that the gas pipeline industry was 99.79 percent reliable in fulfilling its firm contract obligations at primary delivery points, *i.e.*, the contractually specified delivery points, over the ten years leading to and including 2016.

The August 2018 report, “Weather Resilience in the Natural Gas Industry: The 2017-2018 Test and Results,”⁵ is a detailed examination of the natural gas industry’s performance through a series of significant weather events, including Hurricane Harvey, Hurricane Irma, and the “Bomb cyclone.” The study was compiled from a review of press accounts, regional transmission operators’ reports, government reports, and detailed interviews with affected companies.

The October 2018 report, “Defense-in-Depth: Cybersecurity in the Natural Gas and Oil Industry,”⁶ provides insight into the comprehensive cybersecurity programs for the natural gas and oil industries. The October 2018 report discusses the value of risk management-based frameworks and public-private collaboration to bolster the cybersecurity of the natural gas and oil industries and the associated critical infrastructure. It also explains the value of affording industry the flexibility to respond to a constantly-changing threat landscape.

Most recently, the April 2019 report entitled, “Natural Gas: Reliable and Resilient,”⁷ outlines natural gas transportation, related regulatory authorities, and the contracting procedures necessary for customers to receive their required level of service. The April 2019 report demonstrates that the operational characteristics of the natural gas transportation network, in combination with the physical properties of natural gas, effectively minimize the likelihood and severity of service disruptions.

The Natural Gas Council is committed to ensuring the safety and reliability of the natural gas system. Accordingly, the Natural Gas Council urges DOE to utilize these reports when considering how best to enhance the resilience of the oil and natural gas systems cost-effectively.


⁴ Natural Gas Council, *Natural Gas Systems: Reliable & Resilient* (July 2017), available at: <http://martelli.us/ngcouncil/wp-content/uploads/2018/03/Report-Natural-Gas-Systems-Reliable-Resilient.pdf>. Appended at Attachment A.

⁵ Natural Gas Council, prepared by RBN Energy, LLC, *Weather Resilience in the Natural Gas Industry: the 2017-18 Test and Results* (Aug. 2018), available at: <http://naturalgascouncil.org/weather-resilience-in-the-natural-gas-industry/>. Appended at Attachment B.

⁶ Natural Gas Council and Oil and Natural Gas Sector Coordinating Council, *Defense-In-Depth: Cybersecurity in the Natural Gas & Oil Industry* (Oct. 2018) available at: <http://naturalgascouncil.org/wp-content/uploads/2018/10/Defense-in-Depth-Cybersecurity-in-the-Natural-Gas-and-Oil-Industry.pdf>. Appended at Attachment C.

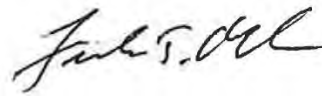
⁷ Natural Gas Council, *Natural Gas: Reliable and Resilient* (April 2019) available at: <http://naturalgascouncil.org/wp-content/uploads/2019/04/Natural-Gas-Reliable-and-Resilient.pdf>. Appended at Attachment D.

Sincerely,



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Enclosures

ATTACHMENTS

ATTACHMENT A

Natural Gas Systems: Reliable & Resilient



Natural Gas Systems: Reliable & Resilient



July 2017

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Preamble

Our trade associations, who together comprise the Natural Gas Council and represent the natural gas delivery system from production to consumption, originally researched and developed this white paper to inform a North American Electric Reliability Corporation (NERC) special assessment on any potential risks to bulk power system reliability from a single point of disruption on major natural gas infrastructure facilities (e.g., storage facilities, key pipeline segments, LNG terminals). The facts and data we gathered in the process of preparing information for NERC underscored the exceptional reliability of the natural gas system. It also revealed the need for a comprehensive resource that explains the underpinnings of natural gas reliability, both physical and contractual. The white paper that follows is the result of our joint effort.

The Natural Gas Council

Members:

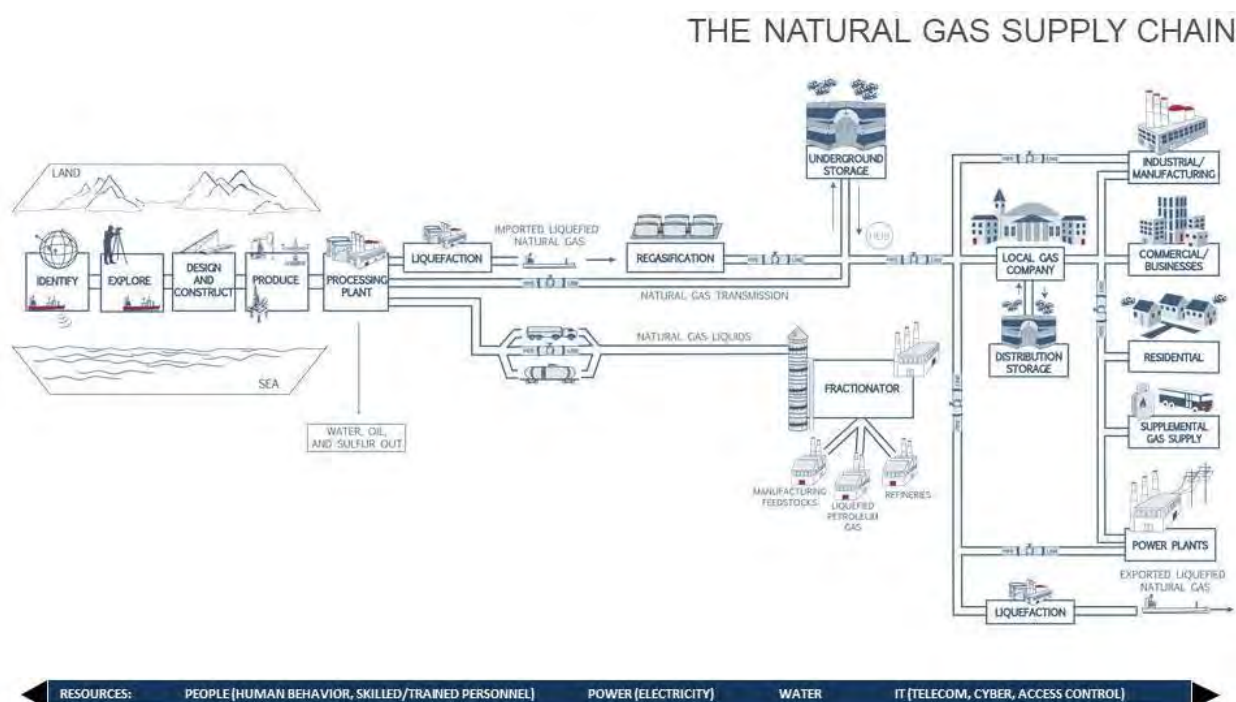
- American Gas Association
- American Petroleum Institute
- Interstate Natural Gas Association of America
- Independent Petroleum Association of America
- Natural Gas Supply Association

July 2017

1. Introduction

The United States has abundant natural gas resources that enable our industry to satisfy customer demand fully. In only a few years' time, the U.S. has become the largest producer of natural gas in the world. Estimates of the gas resource base have more than doubled in the past decade.¹ Since 2010, production has grown almost 30 percent, with government forecasts calling for production to once again reach the record of near 75 billion cubic feet per day this year.² The natural gas supply chain is extensive and spans from the production well-head to the consumer burner-tip (see illustration).

Critical Elements of the Natural Gas Supply Chain



Source: The American Petroleum Industry, Oil and Natural Gas Industry Preparedness Handbook, 2016.

¹ See Potential Gas Committee *Biennial Report of Potential Supply of Natural Gas in the United States*, (December 31, 2014), 2015, available [here](#).

² See EIA *Short Term Energy Outlook*, May 2017 available [here](#) and EIA Natural Gas Summary | Custom Table Builder, available [here](#).

Consumer natural gas demand has grown steadily since 2009 for a variety of reasons: it is abundant, domestic, burns clean and is affordable. Access to abundant, domestic natural gas has given U.S. industrial companies a competitive advantage over their global competition, leading to the resurgence of gas-intensive manufacturing in the U.S. and the creation of more jobs to construct and fill the resulting new and expanded industrial facilities.

At the same time, demand from the power sector has also increased, driven by natural gas's low-carbon emissions, retirements of older coal-fired plants, and the comparatively low cost and small footprint of natural gas-fired power plants.³ In recent years, greater use of natural gas has produced significant reductions in U.S. carbon emissions because, over its lifecycle, natural gas emits only about half the carbon of other fossil fuels when combusted.⁴ Because of these advantages, natural gas is poised to become an even more important part of states' energy portfolios as they seek to meet state clean energy objectives.

Yet, with the forecasted growth in power demand, some – particularly those unfamiliar with natural gas operations and contractual practices – question the ability of natural gas to continue to reliably serve this market. In this paper, we explain how the physical characteristics of natural gas, as well as operational industry practices, provide an extremely high level of reliability and resiliency for gas customers. This paper also explains that while the natural gas industry is physically reliable, if large-volume customers require uninterrupted service, they must choose to enter into advance contractual arrangements for “firm transportation” services that ensure pipeline capacity is available when needed to allow the customer to benefit from this

³ See Leidos (formerly SAIC), *Comparison of Fuels for Power Generation*, 2016, available [here](#).

⁴ See National Renewable Energy Laboratory, “*Harmonization of Initial Estimates of Shale Gas Lifecycle Greenhouse Gas Emissions for Electric Power Generation*,” Proceedings of National Academy of Sciences, July 2014, available [here](#).

reliability. This is how a gas-fired generator (or any pipeline system customer) can achieve continuity of service if that is required.

2. Historic Reliability of Natural Gas Network – Due to Operational Characteristics

The physical operations of natural gas production, transmission and distribution make the system inherently reliable and resilient. Disruptions to natural gas service are rare. When they do happen, a disruption of the system does not necessarily result in an interruption of scheduled deliveries of natural gas supply because the natural gas system has many ways of offsetting the impact of disruptions. As noted in a report from MIT:⁵

The natural gas network has few single points of failure that can lead to a system-wide propagating failure. There are a large number of wells, storage is relatively widespread, the transmission system can continue to operate at high pressure even with the failure of half of the compressors, and the distribution network can run unattended and without power. This is in contrast to the electricity grid, which has, by comparison, few generating points, requires oversight to balance load and demand on a tight timescale, and has a transmission and distribution network that is vulnerable to single point, cascading failures.

The inherent characteristics of natural gas are an important factor that cannot be overlooked. Unlike electricity that travels at the speed of light and flows along a path of least resistance, natural gas moves by pressure. The gas moves through a transportation system with the use of compressors that pressurize the gas to move it over distance. For long distances, compressors are placed at regular intervals to continue the forward movement. In sharp contrast to electricity, natural gas physically moves slowly through a pipeline at an average speed of 15-20 miles per hour, and its flow can be controlled. This allows time for pipeline operators to

⁵ Massachusetts Institute of Technology, Lincoln Laboratory, “Interdependence of the Electricity Generation System and the Natural Gas System and Implications for Energy Security,” May 15, 2013.

manage the flow of natural gas and to adjust their operations in the unlikely event of a disruption. Because of the pipeline operators' ability to manage natural gas on their transportation systems, a failure at a single point on the system typically has only a localized effect.⁶

In addition, natural gas production comes from diverse geographic supply areas spread across many U.S. states and Canada. This abundant and stable supply is coupled with a vast number of production wells dispersed over a wide geographic area that contributes to ensuring that overall natural gas production is rarely impacted by isolated local or regional events. In the U.S. today, there are more than a half million producing gas wells⁷ spread across 30 states.⁸ There are hundreds of natural gas producers, and even the largest U.S. producer contributes less than 5 percent to total domestic supply.⁹ In addition, this diversified supply is connected to an extensive pipeline network.

Another valuable and somewhat unique characteristic of natural gas is its ability to be stored after production. Natural gas is most commonly stored underground in depleted aquifers and oil and gas fields, as well as in salt caverns. It can also be stored above ground in storage tanks as liquefied natural gas ("LNG") for use at import and export facilities and at peak shaving plants, or as compressed natural gas ("CNG") for industrial and commercial uses. In addition to the importance of storage as a supply cushion, it provides vital operational flexibility in the event of constraints in the pipeline and distribution network, as storage facilities are widely dispersed on those networks.

⁶ More detail about the physical, operational characteristics of the natural industry segments can be found in the Appendices to the 2011 Southwest Cold Weather Event report prepared by the staffs of FERC and NERC. Report on Outages and Curtailments During Southwest Cold Weather Event of February 1-5, 2011 (August 2011), Appendices 8-10 ("Southwest Cold Weather Report").

⁷ https://www.eia.gov/dnav/ng/ng_prod_wells_sl_a.htm.

⁸ <https://www.eia.gov/tools/faqs/faq.php?id=46&t=8>.

⁹ <http://www.ngsa.org/wp-content/uploads/2017/03/Top-40-2016-4th-quarter.pdf>.

The natural gas system¹⁰ is not particularly vulnerable to weather-related events. Natural gas pipelines are predominantly underground and protected from the elements. Therefore, natural gas systems are far more resilient in the face of extreme weather events than electric systems. For example, in 2016, fewer than 100,000 natural gas customers nationally experienced disruptions,¹¹ while 8.1 million Americans experienced power outages.¹² According to an April 2017 INGAA survey of 51 interstate pipelines, over the ten-year period 2006-2016, pipelines delivered 99.79 percent of “firm” contractual commitments to firm transportation customers at primary delivery points (i.e., the points specified in their contract). As attested to by INGAA’s survey data, firm pipeline transportation service historically is extremely reliable.

The wide geographic dispersion of production areas further reduces the vulnerability of the supply to localized weather events. Additionally, most natural gas production now occurs onshore, with offshore production making up only 5 percent of total natural gas production compared with 20 percent in 2004.¹³ As a result, the potential for hurricane impact on natural gas production has dramatically diminished.

The operation of the entire natural gas system – production, transmission, distribution and storage – is highly flexible with strong elasticity characteristics. The inherent design of high-pressure and low-pressure gas delivery systems is mechanical by nature. Modern infrastructure has control systems to help monitor, and in some cases operate the pipelines and its components to move the product in a reliable, efficient and effective manner. Operators manage the internal

¹⁰ A detailed diagram of the natural gas industry segments appears at the end of these comments.

¹¹ Source: American Gas Association survey.

¹² EIA, Electric Monthly Table B.2 Major Disturbances and Unusual Occurrences, available at <https://search.usa.gov/search?utf8=%E2%9C%93&affiliate=cia.doe.gov&query=Electric+Emergency+and+Disturbance+2016>

¹³ EIA – Natural Gas Monthly December 2007 and Natural Gas Monthly April 2017: https://www.eia.gov/naturalgas/monthly/pdf/table_07.pdf.

pressure of the delivery system by controlling the amount of natural gas entering and leaving the system. The process of increasing or decreasing pressure happens relatively slowly in a natural gas system because of the compressible nature of the gas. This compressibility lessens the immediacy of impact and increases the probability of detection. Layered onto this control system architecture are overpressure protection devices, which kick-in should the unlikely need arise to prevent the internal gas pressure from threatening the pipeline's integrity. This was demonstrated on January 7, 2014 during a "polar vortex" weather event that stretched across large parts of the United States and caused total delivered gas nationwide to reach an all-time record of 137.0 Bcf in a single day.¹⁴ Despite the unprecedented performance levels required, the industry honored all firm fuel supply and transportation contracts.¹⁵

The joint Federal Energy Regulatory Commission ("FERC")-NERC *Southwest Cold Weather Report* made similar findings about the reliability of the natural gas system during another weather-related event. In the first week of February 2011, the southwest region of the United States experienced historically cold weather that resulted in significant impacts on the electric system in Texas, New Mexico and Arizona, and natural gas service disruptions in those states as well. During the 2011 Southwest outages, 50,000 retail gas customers experienced curtailments when gas pressure declined on interstate and intrastate pipelines and local distribution systems due to the loss of some production to well freezing at a time of increased gas

¹⁴ EIA, Market Digest: Natural Gas (2013-2014), https://www.eia.gov/naturalgas/review/winterlookback/2013/#tabs_Consumption-4

¹⁵ See <https://www.ferc.gov/media/news-releases/2014/2014-4/10-16-14-A-4-presentation.pdf> and "During each of these cold events, customers who had firm transportation capacity on natural gas pipelines generally managed to secure natural gas deliveries." Also see <https://www.ferc.gov/legal/staff-reports/2014/04-01-14.pdf> at Slide 4.

system demand.¹⁶ In contrast, 4.4 million electric customers were affected over the course of the same event.¹⁷ Nonetheless, the *Southwest Cold Weather Report* found that only 10 percent of the electric generation failures were due to fuel supply problems,¹⁸ and that “[f]uel supply problems did not significantly contribute to the amount of unavailable generating capacity in ERCOT.”¹⁹ Further, as noted in the *Southwest Cold Weather Report*, “[n]o evidence was found that interstate or intrastate pipeline design constraints, system limitations, or equipment failures contributed significantly to the gas outages. The pipeline network, both interstate and intrastate, showed good flexibility in adjusting flows to meet demand and compensate for supply shortfalls.”²⁰

Other characteristics of the natural gas system contribute to its historical operational reliability and system resilience. The natural gas transportation network is composed of an extensive network of interconnected pipelines that offer multiple pathways for rerouting deliveries in the unlikely event of a physical disruption. In addition, pipeline capacity is often increased by installing two or more parallel pipelines in the same right-of-way (called pipeline loops), making it possible to shut off one loop while keeping the other in service. In the event of one or more compressor failures, natural gas pipelines can usually continue to operate at pressures necessary to maintain deliveries to pipeline customers, at least outside the affected segment. “Line pack”²¹ in the pipelines can be used, if necessary, to provide operational

¹⁶ Southwest Cold Weather Report at 2.

¹⁷ *Id.* at 1.

¹⁸ *Id.* at 140-142

¹⁹ *Id.* at 153.

²⁰ *Id.* p. 212

²¹ Line pack is the volume of natural gas contained within the pipeline network at any given time. It allows gas received in one area of a pipeline system to be delivered simultaneously elsewhere on the system. It can facilitate non-ratable flows and support pipeline reliability as a temporary buffer for imbalances. However, line pack must be kept reasonably stable throughout the system to preserve delivery pressure and system capacity. Thus, line pack neither creates incremental capacity, nor is it a substitute for appropriate transportation contracts.

flexibility, as noted in the *Southwest Cold Weather Report*.²² As noted above, because of the inherent characteristics of natural gas and the interconnected pipeline system, operators can control and redirect the flow around an outage in one segment. The existence of geographically dispersed production and storage, and its location on different parts of the pipeline and distribution system, also provides flexibility for operators to maintain service in the event of a disruption on parts of the transportation and distribution system.

Similarly, producers use various methods to help ensure operational continuity. Because producers have an economic incentive to continue to flow gas out of the producing field at a constant rate, many techniques are in place to help ensure that operations continue or that any disruption is minimized when a problem arises. While not always possible, producers often rely on more than one processing plant or pipeline rerouting options in a production area, especially when handling a significant level of production. In the unlikely event of an unavoidable disruption of supply at a well or in a field, producers have many other options to balance their supply commitments, including increasing production in other areas or using natural gas they have in storage.

3. The Natural Gas Industry – Focused on Cyber & Physical Security Risks

Cyber and physical security are integral to the natural gas industry. Natural gas pipelines, which move over one-third of the energy consumed daily in the United States, are considered critical infrastructure. All along the natural gas supply chain, from production to delivery, the

²² Southwest Cold Weather Report at 68-70.

industry employs a portfolio of tools to help ensure protection of its facilities from both physical and cybersecurity threats.

On the physical security side, fences, routine patrols and continuous monitoring, as appropriate, help protect above-ground facilities such as compressors, well sites, processing plants and meter stations. The natural gas industry routinely holds briefings and workshops to discuss security concerns, and it has developed industry guidelines and identified leading practices to protect facilities and data. Natural gas trade associations and their members regularly run simulated exercises in response/recovery efforts to help prepare in the event of natural or man-made disasters and work closely with government agencies to share threat information and practices.

On the cybersecurity front, the federal government partners with the natural gas industry on cybersecurity frameworks and initiatives to promote situational awareness, mitigating measures and response/recovery. Critical infrastructure sectors, including natural gas, electric, nuclear, financial, telecommunications, information technology and water, use Information Sharing and Analysis Centers (ISACs) as an adaptive tool to share comprehensive analysis of changing threats within the sector, other sectors and federal and state governments. The Energy Sector is represented by the Downstream Natural Gas ISAC, the Oil & Natural Gas ISAC, and the Electricity ISAC. These ISACs work closely with one another and with other critical infrastructure sector ISACs. The federal government promotes ISACs and Information Sharing and Analysis Organizations (ISAOs) as a best security practice.

As discussed at length in the beginning of this document, there is low risk of single point of disruption (regardless of cause) resulting in uncontrollable, cascading effects. Generally, supply and transportation disruptions can be managed through substitution,

transportation rerouting and storage services. Recognizing the pipeline system resilience and redundancy, the federal government continues to partner with industry on cyber as well as physical security matters. This partnership is best experienced through the TSA Pipeline Security Guidelines and various completed and ongoing security initiatives that strengthen the industry's security posture.

One of the most important aspects of cybersecurity in the pipeline space is ensuring the integrity and operability of the Supervisory Control and Data Acquisition (SCADA) system of each pipeline against cyber compromise. From a cybersecurity perspective, natural gas functions are divided across an enterprise network and an operations network (which includes control system, SCADA, and pipeline monitoring). These two networks are generally isolated from each other, and a portfolio of tools and mechanisms is used to improve the prevention, detection and mitigation of cyber penetration. Pipeline safety regulations and standards state that back-up systems cannot be affected by the same incident that compromises the primary control system; thus fail-safes and redundancies must be independent of the cause of the primary mechanism's failure.

In addition, partnership between the private sector and the federal and state governments is a key part of addressing physical and cybersecurity threats to the nation's critical infrastructure. Industry members routinely participate in internal and industrywide security situation simulation exercises – training exercises that present real-world challenges – with government officials and others to ensure that the industry is better prepared for a cyber or a physical emergency.

Just as with pipeline safety, natural gas utilities apply layers of resilience for cybersecurity by employing firewalls and other tools to improve the prevention, detection and

mitigation of cyber penetration. Further, natural gas delivery systems are mechanical by nature and can still be run manually if necessary. Natural gas is moved by using pressure to control the amount entering and leaving the system. Layered onto this control system architecture are devices that detect changes in pressure, which serve as a safeguard to prevent internal gas pressure from threatening pipeline integrity.

Cybersecurity is also a priority in other areas of supply chain, such as production. Many companies orient their overall cybersecurity programs around the NIST Cybersecurity Framework for Improving Critical Infrastructure Cybersecurity. Using this framework and other consensus standards can equip upstream operators with the process and tools they need to prevent cyberattacks.

Cyber risk management at any company is tailored to that company's assets and potential risks and must also be flexible to respond to ever-changing external threats and internal deployment of digital assets. Although one size does not fit all, there are some common features of cyber risk management programs for industrial control systems (ICS) employed by many offshore and onshore oil and natural gas industry companies, including: training and security awareness, segregating process control networks, restricting access to computer hardware used to manage software and industrial control programs, restricting and monitoring vendor access to equipment and systems, and on-site inspections and cyber-related drills.

4. Firm Contractual Arrangements Assure Reliability of Service

Above, we discussed the high level of reliability provided by the natural gas industry in terms of its physical operations and ability to deliver to its customers. Yet, in order to benefit from this reliability, large-volume customers, such as industrial users, electric generators, commercial customers and LDCs, must do their part to ensure continuity of service by

contracting for firm transportation services to meet their own or their customers' obligations. Absent customers' purchasing pipeline capacity on a firm basis, pipelines may not have spare transportation capacity available on their systems, or a higher priority firm transportation customer may bump the non-firm customers' service for reasons unrelated to physical gas or transportation disruptions. On the coldest days (known as "peak days"), when weather-sensitive firm transportation customers are using their full contractual entitlements, there may be little or no interruptible transportation capacity left over for interruptible customers.

In many circumstances, large-volume customers make arrangements to move natural gas from the wellhead to their burner-tip – that is, through the entire supply chain. In 1992, FERC, which regulates interstate natural gas pipelines, required interstate pipelines to unbundle (i.e., separate) their sales and transportation services, and to provide unbundled transportation service on an open access, not unduly discriminatory basis.²³ As a result of this restructuring, interstate pipelines exited the merchant sales function, meaning that they no longer sell the natural gas that they transport through their pipelines, and the rates they charge are only for the movement of gas through their systems. While FERC's restructuring of the natural gas industry created an additional level of responsibility on the pipeline customer to separately contract for supply and pipeline transportation, it has been beneficial in creating competition by giving gas customers a choice of commodity suppliers and pipeline capacity.

23 The FERC's unbundling of the interstate natural gas pipeline industry was undertaken to improve the competitive structure of the industry to maximize the benefits of the Wellhead Decontrol Act adopted by Congress in 1989. Pipeline Service Obligations and Revisions to Regulations Governing Self-Implementing Transportation Under Part 284 of the Commission's Regulations; and Regulation of Natural Gas Pipelines After Partial Wellhead Decontrol, Order No. 636, 57 FR 13267 (April 16, 1992), III FERC Stats & Regs. ¶ 30,939 (1992) at p.4.

4.1. Understanding Contract Options – Firm vs. Interruptible

The interstate pipeline industry today is contract-based. As such, pipeline customers select the type of service (firm or interruptible) for their transportation and storage service based on their desired level of certainty and reliability. Pipeline customers ensure their gas supply reliability by taking responsibility for choosing the portfolio of natural gas transportation and storage services that meets their needs adequately, not unlike what is necessary with other fuels, such as coal and fuel oil. Pipelines schedule their capacity based on a system of nominations, and, when necessary, restrict service based upon the type of service contracted. Broadly speaking, there are two main types of service that pipeline and storage operators offer to customers: (1) firm service, whereby a shipper chooses to pay a monthly reservation charge to the pipeline that entitles it to transport or store a certain quantity of gas each day, assuming the shipper nominates the quantity and delivers to the pipeline the equivalent amount of natural gas at the receipt points specified in the contract; and (2) interruptible service, which is a lower-quality pipeline service provided by the pipeline when it has spare capacity that is either not under firm contracts or not being used that day by firm transportation customers. Within firm service, many pipelines and storage facilities provide “no-notice” service. No-notice service is the highest level of firm service that a customer can contract. It allows for the reservation of pipeline capacity throughout the 24-hour gas day. This reservation of capacity allows the customer to nominate its firm service on a primary basis throughout the day, offering the highest level of flexibility available on a pipeline.

Under the FERC regulations,²⁴ a firm-service shipper is entitled to “segment” its capacity daily and utilize other delivery points within the path to its delivery point if capacity is available. These delivery points along the route are called “secondary firm points.” Once scheduled by the pipeline, the transportation capacity to secondary receipt and delivery points is as firm as primary firm delivery. Primary firm-service shippers receive the most reliable service, because they have the highest priority when scheduling and are the last to be curtailed in *force majeure* (or unexpected emergency) situations. Secondary firm-service shippers are next in priority for scheduling, but once scheduled, they are curtailed *pro rata* with other primary-firm service. Interruptible shippers, if scheduled, can be bumped by higher priority firm shippers until the Intra-day 2 (ID2) scheduling deadline, and interruptible shippers are curtailed before any firm pipeline customers – regardless of whether the interruptible transportation was scheduled. Subject to capacity availability on the pipeline, the option to contract for firm or interruptible service is the decision of the pipeline customer based on the level of service that it requires. If capacity is not available, a pipeline may decide to expand its system to accommodate customers’ requirements if firm commitments are made.

“Interruptible” transportation contracts (“interruptible”) can be interrupted by a higher priority firm transportation shipper for any reason until 5:30 pm, which is the ID2 scheduling deadline.²⁵ A pipeline customer chooses the contract that best suits its needs and capability to be

²⁴ 18 C.F.R. § 284.7(d).

²⁵ If existing capacity is fully committed under firm contracts, interstate pipelines are not required to expand their facilities to provide transportation service. See 18 CFR 284.7(f) (“A person providing service under Subpart B, C or G of this part is not required to provide any requested transportation service for which capacity is not available or that would require the construction or acquisition of any new facilities.”). This contrasts with the Federal Power Act provisions that impose obligations on electric transmission owners to expand capacity to provide interconnection and transmission services. Federal Power Act section 210 and 211, 16 U.S.C. §§ 824i and 824j. Of

at risk of disrupted service. During a *force majeure* (or unexpected emergency) event applicable to firm pipeline customers, curtailment by interstate pipelines is based on the transportation contract in place, in which case, interruptible transportation contracts that were already confirmed are curtailed first. Interruptible transportation that was not available and never confirmed is not a curtailment of service. **Interstate pipelines do not curtail based on the end-use of the gas: FERC's nondiscriminatory open access regulations preclude this. In fact, an interstate pipeline cannot provide transportation service preferences based on customer classification.**²⁶

4.2. Portfolio of Choice

Interstate pipeline customers can decide to secure their fuel supply through a variety of options. For example, they can purchase firm transportation directly from the pipeline, obtain firm capacity rights through capacity release (reassignment) from another firm shipper, or enter into firm bundled transportation/supply contracts with marketers. Natural gas marketers are entities that can aggregate natural gas into quantities that fit the needs of different types of buyers and then can arrange transportation of that gas to their buyers. A marketer coordinates, through various contractual arrangements, all the necessary steps to transport the gas from the wellhead to the customer. Natural gas marketers also offer natural gas supply delivered on a firm basis, which includes both the commodity and the transmission capacity needed for delivery of the gas. By holding a portfolio of physical capacity assets (pipeline transportation and storage) and supply contracts, a marketer can provide flexible and responsive service to customers.

course, interstate pipelines have an incentive to expand capacity for shippers that commit to firm contracts for the expansion capacity.

²⁶ 18 C.F.R. §§ 284.7(a)(3) and 284.7(b)(1).

Therefore, a marketer's services can be a reliable alternative source of supply for customers during peak periods, if the marketer holds primary firm transportation capacity to the relevant delivery points.

4.3. LDCs as Pipeline Customers

As part of FERC's natural gas industry restructuring in 1992, LDCs converted their bundled firm pipeline sales entitlements to unbundled firm pipeline transportation rights to meet their state regulatory obligations to serve their firm "core" customers. (This is similar to the post-Order No. 888 conversions made by franchised public utilities to network integration service.) LDCs now purchase their natural gas commodity supply and arrange for the transportation of those commodity supplies on interstate pipelines to their systems. LDCs engage in long-range resource planning to ensure their access to supply and the continuous operations of their systems to ensure reliable service to these firm core customers. The delivery of natural gas to core retail customers is of primary importance to LDCs, and their planning involves assessment of potential supply chain disruptions, including commodity supply and interstate transportation disruptions, as well as disruptions that may impact their own local distribution systems.

4.4. Natural Gas-Fired Power Generation

Similar to LDCs, electric generators and other industrial and large commercial gas users must also arrange fuel supply to meet their respective requirements. These customers typically do not purchase their gas supplies from LDCs under their state-regulated tariffs -- unless they are located on an LDC's distribution system, in which case they may contract to use that system for transportation of their own gas supplies purchased in the wholesale market. More typically, many large commercial gas users are connected directly to an interstate or intrastate pipeline that transports the gas supplies they have purchased separately. Again, these large gas users are

responsible for arranging their own fuel supply and must consider the entire fuel supply chain, from production to their plant.²⁷ In practical terms, this means taking into consideration congested transportation paths and pipeline scheduling and curtailment priorities when contracting for delivery of their gas supply. Location alone does not guarantee a large-volume customer security of its gas supply. Location is just one part of a bigger picture that includes the contract-based interstate transportation and storage system, and the utility obligations applicable to LDC systems.

5. Regulatory Requirements Are Relevant to Supply Chain Delivery Options

Historically, the natural gas industry has not been vertically integrated; instead each distinct industry segment's price structure is subject to a different regulatory regime. Broadly speaking, the industry consists of three segments: (1) upstream natural gas production, gathering and processing; (2) pipeline transportation and storage; and (3) local distribution.²⁸ Congress removed all price regulation for natural gas sold by producers in the Wellhead Decontrol Act of 1989, which was followed a few years later by FERC's removal of all price regulation for the sale of natural gas in the wholesale market. Gathering and processing are also not subject to price regulation by the federal government. However, the price, terms and conditions of the interstate transportation and storage of natural gas remain regulated by FERC. Pure intrastate transportation and storage of natural gas is subject to state regulation. The distribution of natural

²⁷ See Frank Brock and Michael Sloan, ICF, "An Electric Gas Market Calls for Flexibility," 2017, (available at https://www.icf.com/perspectives/white-papers/2017/an-electric-gas-market-calls-for-flexibility?_cldee=cGphZ3RpYW5pQG5nc2Eub3Jn&recipientid=lead-94bc42ae6f47e5118109c4346bb59848-27daa500e3404b359d638cd87a34be6b&utm_source=ClickDimensions&utm_medium=email&utm_campaign=may11-2017-com-ene-energy-digest-newsletter&esid=f789549b-b935-e711-80fd-5065f38a19e1).

²⁸ A more detailed diagram of the natural gas industry segments appears at the end of these comments.

gas by LDCs is also subject to state regulation. All pipelines are subject to safety regulation by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration ("PHMSA") or state agencies. Numerous other federal and state agencies regulate various environmental and safety aspects of the natural gas system.

5.1. FERC Regulation of Interstate Transportation and Storage

As noted earlier, FERC's regulation of interstate transportation and storage is contract-based. A pipeline or a storage company's contract is with its pipeline customer. How that pipeline customer chooses to contract for service determines the scheduling of service on the pipeline as well as the firm service curtailment priorities in the event of a pipeline restriction or *force majeure* event. FERC regulations preclude interstate pipelines from undue discrimination in providing service based on the classification of customers. This means that the identity of the customer, whether it is an LDC, electric generator, or a producer, cannot have any bearing on priority of service. In addition, the pipeline is required to honor all firm service contracts.²⁹ Therefore, level of service that a customer has contracted for is of paramount importance.

5.2. State Regulation of Local Distribution – High Priority Customers.

LDCs are regulated by most states as local gas utilities that have an obligation to serve their firm core customers – the customers for which the system is built to serve reliably. LDC systems are built to serve these firm core customers and others on a "design day" (a forecasted peak-load day based on historical weather conditions). While gas utilities may offer an

²⁹ FERC gas regulations define "service on a firm basis" as a service that is "not subject to a prior claim by another customer or another class of service and receives the same priority as any other class of firm services." 18 C.F.R. § 284.7(a)(3).

interruptible “bundled” sales service (which includes commodity supply and the transportation of the supply on the local distribution system) and/or a stand-alone interruptible transportation service for the transportation of customer-owned gas on the local distribution system, the LDC may not be able to maintain interruptible transportation service at all times. During periods of high usage and system constraints, often prevalent on the coldest winter days, LDCs may call on interruptible customers to cease gas usage temporarily, upon which these customers generally switch to a back-up fuel, such as fuel oil.³⁰

In the event of extreme situations that require action to be taken for reasons that include the need to maintain the operational integrity of the system and/or maintain natural gas service to designated high priority customers, including “essential human need” customers, state statutes and public utility regulations may allow an LDC to curtail services to some customers. Historically, these regulatory requirements give the highest priority to residential and commercial customers without short-term alternatives. As a result, a natural gas-fired power generator relying on an LDC distribution system, particularly on an interruptible basis, needs to consider these regulatory obligations of the LDC and, for example, plan for the use of alternate fuels, maintain on-site fuel storage (such as LNG or CNG), or contract for a higher level of service from the LDC (such as firm transportation or emergency service).

³⁰ The tradeoff for these customers is a discounted rate for the interruptible natural gas delivery service, compared with firm service rates, and the customers enter into these interruptible contractual arrangements with that prior knowledge.

6. Storage's Dual Role in the Gas Supply Chain

Underground natural gas storage is an integral component of the natural gas supply chain, with a function different than the other components of that supply chain. Storage serves to augment natural gas production, and the location of a storage facility can also provide operational flexibility for the natural gas delivery infrastructure. There are 385 underground storage facilities in the lower-48 states with a total of 4,688 Bcf of working gas design capacity.³¹ Natural gas storage enables LDCs and interstate pipeline companies to adjust for daily and seasonal fluctuations in demand, in contrast to natural gas production, which remains relatively constant year-round. Storage helps ensure that customers have reliable service and can provide increased price stability. Natural gas storage operators have consistently provided safe and reliable natural gas storage. Because of the critical importance storage plays in the nation's energy portfolio, natural gas storage operators are continually working to help improve safety and reliability through innovations in equipment, processes and methodologies.

6.1. New storage rules will have minimal impact on deliverability

PHMSA's December 2016 interim final rule promulgating safety regulations for underground storage facilities ("Storage IFR")³² will have minimal impact on deliverability. In fact, the Storage IFR is intended to reduce the likelihood of future storage incidents and ultimately improve underground storage safety and reliability. The Storage IFR, like natural gas pipeline safety regulations that preceded it, takes a functional integrity management approach to storage safety and standardizes the methodology by which operators will analyze risk at storage

³¹ <https://www.eia.gov/naturalgas/storagecapacity/>.

³² See 81 Fed. Reg. 91,860 (2016).

facilities. The Storage IFR requires operators to develop rigorous risk-assessment programs that will be used to determine which preventative and mitigating measures are appropriate for the specific conditions at any given storage facility.

6.2. Underground Storage Facilities Are Not Identical

The gas pipeline and associated storage network is different in different regions of the United States. How an underground natural gas storage facility is configured and serves its market also differs across the country. Much attention has been focused on the Aliso Canyon underground natural gas storage facility. This particular facility is a prime example of how one facility's operational configuration and the way in which it serves its market differs from others.

PHMSA's underground storage rule was prompted by an October 23, 2015 leak at a SoCal Gas natural gas storage well at the Aliso Canyon storage field in California. Aliso Canyon is an integrated gas utility-owned storage facility tied directly to intrastate pipelines that serve market load. As a result, the gas delivery system in the area is dependent upon storage withdrawals to meet market demand. However, the gas pipeline and storage network is different in other regions of the United States, where storage operators instead interconnect with multiple pipelines and storage facilities from which they can access supply and transport gas.

Based on the event data reported since 1990, including the Aliso Canyon incident, the likelihood of an unplanned release from an underground gas storage well, calculated using the

Center for Chemical Process Safety 5 (“CCPS”) American calculation for hazardous process facilities, results in a “very unlikely” to “extremely unlikely” or “remote” classification.³³

One well failed at the SoCalGas facility at Aliso Canyon and, in an abundance of caution, California State Regulators ordered the other 113 wells to be temporarily sealed until they could be tested to ensure their integrity and safety or plugged and abandoned. To date, 49 storage wells at the Aliso Canyon Storage facility have passed all the tests required under the Division of Oil, Gas and Geothermal Resources’ (“DOGGR”).

There was no mechanical failure of the other 113 storage wells at Aliso Canyon; the regulator’s decision to shut down the entire facility is an example of regulatory action taken to help mitigate risk. Nevertheless, the consequences of such actions to gas and electric reliability need to be clearly understood when gas flows are restricted.

7. Conclusion

The natural gas industry is not susceptible to wide-spread failure from a single point of disruption in the same manner as the electric system because of the dispersion of production and storage, its redundant characteristics from the extensive integrated pipeline and distribution network, and its low vulnerability to weather-related events. The natural gas industry also has in place robust cyber and physical security protocols to minimize disruptions from manmade or computer threats, and has a resilient, interconnected system that allows it to come back on line quickly in the rare case of a disruption.

³³ American Petroleum Institute, American Gas Association, and Interstate Natural Gas Association of America “Underground Natural Gas Storage: Integrity and Safe Operations,” (July 6, 2016) at 10, available at <https://primis.phmsa.dot.gov/UNG/docs/AGA%20White%20Paper%20-%20UNGS%20Integrity%20and%20Safe%20Ops%2020160706.pdf>.

While the natural gas industry is committed to continuing its high level of reliability, there is an equally important component of assuring continuity of service that remains the responsibility of large-volume customers. These customers should contract for the appropriate level of firm transportation service they require to ensure reliable service. Together, these two components – operational reliability and contractual continuity of service –make natural gas a secure, reliable and resilient choice for customers.

ATTACHMENT B

Weather Resilience in the Natural Gas Industry:

The 2017-18 Test and Results



**WEATHER RESILIENCE IN THE NATURAL GAS
INDUSTRY:
THE 2017-18 TEST AND RESULTS**

PREPARED FOR

THE NATURAL GAS COUNCIL

AUGUST 2018

Richard G. Smead
Managing Director, Advisory Services
RBN Energy, LLC

EXECUTIVE SUMMARY

INTRODUCTION—Proof of Resilience

In July 2017, the Natural Gas Council (NGC) released “Natural Gas Systems: Reliable and Resilient” (NGC Report), a report detailing the characteristics of the U.S. natural gas industry that contribute to its reliability and resilience to weather-related interruption of service, including the ability to compensate for any operational issue and to recover rapidly. Most notable from the July 2017 NGC Report was the finding that the gas pipeline industry exhibited a 99.79 percent reliability in fulfilling its firm contract obligations over the ten years leading to and including 2016. Beginning one month after the release of the NGC Report, a series of significant weather events—two hurricanes and the combination of the Northeast freeze and the Bomb Cyclone—tested the natural gas industry. The industry’s performance through the stress test of those three widely varied and tumultuous events fully reinforced the conclusions of the 2017 NGC Report. The natural gas system performed extremely well during times of high stress and demand demonstrating its reliability and resilience in the most challenging of weather conditions.

The NGC commissioned a second report to study in detail the natural gas industry’s performance through the three aforementioned weather events. This study, “Weather Resilience in the Natural Gas Industry: The 2017-18 Test and Results,” (the NGC Resilience Study) was conducted by RBN Energy, LLC and was compiled from a review of press accounts, regional transmission operators’ reports, government reports, and detailed interviews with 25 affected companies. The following Executive Summary details key elements and conclusions of the NGC Resilience Study.

REVIEW OF THE 2017-2018 WEATHER EVENTS

The 2017-2018 storms spanned the full range of potential weather impacts on the natural gas industry.

Gulf Storms and Flooding: Hurricane Harvey represented a traditional Gulf of Mexico hurricane affecting offshore production and is remembered for flooding and immobilizing the fourth largest U.S. city and the headquarters of much of the natural gas pipeline industry.

Extreme Wind and Flooding in Populated Areas: Hurricane Irma was a fierce South Atlantic and Gulf storm moving the length of the heavily populated state of Florida, which relies on natural gas for power generation more than any other state in the U.S., with some extended impact north into Georgia and the Southeast.

Deep Freeze and Extreme Winter Conditions: The Bomb Cyclone is shorthand for a historic Northeast deep freeze, exacerbated by a snow and ice hurricane affecting Northeast production areas and the most densely populated region in the U.S., the East coast.

DEFINING RESILIENCE

To assess resilience of the natural gas industry, this study created a hybrid definition based upon terminology used by the U.S. Department of Energy and dictionary definitions. The study measures the resilience of the natural gas industry based on its ability to:

- » Prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions, and
- » Withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.

Ultimately, the greatest test of resilience is whether commitments to customers can be met regardless of the degree of stress that is caused by a weather event. As this study demonstrates, the natural gas industry passes this test with flying colors.

OVERALL CONCLUSION

This study of the 2017-2018 experience confirms the natural gas industry's remarkable resilience to wide variety of severe weather.

Figure 1 is a table summarizing the weather events and related industry performance.

Figure 1: Characteristics and Impact of the Three Weather Events

Summary Conclusion: Three Varied Tests, Three Successes for Industry Resilience		
Hurricane Harvey	Hurricane Irma	"Bomb Cyclone"
August 2017	September 2017	Dec./Jan. 2018
<ul style="list-style-type: none"> » Traditional Gulf of Mexico hurricane & flooding seriously affected the Texas region including Houston. <ul style="list-style-type: none"> ▪ 51 inches of rain ▪ \$125 billion in damage (costliest in history) » Customers: No end-use curtailment » Pipelines: Minor, short-term restriction of firm service on pipelines with damaged compressor stations briefly affecting exports but no end-users. » Spot prices: a "non-event"; stayed in \$2.80-\$3.00 range. 	<ul style="list-style-type: none"> » Fierce Atlantic/Gulf of Mexico storm swept the most natural gas-generation intensive state. » Power was out; natural gas was not. <ul style="list-style-type: none"> ▪ Power lines were down ▪ Gas distributed generation still worked. » Customers: Very minor short-term end-use curtailment to evacuated areas; (did not affect customers—they weren't there). » Pipelines: No restrictions on firm pipeline service » Spot prices: a "non-event"; stayed in \$2.80-\$3.00 range 	<ul style="list-style-type: none"> » Historic Northeast deep freeze/snow & ice hurricane » Customers: LDC customers fully served. » Pipelines: <ul style="list-style-type: none"> ▪ Firm customers fully served between their contractual points. ▪ Interruptible and secondary-firm service limited as firm customers used the space they had paid for. » Producers: Some freeze-offs, but storage and cooperative relationships among pipelines covered shortfalls. » Spot prices: Spiked in the Northeast, at the outlet of the pipelines, but Henry Hub and Marcellus saw only minor effects.
Prepared by RBN Energy LLC for the Natural Gas Council		

OPERATIONAL RESILIENCE

The natural gas industry's reliability and resilience may be attributed to four key characteristics:

- » **Underground Facilities:** The extensive underground location of facilities protects them from weather impacts;
- » **Line Pack:** Transmission pipelines incidentally store gas at pressure (called "Line Pack") which provides a buffer that can mitigate the effects of abnormal operating conditions;
- » **Network Reliability:** The network configuration of the pipeline industry means that, in the event of an outage, there is usually a "work-around" that allows continued service to LDCs and directly-connected consumers; and
- » **Confined Impact:** Physical configuration limits impact of a disruption; not susceptible to 'cascading events' such as those on electric transmission systems.

PLANNING & PREPARATION

The natural gas system resilience can be attributable to several factors: primarily planning and preparation, which in combination with physical properties of natural gas resulted in few operational issues that threatened supply or capacity. In cases where there was potential for impaired firm pipeline service, the industry was able to “work around” the issues through rerouting of gas, turning to underground natural gas storage, and/or coordinating among interconnected pipelines to circumvent impacts to firm customers’ service.

In the two major hurricanes, the real news about the natural gas industry was that there *was* no news. The industry performed normally throughout both storms. In the face of large electric-transmission-driven power outages in Florida, steady gas industry performance enabled backup generation, distributed generation and combined heat and power (CHP) installations to continue to operate, thus protecting high-priority electricity needs, despite the statewide loss of the grid.

TIMELY RESPONSE & RECOVERY

Firm service customers, including local distribution companies (LDCs), experienced no impactful curtailment in any of the three storms. There were limited curtailments caused by facility damage, but repairs were completed by the time evacuations were lifted and consumers returned and required service.

NO SHORTFALL OF SUPPLY OR CAPACITY

During the Bomb Cyclone, customers with firm service agreements in the Northeast received their supplies as contracted. The exhaustion of committed firm capacity in New York and New England resulted in spot-price-driven economic impacts in power markets but did not result in a loss of natural gas reliability. Fuel switching by power generators during this time were due to economic decisions and not supply decisions. In the Mid-Atlantic market, the PJM Interconnection (PJM) indicated that any gas-fired generation outages were NOT a result of a failure of firm transportation. Rather, a temporary differential in fuel prices caused some generators to switch from gas-fired generation to coal-fired generation. Unfortunately, a decision by PJM to operate some coal facilities briefly in lieu of gas-fired generation was misinterpreted by the Department of Energy’s National Energy Technology Laboratory (NETL) as a failure of gas-fired generation. PJM directly corrected the NETL assertion, clarifying that the decision was strictly economic, as coal became briefly less expensive than natural gas—gas supply to generators remained fully available.

TYPES OF SERVICE – A CUSTOMER CHOICE

Firm Pipeline Service

The customer pays a fixed monthly charge to reserve capacity between specific points on the pipeline, essentially leasing space whether gas flows or not. This is the highest-priority service, provides underpinning for pipelines to invest capital.

Interruptible Pipeline Service

The customer pays a rate per unit actually transported, only as gas actually flows. If no gas flows, there is no charge to the customer. Interruptible service is a lower priority service than firm, subject to availability of pipeline capacity with no guarantee of service.

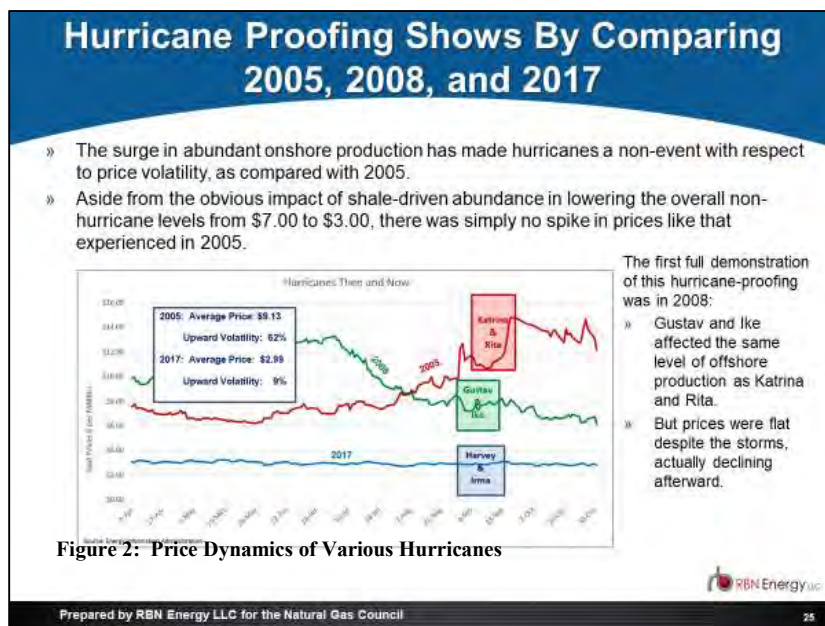
On high-demand days, if customer has only interruptible transportation and is seeking natural gas in the day-ahead market, the customer’s supply options may be limited to local spot markets that are higher-priced than the prices available to firm customers.

Marketer Transportation Options

Marketers and marketers acting as “asset managers” may offer contract options such as rebundled packages of capacity and the gas commodity, able to provide flexible service on the pipeline throughout 24-hour gas day or finding other ways to tailor service to the individual customer’s requirements.

The NGC Report emphasized that any examination of reliability of the natural gas system for individual customers must start from an understanding of which contract choices those customers opted for.

HURRICANE “PROOFING” DUE TO THE SHALE REVOLUTION



A major difference in the impact of Gulf of Mexico hurricanes in past years as compared to today is the lack of sensitivity of the natural gas industry to hurricane-driven supply disruption. Historically, hurricanes in the Gulf of Mexico had a serious impact on supply availability from offshore. While service remained resilient, there were significant economic consequences in the form of higher natural gas prices caused by the supply-demand balance and pipeline bottlenecks moving gas from Texas.

Harvey & Irma

In the recent two major hurricanes, the real news about the natural gas industry was that there was no news. The industry performed as expected throughout both storms. In the face of large electric-transmission-driven power outages in Florida, steady gas industry performance enabled backup generation, distributed generation and combined heat and power installations to continue to operate, thus protecting high-priority electricity needs, despite the statewide loss of the grid.

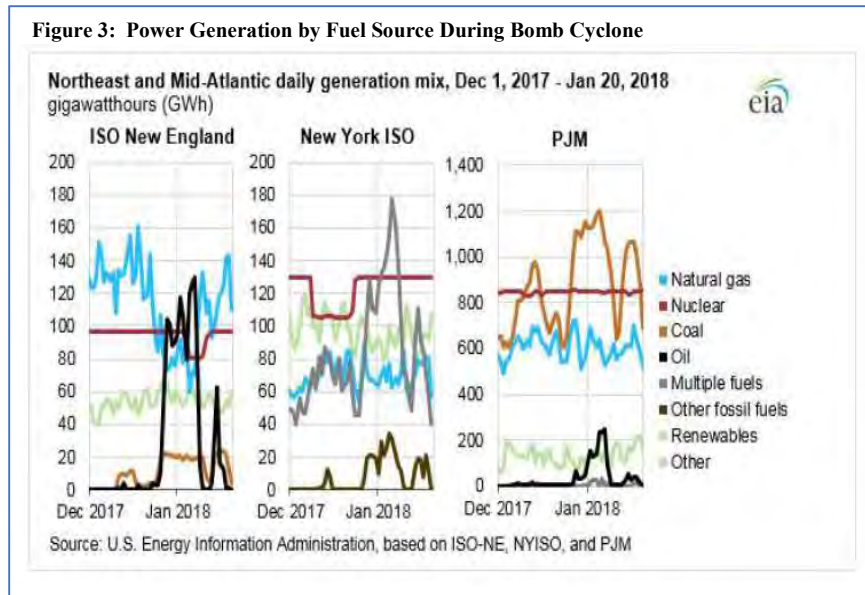
Due to the shift from largely Gulf of Mexico supplies to regionally diverse onshore shale production, this phenomenon has vanished. Shale gas has “hurricane-proofed” the industry for over a decade. Figure 2 is a comparison of price dynamics as between the pre-shale storms of 2005 (Hurricanes Katrina and Rita), with the experience in 2008 (Hurricanes Gustav and Ike) and 2017 (Hurricanes Harvey and Irma).

Bomb Cyclone

PJM, ISO-NE, and NYISO all published post-mortem reports examining performance during the Bomb Cyclone. Meanwhile, the U.S. Energy Information Administration (EIA) published a single overall report on all three. The EIA report’s comprehensive view is best summarized by the main headline of the report: “Market design changes and winter preparedness actions help Northeast and Mid-Atlantic electricity markets handle January’s bomb cyclone weather event.”

Figure 3 is EIA’s summary of the generation mix by fuel in the three power markets. Of the three markets, only New England saw a sharp drop in gas-fired generation (the blue line) and a corresponding increase in alternate fuel during the Bomb Cyclone, representing the use of oil (black) to avoid high spot prices for generators that did not have firm transportation available.

Figure 3: Power Generation by Fuel Source During Bomb Cyclone



PJM (whose electric load was six times as large as either New England or New York) saw a significant increase in coal use (brown), rather than a turn-up of gas facilities. As PJM has explained, this was strictly an economic decision, not a lack of availability of gas.

IN SUMMARY: Resilience and Reliability of Natural Gas Sector Unshaken Through Severe Weather Events

This study sought to examine the natural gas sector's performance through three of the most severe weather events in recent history. Data was gathered from the field, through interviews conducted with company officials, public records, regional transmission operators' reports, media reports and official government records. The results are clear: despite some of nature's harshest conditions, the natural gas sector proved exceedingly reliable and resilient.

Reliability and resilience were demonstrated through the continued service and availability of natural gas despite threatening weather and outages on the electric grid. In the rare instances of natural gas service interruption, the industry demonstrated rapid recovery, thereby minimizing impacts to a negligible amount.

The findings in this study further demonstrate the critical role that contractual agreements serve in enhancing reliability of natural gas service. The Bomb Cyclone spiked spot prices for natural gas temporarily, causing some power generation to switch to alternative fuel sources to minimize cost. Entities such as local distribution companies, that contract for firm natural gas service, were not impacted by these price swings. The findings underscore the significance of appropriate service contracts to meet the needs of the customer.



WEATHER RESILIENCE IN THE NATURAL GAS INDUSTRY THE 2017-18 TEST AND RESULTS

Prepared for
The Natural Gas Council
August 2018

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Prepared by RBN Energy LLC for the Natural Gas Council

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Introduction—Proof of Resilience

- » In July 2017, the Natural Gas Council¹ released “Natural Gas Systems: Reliable and Resilient” (NGC Report) (attached as Appendix A), a report detailing the characteristics of the U.S. natural gas industry that contribute to its reliability, resistance to weather-related interruption of service, including the ability to compensate for any operational issue and to recover rapidly.
- » Beginning one month after the release of the NGC Report, a series of significant weather events—two hurricanes and the combination of the Northeast freeze and the Bomb Cyclone—tested the natural gas industry. The industry’s performance through the stress test of those three widely varied and tumultuous events fully reinforced the conclusions of the NGC Report.
- » This study examines that industry performance in detail. It has been compiled from a review of press accounts, government reports, and detailed interviews with affected companies.



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Why These Three Storms?

The 2017-2018 storms spanned the full range of potential weather impacts on the natural gas industry.

From Gulf Storms and Flooding: Hurricane Harvey

- » A traditional Gulf hurricane affecting offshore production, but then flooding and immobilizing the fourth largest U.S. city and the headquarters of much of the natural gas pipeline industry.

To Extreme Wind and Flooding in Populated Areas: Hurricane Irma

- » A fierce South Atlantic and Gulf storm moving the length of the heavily populated state of Florida, which relies on natural gas for power generation more than any other state in the U.S., with some extended impact north into Georgia and the Southeast.

To a Deep Freeze and Extreme Winter Conditions: The Bomb Cyclone

- » An historic Northeast deep freeze, exacerbated by the “Bomb Cyclone,” a snow and ice hurricane affecting Northeast production areas and the most densely populated region in the U.S., the East coast.



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Definition of “Resilient”

- » The Merriam-Webster Dictionary defines “resilient” as follows:
 - a: capable of withstanding shock without permanent deformation or rupture.
 - b: tending to recover from or adjust easily to misfortune or change.²
- » For the natural gas industry, in the context of the last year’s weather events and incorporating the Department of Energy’s definition of resilience,³ the working definition may be translated to:
 - **Able to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions.**
 - **Able to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.**
- » Ultimately the test is whether commitments to customers can be met regardless of the degree of stress that is caused by a weather event. As this study demonstrates, the natural gas industry passes this test with flying colors.



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Overall Conclusion: Industry Resilience in a Wide Variety of Storms

- » This study concludes that the industry proved remarkably resilient in all three weather events for reasons directly traceable to the characteristics described in the NGC Report
 - Planning and preparation, combined with the physical characteristics of the industry, resulted in very few operational issues that impaired supply or capacity, in any of the three storms.
 - In all cases where any such issues could have impaired firm pipeline service, the industry was able to “work around” the issues, through rerouting of gas, operation of storage, or cooperation among interconnected pipelines, resulting in no impact on firm customers’ service.
 - There was no meaningful curtailment of local distribution companies’ delivery of natural gas to end-users reported in any of the three storms—the limited curtailments caused by facility damage were not meaningful, since repairs were complete by the time evacuations were lifted and consumers were back on site and requiring service.
- » Though some constraints in the Northeast resulted in elevated prices and the use of alternate fuels for generation, these were not due to a shortfall in physical capacity necessary to satisfy firm contracts. **Northeast constraints were the result of market participants exhausting their contractual entitlements to pipeline capacity. Market participants facing constraints either had no such contractual entitlements, or had used them up.**



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Some Notable Specific Observations Bear Out the Resilience Finding

- » In the two major hurricanes, the real news about the natural gas industry was that there was no news.
 - The industry performed normally throughout both storms.
 - In the face of large transmission-driven power outages in Florida, steady gas industry performance enabled backup generation, distributed generation and combined heat and power installations to continue to operate, protecting high-priority needs.
- » In the Northeast, impacts of the exhaustion of committed firm capacity in New York and New England resulted in spot-price-driven impacts in power markets, but did not result in a loss of reliability for gas or for power, and gas consumers shielded from spot prices by firm contracts were protected from local price spikes.
- » In the Mid-Atlantic market, PJM indicated that no gas-fired generation outages were the result of a failure of firm transportation.
 - A decision by PJM to operate some coal facilities briefly in lieu of gas-fired generation was misinterpreted by the Department of Energy's National Energy Technology Laboratory (NETL) as a failure of gas-fired generation.
 - PJM directly corrected the NETL assertion, clarifying that the decision was strictly economic, as coal became briefly less expensive than natural gas—gas supply to generators remained fully available.



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Summary Conclusion: Three Varied Tests, Three Successes for Industry Resilience

Hurricane Harvey

August 2017

- » Traditional Gulf of Mexico hurricane & flooding seriously affected the Texas region including Houston.
 - 51 inches of rain
 - \$125 billion in damage (costliest in history)
- » Customers: No end-use curtailment.
- » Pipelines: Minor, short-term restriction of firm service on pipelines with damaged compressor stations briefly affecting exports but no end-users.
- » Spot prices: a "non-event"; stayed in \$2.80-\$3.00 range.

Hurricane Irma

September 2017

- » Fierce Atlantic/Gulf of Mexico storm swept the most natural gas-generation intensive state.
- » Power was out; natural gas was not.
 - Power lines were down.
 - Gas distributed generation still worked.
- » Customers: Very minor short-term end-use curtailment to evacuated areas; (did not affect customers—they weren't there).
- » Pipelines: No restrictions on firm pipeline service
- » Spot prices: a "non-event"; stayed in \$2.80-\$3.00 range

"Bomb Cyclone"

Dec./Jan. 2018

- » Historic Northeast deep freeze/snow & ice hurricane
- » Customers: LDC customers fully served.
- » Pipelines:
 - Firm customers fully served between their contractual points.
 - Interruptible and secondary-firm service limited as firm customers used the space they had paid for.
- » Producers: Some freeze-offs, but storage and cooperative relationships among pipelines covered shortfalls.
- » Spot prices: Spiked in the Northeast, at the outlet of the pipelines, but Henry Hub and Marcellus saw only minor effects.



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I. NGC RELIABILITY REPORT AND INDUSTRY BACKGROUND: *A HISTORY AND CULTURE OF RELIABILITY*

The July 2017 NGC Report explained in detail the factors that make the natural gas industry reliable and resilient, resulting in a 99.79 percent success rate in meeting its customers' firm-service requirements.



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The NGC Reliability Report

- » The 2017 NGC Report addressed five main aspects of the natural gas industry:
 - History of reliability and the reasons for it;
 - System security, both physical and cyber;
 - The role of firm pipeline contracts in ensuring service;
 - The role of regulation in dealing with reliability at both federal and state levels; and
 - The role of storage in supporting reliability.
- » The NGC Report explained why the natural gas industry is inherently reliable and resilient, with the most important variable for pipeline customers being the level of contractual assurance to which they commit and the most important variable for end-users served by LDCs being how the LDC is regulated.
- » The NGC Report found that the pipeline industry exhibited a 99.79 percent reliability in fulfilling its firm contract obligations (primary service between contractual points) over the ten years through 2016.



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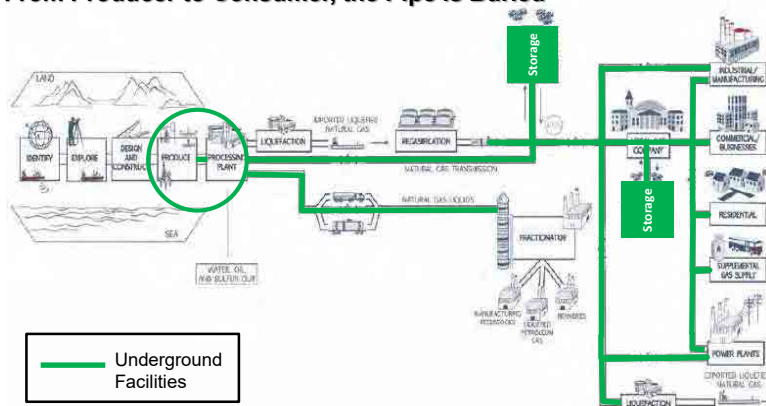
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The NGC Report--Characteristics

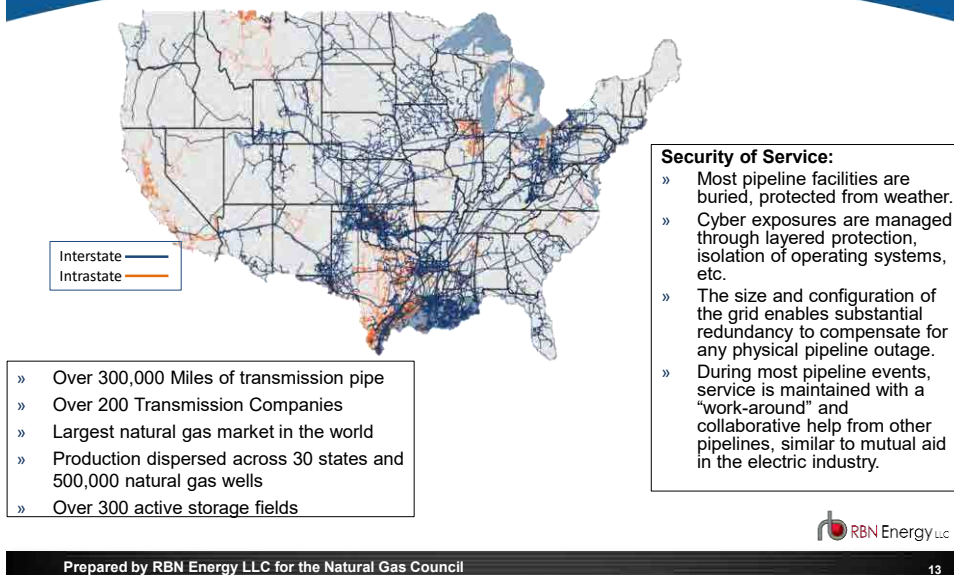
- » The NGC Report emphasized four key characteristics of natural gas support reliability and resilience:
 - **Underground:** The extensive underground location of facilities protects them from weather impacts;
 - **Line Pack:** Transmission pipelines incidentally store gas at pressure (called "Line Pack") which provides a buffer that can mitigate the effects of abnormal operating conditions; and
 - **Network Reliability:** The network configuration of the pipeline industry means that, in the event of an outage, there is usually a "work-around" that allows continued service to LDCs and directly-connected consumers.
 - **Confined Impact:** Physical configuration limits impact of a disruption; not susceptible to 'cascading events' such as those on electric transmission systems
- » The NGC Report also explained the benefit of the transition from offshore (mostly Gulf of Mexico) production to diverse resources onshore; the shale revolution has, in essence, "hurricane-proofed" the industry.

From Producer to Consumer, the Pipe is Buried

From Producer to Consumer, the Pipe is Buried



The U.S. Natural Gas Industry Is Large and Very Resilient



Customer Choice of Firm vs. Interruptible Service Matters When Assessing Reliability

Transportation service is a choice by the customer that determines predictability of customer service and financial underpinning for pipeline. Choice of service must be factored in when assessing reliability.

Firm Pipeline Service

- » Customer pays a fixed monthly charge to reserve capacity between specific points on the pipeline, essentially leasing space whether gas flows or not.
- » This is the highest-priority service, provides underpinning for pipelines to invest capital.
- » Firm service is analogous to reserving and paying for a seat on an airline in advance.
- » High record of reliability: industry 99.79% reliable in fulfilling firm contracts 2007-2016.

Marketer Transportation Options

- » Marketers offer contract options too, such as rebundled packages to provide flexible service on the pipeline throughout 24-hour gas day, along with a range of other service options.

Interruptible Pipeline Service

- » Customer pays per unit, only as gas actually flows, incurring no cost if gas does not flow.
- » Interruptible is a lower priority service than firm, subject to availability of pipeline capacity with no guarantee of service.
- » Pipelines generally do not invest capital to support interruptible service.
- » On high-demand days, if customer has only interruptible transportation and is seeking natural gas on the day-ahead market, customer choice is limited to spot markets that are higher-priced.
- » Interruptible service is analogous to flying stand-by.
- » Customer accepts risk of unpredictability on peak demand days in exchange for lower costs.
- » [SEE APPENDIX B FOR MORE DETAIL ON SERVICES]

II. THE 2017 HURRICANES

HARVEY AUGUST 24- SEPTEMBER 2

IRMA SEPTEMBER 7-13

FIERCE, BUT “NON-EVENTS” FOR THE INDUSTRY

The 2017 hurricanes, caused a great deal of damage, but essentially became inconsequential events for the natural gas industry, thanks to the characteristics and preparation of the industry.



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The Gulf Storms—A Busy Year



- » Harvey(Aug-Sept) profoundly affected Houston, and had barely passed when Irma hit Florida.
- » Irma (Sept) tracked the length of the state resulting in 64% of power being lost (per EIA).
- » Then Maria (Sept) hit in the islands in the Caribbean, creating an additional logistics crisis.

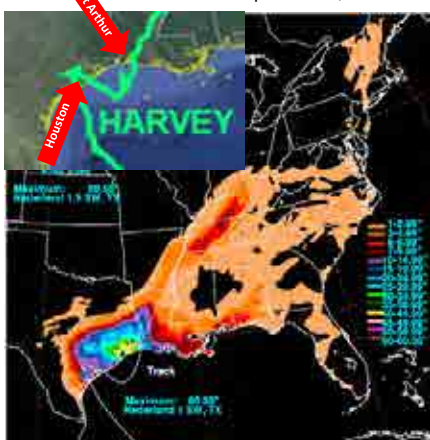


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Harvey Had a Record Impact, but the Natural Gas Industry Performed Normally

Landfall: August 24, 2017
End: September 2, 2017



Source: National Oceanic and Atmospheric Administration

- » Hurricane Harvey made landfall south of Houston, turned back out to sea, came back, stayed in place, then made landfall again at Port Arthur.
- » The resulting rain totaled 51 inches in Houston, and Port Arthur sustained both flooding and wind damage.
- » Harvey was the costliest storm in U.S. history, inflicting damages estimated at \$125 billion.
- » Yet the natural gas industry continued to perform normally before, during, and after the storm.



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Irma Took Out Power Region-Wide, but Gas Stayed on and Performed Normally

Landfall: September 7, 2017
End: September 13, 2017



Source: National Oceanic and Atmospheric Administration/NASA

- » Hurricane Irma ultimately threatened, but was not centered over the Gulf.
- » It went straight up the West Coast of Florida, causing widespread damage throughout the state that relies on natural gas for electricity more any other.
 - Power was out.
 - Natural gas supply was unimpaired to all users, including distributed generation.
 - While power outages also happened in Georgia, Alabama, and the Carolinas, none were related to unavailability of natural gas supply.
- » Throughout, gas performed normally, allowing alternative generation to operate.



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Service During Harvey Continued Normally, Due to Resilience and Preparation

- » Harvey's impact spanned the Houston metropolitan area, smaller cities south (Port O'Connor, etc.) and smaller cities to the Northeast (Port Arthur, etc.).
- » Utility and pipeline emergency protocols, well-established from experience with hurricanes, were implemented and were effective.
- » There was no failure of service to end users. At the LDC level, it was necessary in many instances, for safety reasons, to turn off gas service to end-use residences and businesses that had been flooded, in the same way that power was intentionally disconnected at such locations. Neither was a failure of service, merely a normal safety precaution in the face of severe flooding.
- » Several compressor stations in South Texas and Louisiana were closed for safety reasons, with some actual damage. Minor compressor station damage resulted in limited restriction of firm service on the affected pipelines, but restrictions were short-term and minor. End-use customers did not experience any failure of natural gas service as pipelines successfully worked around any issues.



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Reliability of Natural Gas was Unaffected by Harvey

- » The most widespread problem caused by Harvey was severe flooding. Fortunately, high-wind damage was limited, thus avoiding widespread power outages from damage to transmission and distribution lines. Gas-fired generation performed normally, with no impairment of natural gas supply.
- » The most pronounced impacts of Harvey involved mobility.
 - For pipelines headquartered in the Houston area, this meant operating systems and managing customer nominations using remote locations and distributed networks.
 - For the gas distribution system, this meant needing to reach areas of severe flooding to turn off gas for safety reasons, in flooded residences and businesses.
 - Impassable roads meant that large fleets of boats and large trucks were necessary to locate crews where they were needed.
- » The Texas Railroad Commission reported no significant problems for natural gas facilities or operations.
- » Thanks to natural gas resilience, Harvey—the most costly storm in U.S. history—was a fully manageable event for natural gas service.



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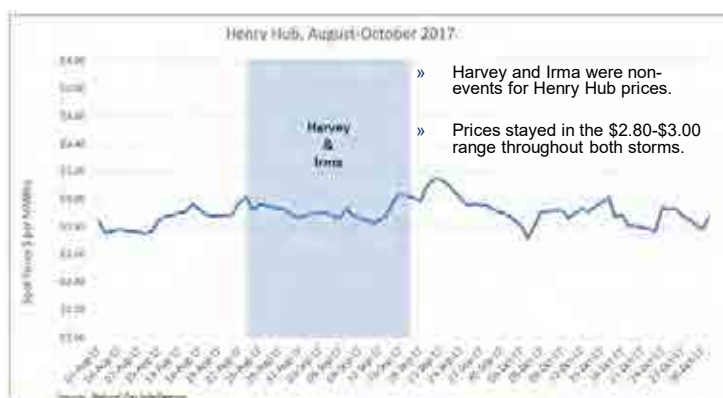
20

Pipelines and LDCs Delivered During Irma

- » Irma did not cause any restrictions to firm pipeline service.
- » Very limited end-use curtailment took place, due to damage to LDC lines from uprooted trees.
 - The duration was only 24 hours until repairs were accomplished.
 - Meanwhile, since residents had been evacuated for safety reasons, the limited service interruptions were insignificant.
- » Storm damage incurred by the gas industry primarily involved above-ground LDC facilities such as buildings. Damages did not affect reliability of service.

Henry Hub Spot Prices Through Harvey and Irma

Spot market price behavior can be a good indicator of whether any pipeline constraints exist that may eventually cause pressure on service. Through both Harvey and Irma, *no constraint-driven price behavior was observed.*



Irma: Widespread Power Outages, No Meaningful Gas Outages

- » Irma's impact spanned the entire Florida peninsula, plus areas of states such as Georgia (although at lower intensity than in Florida). Utility and pipeline emergency protocols, well-established from experience with hurricanes, were implemented and were effective.
- » The most widespread energy problem caused by Irma was damage to power transmission and distribution systems, causing the loss of 64 percent of Florida's electric load (EIA "Today in Energy," December 21, 2017). Two nuclear units went offline, but there are no reports of gas-fired generation failing to run when needed. Primarily, the loss of load caused all generation to operate at low levels or not at all.
- » But natural gas service continued *normally*, with pipelines and LDCs both avoiding major impairment—gas flowed even when power could not.
- » **Thus, those customers with distributed gas generation, combined heat and power, and gas-fired emergency generation were able to maintain power service.**



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Shale Gas Has Hurricane-Proofed the Industry for a Decade

- » This experience was very different from past experience with Gulf hurricanes.
 - Historically, Gulf hurricanes had a serious impact on supply availability from offshore, creating sudden supply-demand imbalances that drove prices up.
 - Physical supply was maintained, primarily by pulling very hard from other areas such as Texas.
 - While service remained resilient, there were significant economic consequences in the form of higher natural gas prices caused by the supply-demand balance and pipeline bottlenecks moving gas from Texas.
- » Due to the shift from largely Gulf of Mexico supplies to regionally diverse onshore shale production, this phenomenon has vanished. Shale gas has "hurricane-proofed" the industry for over a decade.
- » Appendix C is an American Petroleum Institute discussion of storm impacts on the oil and gas industries. The discussion identifies no natural gas issues. Shale-driven abundance has caused natural gas supply to be a solution, not a problem.



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Hurricane Proofing Shows By Comparing 2005, 2008, and 2017

- » The surge in abundant onshore production has made hurricanes a non-event with respect to price volatility, as compared with 2005.
- » Aside from the obvious impact of shale-driven abundance in lowering the overall non-hurricane levels from \$7.00 to \$3.00, there was simply no spike in prices like that experienced in 2005.

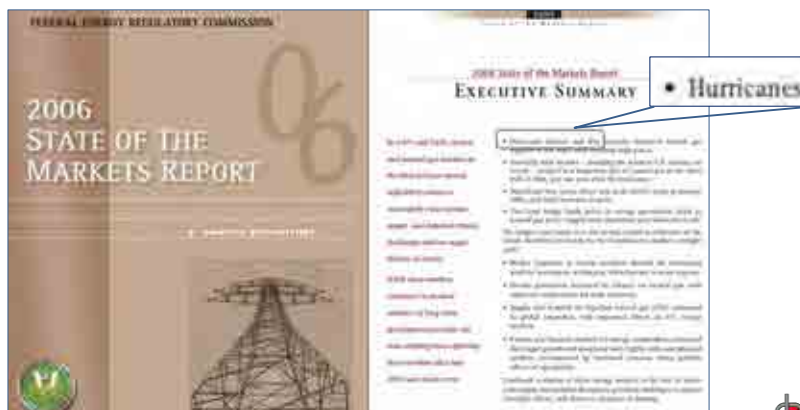


The first full demonstration of this hurricane-proofing was in 2008:

- » Gustav and Ike affected the same level of offshore production as Katrina and Rita.
- » But prices were flat despite the storms, actually declining afterward.

FERC Saw Hurricanes as Very Important in 2005. . .

- » The impact of the 2005 storms was apparent in FERC's State of the Markets report covering 2005.⁴ "Hurricanes Katrina and Rita" were the first words of the report.



But a Non-Issue in 2017

- » But the words “hurricane,” “Harvey,” and “Irma” do not appear anywhere in the FERC State of the Markets Report covering 2017.⁵
- » The FERC market analysis clearly did not consider the hurricanes to be market “events.”



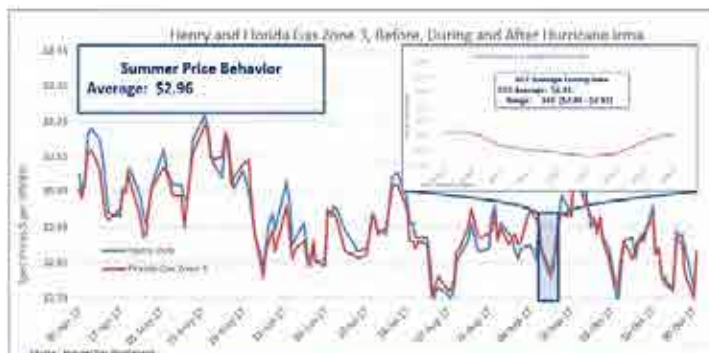
In Addition to Insulation from Offshore Losses, Industry Resilience Showed Onshore

- » Harvey's onshore impact went from approximately Port O'Connor to Port Arthur, with Houston's massive population and industrial concentration in the center a primary target.
- » That arc defines the Houston Ship Channel (HSC) market area.
- » Service continuity for the HSC during the storm is strongly indicated by HSC prices that were actually more stable than during other portions of the summer, as shown below.



Service/Price Continuity Also Prevailed for Irma and Pipeline Service to Florida

- » Irma tracked up the west side of the Florida peninsula. Price activity indicated no real Irma-related impact on pipeline service
- » The primary price index for the entry point into Florida, FGT Zone 3 shown below, tracked Henry Hub prices throughout the summer.
- » During Irma itself, both level and volatility were below the results for the full summer. (Florida city gate prices were only sporadically reported during the storm, but no major pipeline outages were reported, so FGT Zone 3 is representative of wholesale spot prices).



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III. THE BOMB CYCLONE AND NORTHEAST FREEZE

RELIABILITY AND PRICE STABILITY FOR FIRM CUSTOMERS

The Northeast Bomb Cyclone provided a winter test of the natural gas network, in terms of both temperatures and wind. The industry passed with flying colors. Firm customers received full service, allowing access to reasonably priced supplies



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And then Winter—The Bomb Cyclone

Cold and Blizzard: December 27, 2017
End of Bomb Cyclone: January 7, 2018



Source: National Oceanic and Atmospheric Administration/NASA

- » In the midst of a severe cold wave and blizzard beginning in December, the Bomb Cyclone descended on the East Coast in early January.
- » A bomb cyclone, or explosive cyclogenesis, is a non-tropical hurricane-type disturbance that can happen at any time, but this winter's was coupled with severely low temperatures and substantial snowfall. It was technically labeled Winter Storm Grayson, but consistent with press reports, "bomb cyclone" has been used as shorthand for the combination of conditions that existed in the storm.⁶
- » Regional spot gas prices were high, and national spot prices were temporarily elevated somewhat, but service was maintained.



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Firm Service Was Unaffected During the Cold Snap

- » Overall, there was no curtailment of service to firm end users served by LDCs.
- » Firm pipeline customers received service between their stated contractual receipt and delivery points (Primary Firm service) with **100 percent reliability**.
- » Since primary firm customers were fully utilizing their capacity, pipelines had little or no capacity left for lower-priority customers for whom that capacity had not been built.
- » Firm end-users were unaffected by the limited instances (in both size and duration) of producer freeze-offs and pipeline outages. Gas storage and cooperative relationships among pipelines maintained supply and deliveries to the market.



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Physical Reliability Was Very High

- » In the Northeast, physical reliability was high throughout the winter event—retail gas consumers and wholesale gas customers with firm contracts received their supply to the full extent of their contractual rights.
- » The primary observable impacts were in spot-market prices. The national and regional situations contrasted sharply.
- » Nationally, Henry Hub prices increased briefly, averaging \$3.76 for January as compared with a full-winter average of \$2.99.
- » Marcellus shale gas, in close proximity to East Coast markets, averaged 68 cents below the Henry Hub average for the winter, at \$2.31 and was available at that price to East Coast customers holding firm pipeline capacity from the Marcellus.
- » However, East Coast *spot market* customers, having not locked in firm pipeline access to these low-cost supplies during peak periods, were subject to high sellers' market prices at pipeline outlets.



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Firm Customers Avoided any Run-Up in Local Spot Prices

- » Spot market customers paid a price:
 - Over the course of the entire winter, customers relying on the spot market paid average regional spot prices of \$6.74 to \$7.61 for the winter, including the impact of a sharp temporary run-up during the Bomb Cyclone.
 - However, particularly during that sharp run-up, the actual volumes traded at the very high prices averaged at most 1 to 2 percent of the market.
 - In other words, the extremely high prices did not affect a great deal of natural gas (see Slide 36).
- » Customers with firm transportation were shielded from the elevated spot prices:
 - Customers who bought gas in the production areas and transported it through firm capacity or through arrangements with marketers were able to benefit from lower supply-area prices plus the actual cost of transportation.
 - These customers paid approximately \$3.30 to \$4.00 per MMBtu average for the winter (assuming \$1.00 for pipeline transportation cost and rounding).
- » In New England, rather than buy natural gas at the high spot prices, many generators turned to their dual-fuel capability to use oil, usually for economic reasons rather than because of an unavailability of natural gas supply.

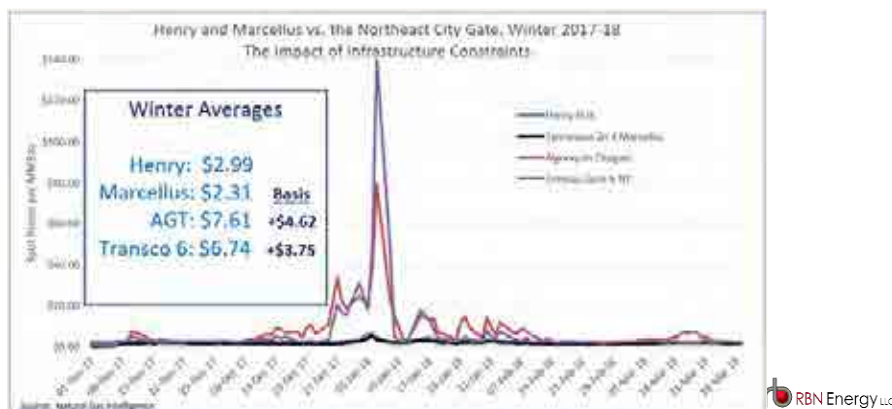


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Northeast Infrastructure Constraints Led to Large Cold-Driven Spot Price Spikes

- » The premium of as much as \$4.31 (Algonquin minus the Marcellus price plus transport) is the price paid by customers without firm transportation.
- » Only small volumes, 1 to 2 percent of the market, reported paying the extremely high prices reported at some Northeast city gates during the Bomb Cyclone.⁷



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LDCs Avoided the Bulk of the Winter Spot Price Spikes by Using Firm Service

- » Gas LDCs used committed firm transportation to reach low-price supply areas (\$3.30 to \$4.00 delivered, as opposed to the regional spot prices of \$6.74 to \$7.61 for the winter).
 - These base purchases constituted the bulk of each LDC's portfolio, but each LDC planned its business to optimize cost-effectiveness.
 - LDCs apportion their supply sources over "load duration curves," to select the most cost-effective mix of firm transportation, storage, peak shaving such as propane-air or LNG, and high-price spot purchases, based upon the expected frequency or infrequency of severe weather spikes.
- » Meanwhile, very little gas appears to have actually been traded at the very high prices. Based on data from S&P Global Market Intelligence (SNL),⁸ less than 1 percent in New England and less than 2 percent in New York City was traded at those high prices.

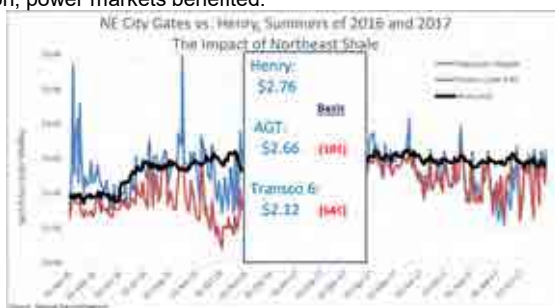
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The Summer Experience Demonstrates What Adequate Pipeline Capacity Could Mean

- » Despite the high prices experienced during a harsh winter, the Northeast summer experience (when electric load peaks for cooling demand) indicates how the region could perform with adequate pipeline capacity.
- » In the summer (as demonstrated here by the actual history for the summers of 2016 and 2017), flexible pipeline capacity and nearby low-cost Marcellus shale gas yielded spot prices well below Henry Hub. New York and New England had some of the lowest natural gas prices in the United States, and since that was during the electric peak season, power markets benefited.



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IV. GAS-FIRED POWER IN THE BOMB CYCLONE

EXPOSING THE COST OF INADEQUATE PIPELINE COMMITMENT

Gas-fired generation with firm pipeline transportation performed normally during the Bomb Cyclone, while generation without firm pipeline transportation was exposed to high spot prices. All necessary power generation received service.

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How Gas-Fired Generation Fits In

- » Power generators are particularly affected by the firm-interruptible distinction, because a large number of generators rely on interruptible transportation despite their generation commitments to power markets.
- » Debates around resilience at the Federal level are focused on electric service.
 - In those debates, gas-fired generation tends to be singled out as endangering electric reliability and resilience—but far too often without any real inquiry into generators' contracting decisions.
 - The resilience shown by the natural gas industry, as recounted in this study, translates to resilience of gas-fired generation, but only to the extent that generation commits to pipeline capacity through firm contracts. Generators choose the level of reliability and resilience they desire from pipeline service.
- » Thus, it is valuable to review the experience of generation during the Bomb Cyclone, primarily through reports of the RTO/ISO operators of organized markets and the observations of the EIA and FERC.



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Overall Conclusion as to Generation

- » The regions heavy in gas-fired generation performed well during the Bomb Cyclone. As noted, firm gas customers received their fuel as needed, without interruption.
- » On a broader scale, when spot-price-dependent generation became very expensive, markets such as New England caused generators to move to alternate fuels, primarily oil.
- » In PJM, a market where generators make extensive use of firm transportation, the escalation in Henry Hub prices caused coal to be temporarily more economic, so the generation mix was adjusted to run existing coal plants. Gas plants could have run at a higher level, but were held in reserve as "out of the money," a statistic that was misinterpreted by DOE's National Energy Technology Laboratory (NETL), and corrected by PJM as demonstrated in Slides 41-44.
- » Overall, no threats to reliability were reported.
- » **Outcomes were based on a series of economic choices.**



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NETL's Claim and PJM's Response

- » As noted, DOE's NETL issued a report on the role played by coal and nuclear units⁹ claiming that PJM's dispatch of coal units during the Bomb Cyclone meant that there would have been a major reliability crisis without coal.
- » PJM strongly contradicted that conclusion.¹⁰ PJM stated in no uncertain terms that its dispatch decision was purely economic, and that no resource shortage drove its choice to run coal plants. Below are the NETL statement and PJM response:

NETL Report, Executive Summary at p. 1

"In PJM, the largest of the ISOs, coal provided the most resilient form of generation, due to available reserve capacity and on-site fuel availability, far exceeding all other sources (providing three times the incremental generation from natural gas and twelve times that from nuclear units); without available capacity from partially utilized coal units, PJM would have experienced shortfalls leading to interconnect-wide blackouts."

PJM Response to NETL, March 13, 2018 (emphasis added)

"PJM agrees that the report underscores the importance of a fuel-secure generation fleet to serve future demands. But in PJM's view, the report erroneously concludes that the relative economics of coal and nuclear vs. natural gas during the cold snap, which drove the dispatch of coal units (i.e., that the cost of coal was lower), indicates that the system would have faced "shortfalls leading to interconnect-wide blackouts" during this period. As PJM demonstrated in its own report on system performance during the cold snap, **PJM had adequate amounts of resources to supply power—the price of natural gas relative to coal and nuclear during the cold snap drove dispatch decisions.**

During the cold snap, the region experienced an increase in the price of natural gas, which made coal resources (which often did not run under periods of lower natural gas prices) the more economic choice during times of high gas prices. **But one cannot extrapolate from these economic facts a conclusion as to future reliability within PJM.**



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EIA and RTO/ISO Reports on the Winter

- » While PJM, ISO-NE, and NYISO all published post-mortem reports examining performance during the Bomb Cyclone,¹¹ the Energy Information Administration (EIA) published a single overall report on all three.
- » The EIA report is included with this study as Appendix D. Its comprehensive view is best summarized by the main headline of the report:

"Market design changes and winter preparedness actions help Northeast and Mid-Atlantic electricity markets handle January's bomb cyclone weather event."

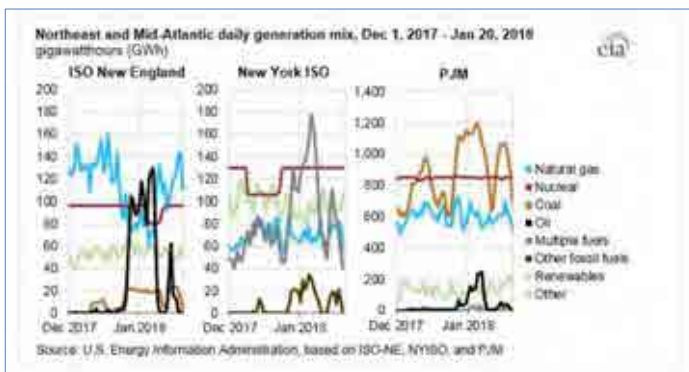


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EIA's Overall Summary of Northeast Generation

- » Of the three markets, only New England saw a sharp drop in gas-fired generation (the blue line) and a corresponding increase in alternate fuel during the Bomb Cyclone, representing the use of oil (black) to avoid high spot prices for generators that did not have firm transportation available.
- » PJM (whose electric load was six times as large as either New England or New York) saw a significant increase in coal use (brown), rather than a turn-up of gas facilities. As PJM has explained, this was strictly an **economic decision, not a lack of availability of gas.**

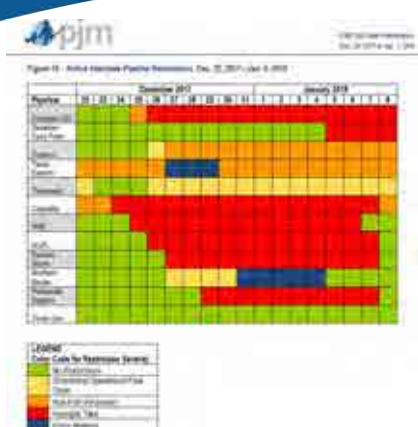


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PJM's Tabulation Shows High Pipeline Reliability



- » PJM's report on the cold snap included a tabulation of the situation on 11 pipelines spanning its extensive footprint, from December 22 to January 8.¹²
- » The tabulation itemized, by pipeline and by day, periods of no restriction (green), days covered by operational flow orders (OFOs, yellow), the restriction of "non-firm" service (orange), the restriction of flows to ratable takes (red), and the occurrence of *force majeure* outages (blue).
- » Out of 198 pipeline/day combinations, there were only eight days that experienced any *force majeure* events, and PJM clarified that all such events **affected only non-firm service:**
 - ***"There were no reported firm capacity restrictions during this period, and all force majeure events were related to generators with interruptible capacity."***¹³

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Other Power Issues: More Clarity as to Forced Outages

- » Within the RTO/ISO community, natural gas contracting decisions are often included in the overall forced outage.
 - For example, as noted above, PJM indicated that there were no firm restrictions on pipeline service during the Bomb Cyclone. However, the same report showed substantial gas-related forced outages:



- **PJM's language cited earlier made it clear that gas outages were the result of contract choices, not any failure on the part of the gas industry.**
- » It could be very helpful to provide more detail as to the reasons for forced outages in all situations.

V. COMPANY CASE STUDIES RELIABLE SERVICE FROM EVERY SECTOR THROUGHOUT THE WEATHER EVENTS

A summary examination of individual company experience demonstrates both the techniques and the success of company preparation and response.

Overall Structure of Outreach

- » Ultimately, this study effort reached out to 25 companies in the pipeline, production, and local distribution business, spanning areas affected by all three storms.
- » Detailed responses or interviews were completed by two thirds of the survey population.
- » The conclusions throughout this study incorporate the consensus observation of those companies, additionally informed by public information from various regulators and by reviews of both mainstream media and industry trade press sources.
- » However, a few anecdotal or consolidated examples stand out as worth exploring here.



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Representative Pipeline Assessment of Generic Storm Impact (1)

This is an individual company's summary, from a system that spans both the Gulf Coast and the Northeast. The response epitomizes what was received from the major pipeline systems as their overall reaction to weather events, so is included here as generic guidance:

- » Pipelines have very detailed and extensive Integrated Preparedness Procedures on how to handle various events that may impact the pipelines systems that cover operations, physical interruptions, weather events, and cyber events, to name just a few, that allow for a very quick response and recovery.
- » Weather events such as hurricanes and or cold weather periods impact very specific areas of the pipelines and do not impact overall system operations or deliveries.
 - Typically there is minimal to no impact to compressor stations along the Gulf Coast as they are built to sustain high winds and flooding.
 - Stations shut in and personnel evacuated for safety are re-manned as early as possible.
 - Pipeline to pipeline interconnectivity and other compression not impacted by the storms were sufficient to meet all firm obligations.
 - Biggest impact to pipes during the hurricanes was the overall load decrease due to the electric infrastructure failure along the Gulf Coast—without power lines, there is nowhere for generated power to go, so gas-fired generation runs less, despite having access to fuel.



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Representative Pipeline Assessment of Generic Storm Impact (2)

- » Bomb Cyclones (cold weather events) and hurricanes typically have very little impact to the pipeline systems.
- » Very little generation load in New England is contracted for firm service;
 - Generation load desiring to obtain gas supply and deliver under interruptible services would most likely not flow during the Bomb Cyclone, leaving the generator to buy gas in a "seller's market" at the outlet of the pipeline.
 - Generation committed to firm transportation had reliable service.



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Example of Preparation Leading to Reliability in the Bomb Cyclone

- » **Planning and Briefing:**
 - Gas Control Leaders collaborated with Field Operations Leaders to understand the potential impact of the looming weather. From that collaboration, a facility staffing plan was developed to ensure reliability and accessibility of the facility at risk.
 - Update calls were implemented to provide a field assessment and current weather conditions. These calls occurred as needed, once a day, twice a day, or more frequently – depending upon circumstance. Gas Control monitored forecasts and increased line pack anticipating strong market pull.
- » **Operation:**
 - Storage wells were in a ready state and strategically activated for optimized operational needs.
 - System health checks were conducted on real-time systems (SCADA) and members of the Technical Services team continued those health checks around the clock.
 - Field personnel stood ready around the clock to provide on-site support with compressor stations, measurement equipment and storage facilities across the system.
- » **Monitoring and Coordination:**
 - Members of the commercial operations team monitored electronic bulletin boards (EBB) of other 3rd party pipes to understand other pipes' risk for receipt, deliverability, and/or restrictions.
 - Members of the Mid- Atlantic Contingency Group (representing nearly 21 pipes – LDCs, Midstream, Producers, Pipelines, etc.) participated in meetings to share best practices and weather preparation activities.



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Sample LDC Preparations— Harvey & Irma

- » A variety of responses were received from utilities in both Texas and Florida, both being areas well used to hurricane impacts. Thus, the types of preparations were very similar across the two areas. A composite of the responses follows:
- » Upon notice that a storm is likely, depending on the severity of the expected event, the utility implements various levels of the measures contained in its emergency operations plan (EOP). These include:
 - Updating and confirming contact lists for company personnel, regulatory agency, and pipelines;
 - Testing emergency generators;
 - Coordinating with first-response agencies to be ready to disable gas service if hazardous situations are present;
 - Communicating with public agencies to be aware of transportation issues;
 - Confirming availability of alternative transportation in the event of flooding;
 - Ensuring that alternative communication mechanisms work in case of communication interruption;
 - Briefing service and distribution crews for emergency response;
 - Mobilizing fallback locations for operations coordination, service support, etc.;
 - Arranging temporary housing for emergency-response and key operational employees.



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Sample Northeast LDC Preparations—Bomb Cyclone (1)

- » Planning and Briefing:
 - Staff meteorologist monitored government and contract weather services for developing weather systems to identify those that could adversely impact utility operations and/or infrastructure. Advisories were issued regarding progress, timing, and expected severity and impact.
 - Conference calls were held to provide weather updates and to help ensure preemptive steps required in each organizations Emergency Response Plans were implemented.
- » Coordination:
 - Agreements were in place (including the associated Memorandums of Understanding) with local, city, county, and state emergency management organizations for parking and storage of equipment.
 - Participated in Mutual Assistance calls with Regional Mutual Assistance Groups (RMAGs) to discuss plans and impacts of coastal storm, resource needs, and availability.
 - Initiated communications with key external stakeholders focusing upon the potential of a coastal storm event.
 - Established communication with transportation agencies to get updates on transportation due to storm.
 - Contacted other utilities and contractors regarding availability for gas and electric support..



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Sample Northeast LDC Preparations—Bomb Cyclone (2)

» Procedures, Materials, Staffing:

- Ensured Emergency Preparedness to coordinate augmented requirements with gas and electric operations.
- Initiated the appropriate level Incident Command Structure (ICS)
- Activated the necessary System Emergency Assignments for supplemental resources requirements
- Reviewed and updated materials and equipment required before, during, and after a significant coastal storm;
- Reviewed and updated staffing requirements
- Reviewed past coastal storm performances and implementation/documentation of process improvements realized thereby.
- Ensured protection of locally stored equipment and critical supplies, from potential flood damage.
- Identified and updated staging/evacuation areas for the purpose of storing equipment and materials in response to a significant coastal storm.
- Coordinated with Logistics and other supporting groups, as appropriate, to update this information.
- Assigned employees to emergency storm positions.



VI. CONCLUSIONS AND OBSERVATIONS, RESILIENCE IN THE FACE OF WEATHER CHALLENGES



The Gas Industry Showed its Resilience through Major Challenges

- » Based on the public records, interviews, and observations of the three major weather events affecting the last year, the gas industry faced the full range of the challenges weather can pose, and prevailed convincingly.
- » Succeeding through these events without reportable issues fully demonstrates the first aspect of resilience -- resistance to shocks that can cause damage..
- » Rapid recovery from or mitigation of any issues that did occur demonstrates the second aspect of resilience.
- » The most significant effects that were observed were the economic consequences of the freeze and Bomb Cyclone, primarily involving gas prices for power generation where sufficient firm commitments were not in place.



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The Northeast Experience Shows More about Choices than Resilience

- » In the areas hardest-hit by the freeze and Bomb Cyclone, price behavior reflected the contractual choices of pipeline users in the market, and otherwise generally tracked normal supply and demand.
- » In power markets, successful management of gas along with other resources maintained reliability, sometimes holding gas in reserve for economic reasons.
- » The extent to which some coal and nuclear facilities were temporarily relied upon could suggest that as those facilities phase out and gas becomes more of a dominant baseload fuel, the longstanding need for more firm transportation in some markets may be exacerbated and confirmed.
- » The need for market participants to firm up their contractual requirements as the generation mix evolves does not indicate a lack of resilience in natural gas supply and infrastructure—just a need for the market to evolve.



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Footnotes

- 1_/ The Natural Gas Council (NGC) comprises the primary national trade associations for the natural gas industry: the American Gas Association; the American Petroleum Institute; the Independent Petroleum Association of America; the Interstate Natural Gas Association of America; and the Natural Gas Supply Association.
- 2_/ <https://www.merriam-webster.com/dictionary/resilient>
- 3_/ Presidential Directive PPD-21, "the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents."
- 4_/ <https://www.ferc.gov/market-oversight/reports-analyses/st-mkt-ovr/som-rpt-2006.pdf>
- 5_/ <https://www.ferc.gov/market-oversight/reports-analyses/st-mkt-ovr/2017-som-A-3.pdf>
- 6_/ "What the Heck is a Bomb Cyclone?" Rachel Feltman, Popular Science, January 3, 2018 <https://www.popsci.com/bomb-cyclone>
- 7_/ S&P Global Market Intelligence, Daily Gas Report, January 8, 2018 page 11, Electronic Bulletin Board Operationally Available Capacity reports for Algonquin Gas Transmission and Transcontinental Gas Pipeline, analysis by RBN.
- 8_/ *Ibid.*
- 9_/ https://www.netl.doe.gov/energy-analyses/temp/ReliabilityandtheOncomingWaveofRetiringBaseloadUnitsVolumeITheCriticalRoleofThermalUnits_031318.pdf
- 10_/ <http://www.pjm.com/~media/library/reports-notices/weather-related/20180413-pjm-response-to-netl-report.ashx>
- 11_/ www.pjm.com/~media/library/reports-notices/weather-related/20180226-january-2018-cold-weather-event-7_7_report.ashx
https://www.iso-ne.com/static-assets/documents/2018/02/02272018_pr_remarks_state-of-the-grid.pdf
http://www.nyiso.com/public/webdocs/markets_operations/committees/bic_miwg/meeting_materials/2018-04-02/Item%20C%20-%20NYISO%20Winter%20Operations.pdf
- 12_/ www.pjm.com/~media/library/reports-notices/weather-related/20180226-january-2018-cold-weather-event-report.ashx, p. 18
- 13_/ *Ibid.*, p. 17.

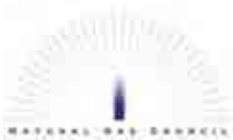


APPENDIX A JULY 2017 NGC RELIABILITY REPORT





Natural Gas Systems: Reliable & Resilient



July 2017

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Preamble

Our trade associations, who together comprise the Natural Gas Council and represent the natural gas delivery system from production to consumption, originally researched and developed this white paper to inform a North American Electric Reliability Corporation (NERC) special assessment on any potential risks to bulk power system reliability from a single point of disruption on major natural gas infrastructure facilities (e.g., storage facilities, key pipeline segments, LNG terminals). The facts and data we gathered in the process of preparing information for NERC underscored the exceptional reliability of the natural gas system. It also revealed the need for a comprehensive resource that explains the underpinnings of natural gas reliability, both physical and contractual. The white paper that follows is the result of our joint effort.

The Natural Gas Council

Members:

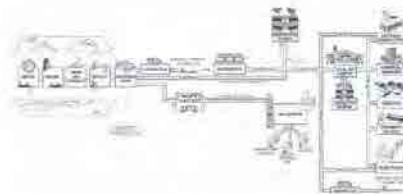
American Gas Association
American Petroleum Institute
Interstate Natural Gas Association of America
Independent Petroleum Association of America
Natural Gas Supply Association

July 2017

1. Introduction

The United States has abundant natural gas resources that enable our industry to satisfy customer demand fully. In only a few years' time, the U.S. has become the largest producer of natural gas in the world. Estimates of the gas resource base have more than doubled in the past decade.¹ Since 2010, production has grown almost 30 percent, with government forecasts calling for production to once again reach the record of near 75 billion cubic feet per day this year.² The natural gas supply chain is extensive and spans from the production well-head to the consumer burner-top (see illustration).

Critical Elements of the Natural Gas Supply Chain



Source: The American Petroleum Institute, AIA and Natural Gas Industry Participation Institute (AIAI), 2016.

¹ See Petroleum Geoscientists' *Revised Review of Potential Supply of Natural Gas in the United States*, (December 11, 2014, 2015), available <http://www.aiaa.org>.
² See AIA Short-Term Energy Outlook, May 2017 available <http://www.aiaa.org> and AIA Natural Gas Summary (Current Table Available, available <http://www.aiaa.org>).

¹ Consumer natural gas demand has grown steadily since 2009 for a variety of reasons: it is abundant, inexpensive, burns clean and is affordable. Natural gas provides economic growth and jobs, gives U.S. industries a competitive advantage over their global competitors.

² Owing to the emergence of gas-intensive manufacturing in the U.S. and the amount of investment in natural gas infrastructure, the U.S. has a growing natural gas surplus.

³ As the world's most abundant fossil fuel, natural gas is also abundant, distributed around the globe, and easy to transport, and its use is growing rapidly. The U.S. has a growing natural gas surplus. Natural gas is abundant, distributed around the globe, and easy to transport, and its use is growing rapidly. The U.S. has a growing natural gas surplus. Natural gas is abundant, distributed around the globe, and easy to transport, and its use is growing rapidly. The U.S. has a growing natural gas surplus.

⁴ Yet, with the increasing growth in power demand, some – particularly those associated with natural gas pipelines and power plants – question the ability of natural gas to continue to reliably serve this market. In this paper, we evaluate how the physical characteristics of natural gas, as well as operational factors, provide an extremely high level of reliability and efficiency for power generation. This paper also explains that while the natural gas market is physically reliable, if large volume customer require uninterrupted service, they must choose to enter into a long-term contract with a gas supplier.

⁵ The United States is the world's largest natural gas producer and consumer. The U.S. has a growing natural gas surplus. Natural gas is abundant, distributed around the globe, and easy to transport, and its use is growing rapidly. The U.S. has a growing natural gas surplus.

⁶ The U.S. has a growing natural gas surplus. Natural gas is abundant, distributed around the globe, and easy to transport, and its use is growing rapidly. The U.S. has a growing natural gas surplus.

2. Physical Reliability of Natural Gas Network – Due to Operational Characteristics

The physical properties of natural gas production, transportation and distribution make the system extremely reliable and efficient. The system is based on a few key principles: (1) the high flow rate, (2) the high pressure, (3) the high temperature, and (4) the high density. These properties make the system extremely reliable and efficient.

The natural gas network has two major points of failure: the gas wells and the gas pipelines. The gas wells are the source of the gas, and the gas pipelines are the main mode of transport. The gas wells are the source of the gas, and the gas pipelines are the main mode of transport.

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¹² The U.S. has a growing natural gas surplus. Natural gas is abundant, distributed around the globe, and easy to transport, and its use is growing rapidly. The U.S. has a growing natural gas surplus.

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¹⁵ The U.S. has a growing natural gas surplus. Natural gas is abundant, distributed around the globe, and easy to transport, and its use is growing rapidly. The U.S. has a growing natural gas surplus.

¹⁶ The U.S. has a growing natural gas surplus. Natural gas is abundant, distributed around the globe, and easy to transport, and its use is growing rapidly. The U.S. has a growing natural gas surplus.

has instead chosen to keep matters, well, in-house, even appointing the *gasControl* as its compliance officer, the position in a relatively self-contained offshore resource. Offshore means the internal, protected of the *Belcor* system by controlling the amount of interest gas entering and leaving the system. The process of increasing or decreasing gas flows remains completely steady (in a natural gas system because of the compressible nature of the gas). This responsibility allows the limitation of oil inputs and maintains the probability of delivery to a specified customer level, even in the event of an emergency production closure, which back the market will be publicly stated soon to increase the interest gas pressure from threatening the smaller's integrity. This was demonstrated on January 7, 2013 during a "prime contract" operation that distributed to some large users of the United States and a small town delivered gas amount of 100 m in a classic amount of 157.1 Btu in a single day.¹⁰ Despite the environmental protection level's required for safety, however, all of the work supply and emergency resources.

The just-linked Energy Regulatory Commission (FERC) and the Securities and Exchange Commission issued similar findings about the reliability of the natural gas pipeline during market clearing periods in the last half year of February 2011. The findings issue of the linked issues experienced historically with another firmament to experience success in the energy system in Texas, New Mexico and Arizona, and found the pipeline's operation in these areas to fail. During the 2011 business hours, 200000 cubic feet of gas were not transported as planned. During the 2011 business hours, 200000 cubic feet of gas were not transported as planned. During the 2011 business hours, 200000 cubic feet of gas were not transported as planned.

For more information on the *Journal of Management Inquiry*, please visit the journal's website at <http://jmi.sagepub.com>. For more information on the *Journal of Management Inquiry*, please visit the journal's website at <http://jmi.sagepub.com>. For more information on the *Journal of Management Inquiry*, please visit the journal's website at <http://jmi.sagepub.com>.

distribution systems due to the loss of some production to well freezing at a time of increased gas system demand.¹⁶ In contrast, 4.4 million electric customers were affected over the course of the same event.¹⁷ Nonetheless, the *Southwest Cold Weather Report* found that only 10 percent of the electric generation failures were due to fuel supply problems,¹⁸ and that “[f]uel supply problems did not significantly contribute to the amount of unavailable generating capacity in ERCOT.”¹⁹ Further, as noted in the *Southwest Cold Weather Report*, “[a]necdote was found that interstate or intrastate pipeline design constraints, system limitations, or equipment failures contributed significantly to the gas outages. The pipeline network, both interstate and intrastate, showed good flexibility in adjusting flows to meet demand and compensate for supply shortfalls.”²⁰

Other characteristics of the natural gas system contribute to its historical operational reliability and system resilience. The natural gas transportation network is composed of an extensive network of interconnected pipelines that offer multiple pathways for rerouting deliveries in the unlikely event of a physical disruption. In addition, pipeline capacity is often increased by installing two or more parallel pipelines in the same right-of-way (called pipeline loops), making it possible to shut off one loop while keeping the other in service. In the event of one or more compressor failures, natural gas pipelines can usually continue to operate at pressures necessary to maintain deliveries to pipeline customers, at least outside the affected

- Southwest Cold Weather Report at 2
 1611 at 5.
 1612 at 1405-1412
 1613 at 1513.
 1614 at p. 211.

segment. "Line pack"²¹ in the pipelines can be used, if necessary, to provide operational flexibility, as noted in the *Southwest Cold Weather Report*.²² As noted above, because of the inherent characteristics of natural gas and the interconnected pipeline system, operators can control and redirect the flow around an outage in one segment. The existence of geographically dispersed production and storage, and its location on different parts of the pipeline and distribution system, also provides flexibility for operators to maintain service in the event of a disruption on parts of the transportation and distribution system.

Similarly, producers use various methods to help ensure operational continuity. Because producers have an economic incentive to continue to flow gas out of the producing field at a constant rate, many techniques are in place to help ensure that operations continue or that any disruption is minimized when a problem arises. While not always possible, producers often rely on more than one processing plant or pipeline rerouting options in a production area, especially when handling a significant level of production. In the unlikely event of an unavoidable disruption of supply at a well or in a field, producers have many other options to balance their supply commitments, including increasing production in other areas or using natural gas they have in storage.

3. The Natural Gas Industry – Focused on Cyber & Physical Security Risks

²⁹ Line pack is the volume of natural gas contained within the pipeline network at any given time. It allows gas received in one area of a pipeline system to be delivered simultaneously elsewhere on the system. It can facilitate non-routine flows and support pipeline reliability as a temporary buffer for imbalances. However, line pack must be kept reasonably stable throughout the system to preserve delivery pressure and system capacity. Thus, line pack neither creates incremental capacity, nor is it a substitute for appropriate transportation contracts.

Southwest Cold Weather Report at 68,70

Cyber and physical security are integral to the natural gas industry. Natural gas pipelines, which move over one-third of the energy consumed daily in the United States, are considered critical infrastructure. All along the natural gas supply chain, from production to delivery, the industry employs a portfolio of tools to help ensure protection of its facilities from both physical and cybersecurity threats.

On the physical security side, fences, routine patrols and continuous monitoring, as appropriate, help protect above-ground facilities such as compressors, well sites, processing plants and meter stations. The natural gas industry routinely holds briefings and workshops to discuss security concerns, and it has developed industry guidelines and identified leading practices to protect facilities and data. Natural gas trade associations and their members regularly run simulated exercises in response/recovery efforts to help prepare in the event of natural or man-made disasters and work closely with government agencies to share threat information and practices.

On the cybersecurity front, the federal government partners with the natural gas industry on cybersecurity frameworks and initiatives to promote situational awareness, mitigating measures and response/recovery. Critical infrastructure sectors, including natural gas, electric, nuclear, financial, telecommunications, information technology and water, use Information Sharing and Analysis Centers (ISACs) as an adaptive tool to share comprehensive analysis of changing threats within the sector, other sectors and federal and state governments. The Energy Sector is represented by the Downstream Natural Gas ISAC, the Oil & Natural Gas ISAC, and the Electricity ISAC. These ISACs work closely with one another and with other critical infrastructure sector ISACs. The federal government promotes ISACs and Information Sharing and Analysis Organizations (ISAOs) as a best security practice.

As discussed at length in the beginning of this document, there is low risk of single point of disruption (regardless of cause) resulting in uncontrollable, cascading effects. Generally, supply and transportation disruptions can be managed through substitution, transportation rerouting and storage services. Recognizing the pipeline system resilience and redundancy, the federal government continues to partner with industry on cyber as well as physical security matters. This partnership is best experienced through the TSA Pipeline Security Guidelines and various completed and ongoing security initiatives that strengthen the industry's security posture.

One of the most important aspects of cybersecurity in the pipeline space is ensuring the integrity and operability of the Supervisory Control and Data Acquisition (SCADA) system of each pipeline against cyber compromise. From a cybersecurity perspective, natural gas functions are divided across an enterprise network and an operations network (which includes control system, SCADA, and pipeline monitoring). These two networks are generally isolated from each other, and a portfolio of tools and mechanisms is used to improve the prevention, detection and mitigation of cyber penetration. Pipeline safety regulations and standards state that back-up systems cannot be affected by the same incident that compromises the primary control system; thus fail-safes and redundancies must be independent of the cause of the primary mechanism's failure.

In addition, partnership between the private sector and the federal and state governments is a key part of addressing physical and cybersecurity threats to the nation's critical infrastructure. Industry members routinely participate in internal and industrywide security situation simulation exercises – training exercises that present real-world challenges – with

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Above, we discussed the high level of reliability provided by the natural gas industry in terms of its physical operations and ability to deliver to its customers. Yet, in order to benefit from this reliability, large-volume customers, such as industrial users, electric generators, commercial customers and LDCs, must do their part to ensure continuity of service by contracting for firm transportation services to meet their own or their customers' obligations. Absent customers' purchasing pipeline capacity on a firm basis, pipelines may not have spare transportation capacity available on their systems, or a higher priority firm transportation customer may bump the non-firm customers' service for reasons unrelated to physical gas or transportation disruptions. On the coldest days (known as "peak days"), when weather-sensitive firm transportation customers are using their full contractual entitlements, there may be little or no interruptible transportation capacity left over for interruptible customers.

In many circumstances, large-volume customers make arrangements to move natural gas from the wellhead to their burner-tip – that is, through the entire supply chain. In 1992, FERC, which regulates interstate natural gas pipelines, required interstate pipelines to unbundle (i.e., separate) their sales and transportation services, and to provide unbundled transportation service on an open access, not unduly discriminatory basis.²³ As a result of this restructuring, interstate pipelines exited the merchant sales function, meaning that they no longer sell the natural gas that they transport through their pipelines, and the rates they charge are only for the movement of gas through their systems. While FERC's restructuring of the natural gas industry created an

²³ The FERC's unbundling of the interstate natural gas pipeline industry was undertaken to improve the competitive structure of the industry to maximize the benefits of the Wellhead Discount Act adopted by Congress in 1989. Pipeline Service Obligations and Revisions to Regulations Governing Self-Implementing Transportation Under Part 284 of the Commission's Regulations; and Regulation of Natural Gas Pipelines After Partial Wellhead Discount, Order No. 636, 57 FR 13267 (April 16, 1992), 63 FERC Stat. & Reg. ¶ 30,939 (1992) at p.4.

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cybersecurity by employing firewalls and other tools to improve the prevention, detection and mitigation of cyber penetration. Further, natural gas delivery systems are mechanical by nature and can still be run manually if necessary. Natural gas is moved by using pressure to control the amount entering and leaving the system. Layered onto this control system architecture are devices that detect changes in pressure, which serve as a safeguard to prevent internal gas pressure from threatening pipeline integrity.

Cybersecurity is also a priority in other areas of supply chain, such as production. Many companies orient their overall cybersecurity programs around the NIST Cybersecurity Framework for Improving Critical Infrastructure Cybersecurity. Using this framework and other consensus standards can equip upstream operators with the process and tools they need to prevent cyberattacks.

Cyber risk management at any company is tailored to that company's assets and potential risks and must also be flexible to respond to ever-changing external threats and internal deployment of digital assets. Although one size does not fit all, there are some common features of cyber risk management programs for industrial control systems (ICS) employed by many offshore and onshore oil and natural gas industry companies, including: training and security awareness, segregating process control networks, restricting access to computer hardware used to manage software and industrial control programs, restricting and monitoring vendor access to equipment and systems, and on-site inspections and cyber-related drills.

4. Firm Contractual Arrangements Assure Reliability of Service

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additional level of responsibility on the pipeline customer to separately contract for supply and pipeline transportation, it has been beneficial in creating competition by giving gas customers a choice of commodity suppliers and pipeline capacity.

4.1. Understanding Contract Options – Firm vs. Interruptible

The interstate pipeline industry today is contract-based. As such, pipeline customers select the type of service (firm or interruptible) for their transportation and storage service based on their desired level of certainty and reliability. Pipeline customers ensure their gas supply reliability by taking responsibility for choosing the portfolio of natural gas transportation and storage services that meets their needs adequately, not unlike what is necessary with other fuels, such as coal and fuel oil. Pipelines schedule their capacity based on a system of nominations, and, when necessary, restrict service based upon the type of service contracted. Broadly speaking, there are two main types of service that pipeline and storage operators offer to customers: (1) firm service, whereby a shipper chooses to pay a monthly reservation charge to the pipeline that entitles it to transport or store a certain quantity of gas each day, assuming the shipper nominates the quantity and delivers to the pipeline the equivalent amount of natural gas at the receipt points specified in the contract; and (2) interruptible service, which is a lower-quality pipeline service provided by the pipeline when it has spare capacity that is either not under firm contracts or not being used that day by firm transportation customers. Within firm service, many pipelines and storage facilities provide "no-notice" service. No-notice service is the highest level of firm service that a customer can contract. It allows for the reservation of pipeline capacity throughout the 24-hour gas day. This reservation of capacity allows the

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customer to nominate its firm service on a primary basis throughout the day, offering the highest level of flexibility available on a pipeline.

Under the FERC regulations,²⁴ a firm-service shipper is entitled to “segment” its capacity daily and utilize other delivery points within the path to its delivery point if capacity is available. These delivery points along the route are called “secondary firm points.” Once scheduled by the pipeline, the transportation capacity to secondary receipt and delivery points is as firm as primary firm delivery. Primary firm-service shippers receive the most reliable service, because they have the highest priority when scheduling and are the last to be curtailed in *force majeure* (or unexpected emergency) situations. Secondary firm-service shippers are next in priority for scheduling, but once scheduled, they are curtailed *pro rata* with other primary-firm service. Interruptible shippers, if scheduled, can be bumped by higher priority firm shippers until the intra-day 2 (ID2) scheduling deadline, and interruptible shippers are curtailed before any firm pipeline customers – regardless of whether the interruptible transportation was scheduled. Subject to capacity availability on the pipeline, the option to contract for firm or interruptible service is the decision of the pipeline customer based on the level of service that it requires. If capacity is not available, a pipeline may decide to expand its system to accommodate customers’ requirements if firm commitments are made.

“Interruptible” transportation contracts (“interruptible”) can be interrupted by a higher priority firm transportation shipper for any reason until 5:30 pm, which is the ID2 scheduling deadline.²⁵ A pipeline customer chooses the contract that best suits its needs and capability to be

²⁴ 18 C.F.R. § 284.7(d).

²⁵ If existing capacity is fully committed under firm contracts, interstate pipelines are not required to expand their facilities to provide transportation service. See 18 C.F.R. 284.7(d) (“A person providing service under Subpart B,

By holding a portfolio of physical capacity assets (pipeline transportation and storage) and supply contracts, a marketer can provide flexible and responsive service to customers.

Therefore, a marketer’s services can be a reliable alternative source of supply for customers during peak periods, if the marketer holds primary firm transportation capacity to the relevant delivery points.

4.3. LDCs as Pipeline Customers

As part of FERC’s natural gas industry restructuring in 1992, LDCs converted their bundled firm pipeline sales entitlements to unbundled firm pipeline transportation rights to meet their state regulatory obligations to serve their firm “core” customers. (This is similar to the post-Order No. 888 conversions made by franchised public utilities to network integration service.) LDCs now purchase their natural gas commodity supply and arrange for the transportation of those commodity supplies on interstate pipelines to their systems. LDCs engage in long-range resource planning to ensure their access to supply and the continuous operations of their systems to ensure reliable service to these firm core customers. The delivery of natural gas to core retail customers is of primary importance to LDCs, and their planning involves assessment of potential supply chain disruptions, including commodity supply and interstate transportation disruptions, as well as disruptions that may impact their own local distribution systems.

4.4. Natural Gas-Fired Power Generation

Similar to LDCs, electric generators and other industrial and large commercial gas users must also arrange fuel supply to meet their respective requirements. These customers typically do not purchase their gas supplies from LDCs under their state-regulated tariffs – unless they are located on an LDC’s distribution system, in which case they may contract to use that system for transportation of their own gas supplies purchased in the wholesale market. More typically,

at risk of disrupted service. During a *force majeure* (or unexpected emergency) event applicable to firm pipeline customers, curtailment by interstate pipelines is based on the transportation contract in place, in which case, interruptible transportation contracts that were already confirmed are curtailed first. Interruptible transportation that was not available and never confirmed is not a curtailment of service. **Interstate pipelines do not curtail based on the end-use of the gas: FERC’s nondiscriminatory open access regulations preclude this. In fact, an interstate pipeline cannot provide transportation service preferences based on customer classification.**²⁶

4.2. Portfolio of Choice

Interstate pipeline customers can decide to secure their fuel supply through a variety of options. For example, they can purchase firm transportation directly from the pipeline, obtain firm capacity rights through capacity release (reassignment) from another firm shipper, or enter into firm bundled transportation/supply contracts with marketers. Natural gas marketers are entities that can aggregate natural gas into quantities that fit the needs of different types of buyers and then can arrange transportation of that gas to their buyers. A marketer coordinates, through various contractual arrangements, all the necessary steps to transport the gas from the wellhead to the customer. Natural gas marketers also offer natural gas supply delivered on a firm basis, which includes both the commodity and the transmission capacity needed for delivery of the gas.

C or G of this part is not required to provide any requested transportation service for which capacity is not available or that would require the construction or acquisition of any new facilities.” This contrasts with the Federal Power Act provisions that impose obligations on electric transmission owners to expand capacity to provide interconnection and transmission services. Federal Power Act section 210 and 211, 16 U.S.C. §§ 824a and 824b. Of course, interstate pipelines have an incentive to expand capacity for shippers that commit to firm contracts for the transport capacity.

²⁶ 18 C.F.R. §§ 284.7(a)(5) and 284.7(b)(1).

large, large customers of gas markets who contracted directly to interstate or intrastate pipelines that transport the gas supplies they rely on for their operations. Again, these large gas users are responsible for operating their own fuel supply and must consider the costs that supply chain, from production to their gate.²⁷ In practical terms, this means taking into consideration logistical transportation paths and pipeline scheduling and commitment practices when estimating the reliability of their gas supply. Location alone does not guarantee a large volume customer security of its gas supply. Location is just one part of a bigger picture that includes the contract it found (contract transportation) and bought (storage), and the ability obligations applicable to LDC systems.

5. Regulatory Requirements Are Relevant to Supply Chain Delivery Options

Historically, the natural gas industry has not been vertically integrated, instead relying on three industry segments: (1) upstream natural gas production, gathering and processing; (2) pipeline transportation and storage; and (3) local distribution.²⁸ Congress passed the first regulation for natural gas sold by producers to the Wholesale Discount Act of 1961, which was followed a few years later by FERC’s second set of price regulations for the sale of natural gas in the wholesale market. Gathering and processing are also not subject to

²⁷ See David Black and Michael Thoreson, B.J., “Do I know that, Market? I told the President,” 30 U. Louisville L. Rev. 119, 120 (2002) (discussing the “three segments” of the natural gas industry: production, gathering and processing; pipeline transportation; and local distribution). See also, “The Natural Gas Industry,” 100 U.S. 100 (1999) (discussing the “three segments” of the natural gas industry: production, gathering and processing; pipeline transportation; and local distribution).

price regulation by the federal government. Through the price, terms and conditions of sale, interstate transportation and storage of natural gas is regulated by FERC. Pure interstate transportation and storage of natural gas is subject to rate regulation. The distribution of natural gas by LDCs is also subject to rate regulation. All pipelines are subject to safety regulation by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration ("PHMSA") or state agencies. Numerous other federal and state agencies legislate various environmental and safety aspects of the natural gas system.

4.1. FERC Regulation of Interstate Transportation and Storage

As noted earlier, FERC's regulation of interstate transportation and storage is comprehensive. A pipeline or a storage company's contract with its pipeline customer, from the pipeline customer's contract to another, the service agreement for scheduling of service on the pipeline as well as the firm service agreement, provides to the owner of a pipeline contract or other resource owner. FERC regulations provide interstate pipelines from state-to-state distribution in providing service based on the classification of customer. This means that the identity of the customer, whether it is an LDC, electric generator, or a producer, cannot force any timing or priority of service. In addition, the pipeline is required to honor all firm service contracts.³⁰ Therefore, most of service that a customer has contracted for is of guaranteed performance.

4.2. State Regulation of Local Distribution - High Priority Customers

³⁰ FERC gas regulation defines "firm service" as a service that is "not subject to a price ceiling or a market-based or market-like price and delivery of the service is not subject to a price ceiling or a market-based or market-like price." 18 C.F.R. § 283.2(a)(2).

fuels, maintain on-site fuel storage (such as LNG or CNG), or contract for a higher level of service from the LDC (such as firm transportation or emergency service).

LDCs are regulated by most states as local gas utilities that have an obligation to serve their firm core customers – the customers for which the system is built to serve reliably. LDC systems are built to serve these firm core customers and others on a "design day" (a forecasted peak-load day based on historical weather conditions). While gas utilities may offer an interruptible "bundled" sales service (which includes commodity supply and the transportation of the supply on the local distribution system) and/or a stand-alone interruptible transportation service for the transportation of customer-owned gas on the local distribution system, the LDC may not be able to maintain interruptible transportation service at all times. During periods of high usage and system constraints, often prevalent on the coldest winter days, LDCs may call on interruptible customers to cease gas usage temporarily, upon which these customers generally switch to a back-up fuel, such as fuel oil.³¹

In the event of extreme situations that require action to be taken for reasons that include the need to maintain the operational integrity of the system and/or maintain natural gas service to designated high priority customers, including "essential human need" customers, state statutes and public utility regulations may allow an LDC to curtail services to some customers. Historically, these regulatory requirements give the highest priority to residential and commercial customers without short-term alternatives. As a result, a natural gas-fired power generator relying on an LDC distribution system, particularly on an interruptible basis, needs to consider these regulatory obligations of the LDC and, for example, plan for the use of alternate

³¹ The tradeoff for these customers is a discounted rate for the interruptible natural gas delivery service, compared with firm service rates, and the customers enter into these interruptible contractual arrangements with that prior knowledge.

6. Storage's Dual Role in the Gas Supply Chain

Understanding natural gas storage is an integral component of the natural gas supply chain, with a function different than the other components of that supply chain. Storage serves to augment natural gas production and the function of a storage facility can also provide operational flexibility for the natural gas delivery infrastructure. There are 163 underground storage facilities in the lower-48 states with a total of 648 Bcf of working gas storage capacity.³² Natural gas storage enables LDCs and interstate pipeline companies to adjust the daily and seasonal fluctuations in demand, in response to regional gas production, which generally follows a seasonal pattern. Storage helps ensure that customers have reliable service and can provide increased price stability. Storage gas storage operators have consistently provided safe and reliable natural gas storage. Because of the critical importance storage plays in the nation's energy portfolio, natural gas storage operators are continually working to help increase safety and reliability through investments in equipment, processes and methodologies.

6.1. New storage rules will have minimal impact on deliverability

PHMSA's December 2016 natural gas rule promulgating safety requirements for underground storage facilities ("Storage FR")³³ will have minimal impact on deliverability. In fact, the Storage FR is intended to clarify the function of future storage facilities and ultimately improve underground storage safety and reliability. The Storage FR, like natural gas pipeline safety regulations that preceded it, takes a functional integrity management approach to storage (API) and standardizes the methodology by which operators will analyze risk of storage.

³² <http://www.eia.gov/brochures/naturalgasstorage/>

³³ 81 Fed. Reg. 81,840 (2016).

facilities. The Storage IFR requires operators to develop rigorous risk-assessment programs that will be used to determine which preventative and mitigating measures are appropriate for the specific conditions at any given storage facility.

6.2. Underground Storage Facilities Are Not Identical

The gas pipeline and associated storage network is different in different regions of the United States. How an underground natural gas storage facility is configured and serves its market also differs across the country. Much attention has been focused on the Aliso Canyon underground natural gas storage facility. This particular facility is a prime example of how one facility's operational configuration and the way in which it serves its market differs from others.

PHMSA's underground storage rule was prompted by an October 23, 2015 leak at a SoCal Gas natural gas storage well at the Aliso Canyon storage field in California. Aliso Canyon is an integrated gas utility-owned storage facility tied directly to intrastate pipelines that serve market load. As a result, the gas delivery system in the area is dependent upon storage withdrawals to meet market demand. However, the gas pipeline and storage network is different in other regions of the United States, where storage operators instead interconnect with multiple pipelines and storage facilities from which they can access supply and transport gas.

Based on the event data reported since 1990, including the Aliso Canyon incident, the likelihood of an unplanned release from an underground gas storage well, calculated using the

Center for Chemical Process Safety's ("CCPS") American calculation for hazardous process facilities, results in a "very unlikely" to "extremely unlikely" or "remote" classification.³⁵

One well failed at the SoCalGas facility at Aliso Canyon and, in an abundance of caution, California State Regulators ordered the other 113 wells to be temporarily sealed until they could be tested to ensure their integrity and safety or plugged and abandoned. To date, 49 storage wells at the Aliso Canyon Storage facility have passed all the tests required under the Division of Oil, Gas and Geothermal Resources' ("DOGGR").

There was no mechanical failure of the other 113 storage wells at Aliso Canyon; the regulator's decision to shut down the entire facility is an example of regulatory action taken to help mitigate risk. Nevertheless, the consequences of such actions to gas and electric reliability need to be clearly understood when gas flows are restricted.

7. Conclusion

The natural gas industry is not susceptible to wide-spread failure from a single point of disruption in the same manner as the electric system because of the dispersion of production and storage, its redundant characteristics from the extensive integrated pipeline and distribution network, and its low vulnerability to weather-related events. The natural gas industry also has in place robust cyber and physical security protocols to minimize disruptions from manmade or

35. American Petroleum Institute, American Gas Association, and Interstate Natural Gas Association of America "Underground Natural Gas Storage: Integrity and Safe Operations," (July 6, 2016) at 10, available at <https://prints.phmsa.dot.gov/1NG/docs/AGA%20White%20Paper%20-%20INAGS%20Integrity%20and%20Safe%20Ops%2020160706.pdf>.

computer threats, and has a resilient, interconnected system that allows it to come back on line quickly in the rare case of a disruption.

While the natural gas industry is committed to continuing its high level of reliability, there is an equally important component of assuring continuity of service that remains the responsibility of large-volume customers. These customers should contract for the appropriate level of firm transportation service they require to ensure reliable service. Together, these two components – operational reliability and contractual continuity of service – make natural gas a secure, reliable and resilient choice for customers.

APPENDIX B

TYPES OF PIPELINE SERVICE AND IMPLICATIONS FOR GENERATORS



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A Primer on Types of Service Customers Can Choose and the Results

Basic Pipeline Service Offerings Customers Can Choose:

1. **Firm Service:** The customer pays a fixed monthly charge to reserve capacity between specific points on the pipeline, essentially leasing space whether gas flows or not. This is the highest-priority service, for which the pipeline invests capital.
2. **Interruptible Service:** The customer pays a charge per unit, only as gas actually flows, incurring no cost if gas does not flow. A lower priority service than firm, subject to availability of pipeline capacity with no guarantee of service. Pipelines generally do not invest capital to support interruptible service.
3. **Secondary Firm Service:** A hybrid, this service occurs when a firm customer deviates from the designated contractual receipt and delivery points—service is allowed, but is lower priority than service between the contractual points, which is known as “Primary Firm.”

Together, Secondary Firm and interruptible service are referred to by some pipeline customers as “non-firm service,” although Secondary Firm is really a lower-priority category of firm service as compared with Primary Firm service.



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The Meaning of Firm Service

- » “Firm” vs. “non-firm” service is not an obscure distinction drawn by the pipeline industry for some arbitrary reason. The distinction is at the heart of customer choice in the open-access pipeline environment: The type of service is a choice by the customer, determining the customer’s selected level of reliability and the pipeline’s financial commitment to supporting that reliability:
 - Firm customers are making a fixed financial commitment to the reservation of capacity, a commitment that underpins the pipeline’s investment in that capacity.
 - Non-firm customers are choosing to “pay as they go” as capacity is available, thus running the risk that firm customers will use all the pipeline’s capacity (for which they have pre-paid).
- » The firm/non-firm distinction is directly analogous to the difference between an airline passenger with a reserved seat, and a standby passenger:
 - If the plane is full, the standby passenger (“non-firm”) must wait until space is available, while the reserved-seat (“firm”) passenger has priority.
 - “Non-firm” natural gas pipeline customers are in the same situation—by not having made a commitment to the pipeline, they cannot expect equal priority to committed firm customers, or expect new investment on their behalf.



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Firm Transportation Has Been a Success

Physical Reliability of Firm Service

- » As noted earlier, due to the reliability characteristics and the capable and sophisticated operation of pipeline systems, the industry exhibited a 99.79 percent reliability in fulfilling its firm contract obligations (primary service between contractual points) over the ten years through 2016.

Price Stability through Access to Major Supply Points

- » Additionally, firm customers have been able to buy supply at supply-area prices, then transport it through their reserved capacity--avoiding regional constraint-driven price escalation. Conversely, during constrained periods, non-firm customers frequently are subject to very high constraint-driven market-area prices in the spot market, because they are subject to a sellers’ market.

Marketers Offer Additional Transportation Options

- » Other contract options can include rebundled service offered by marketers, for example providing flexible capacity on the pipeline throughout 24-hour gas day, along with options for a range of other service and levels of firmness.



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Gas and the Power Industry (1)

- » Evolution of the power industry to greater reliance on natural gas has brought fuel reliability and resilience into sharper focus.
 - The generator, like any customer, is free to select the level of service priority that suits its needs and willingness to pay.
 - The pipeline resilience and reliability are independent of the level of service priority contracted by the generator.
- » Instances in which natural gas was not available to power generators virtually always involved non-firm service, rather than the firm-service offerings of the pipelines.
- » Additionally, in examining reliability, it is important to know the character of the gas-supply arrangements feeding the subject transportation.
 - Has the generator arranged for pipeline transportation with ready access to the large, flexible and liquid gas supply markets throughout the industry?
 - Is the generator relying upon the daily spot market, at the outlets of constrained portions of the pipeline network (portions in which the committed firm customers are using all of the capacity for which they have paid)?
 - It also matters whether the customer chose to make arrangements (contractual or portfolio structures) to be able to call on commodity gas supply upon short notice (e.g., over a weekend when multi-day arrangements can cause much of the available supply to be spoken for).
- » ***Reliability for any individual customer is a function of the contractual relationships for both supply and transportation that the customer has chosen to put in place. The overall system physical reliability is a separate issue and has been excellent.***

APPENDIX C

API TRANSCRIPT REGARDING HURRICANE PERFORMANCE

AMERICAN PETROLEUM INSTITUTE

September 8, 2017
11:30 a.m. ET

Reid Porter: Good morning. Thank you for joining today's call.

Today's call will be led by API's President and CEO, Jack Gerard. We've also been joined by a leading energy expert, Guy Caruso, who's a senior and national security advisor at the CSIS, Center for Strategic and International Studies. As well as Bob McNally with the Rapidan Group, a fellow -- and also a fellow at the Columbia University Center on Global Energy Policy, and former international and domestic energy advisor in the Bush Administration.

As this discussion will involve supply and economic impact as well as historical trends, we will begin this call with a reminder of API's obligations under antitrust law.

Mara Zimmerman: So, as a reminder to everybody during today's call, there should not be any discussion or predictions about future prices, supplies, or costs. Please don't share, to the extent you have it, any confidential or nonpublic information about particular companies or vendors. And please do not make any derogatory comments regarding specific companies or vendors.

At any point during today's call, if you have a question related to an antitrust issue, please let us know.

Reid Porter: And with that, we give the floor to API President and CEO, Jack Gerard.

Jack Gerard: Well, thank you, Reid, and thank you, Mara, for that reminder as we begin today. And thank each of you for joining us on this important call today. I

It once again has been a lesson that we need to take precautions in all sectors from the production side where offshore production was off as much as 400,000, 500,000 barrels a day. Now most of that is back. Onshore, still some offline in the Eagle Ford area and the processing facilities that are needed to process both the oil and gas are affected by lack of electricity and flooding.

Those are coming back in both the oil and gas, as well as natural gas, liquid sectors. Downstream refineries in that region represent about 25 percent of the U.S. capacity and much of that was offline but it's coming back nicely. I think four to five are still offline. But many of the others are well on their way to recovery. Midstream ports and terminals are mostly open with some restrictions.

That's important, even more important, for Harvey than, let's say, it was for Katrina because now we are a major exporter of both, refined products in particular, but also crude oil. So the ability of having ports and terminals open is more important now than ever that they're coming back pretty rapidly. Another new development since Katrina is the need for rail capacity to move not only crude oil, particularly from the midcontinent to the south refineries, but also the movement of ethanol which is needed for blending to bring the gasoline to meet the 10 percent requirements.

That is also important and fortunately is coming back well. On the downstream, pipelines are critically important. Colonial pipeline serving the southeast and northeast part of U.S. is now back almost to full capacity as they're linking up with the refineries that are coming back online. The Explorer pipeline bringing product up to Tulsa and Midwest is now practically back full capacity.

And that's critically important, particularly for Colonial, because it brings gasoline into Georgia and other areas that are then serving Florida by truck. One common denominator for all sectors is electric power. And one of the differences in Harvey's impact versus Katrina is that there has been less impact on electric power capacity and outages for customers during Harvey than it was for Katrina.

want to start off, I'm sure I'm expressing your sentiments as well, that our thoughts and prayers are with those who are recovering, not only from Harvey in Texas and Southern Louisiana, but also to those who are now facing the impacts from Irma and potentially Jose; especially some of you in the regions that are in the impacted areas right now.

We -- our thoughts and prayers are with you and we greatly appreciate you joining us today for this broader conversation. Also want to say how inspired we are to see the way the communities have come together in the affected areas to help one another out. That true American spirit, if you will, or local spirit of those who realize the seriousness of these storms and what we can do to deal with them.

So today, we thought as you were writing on these events in the coming days and weeks, that it might be useful for you to have further insight knowledge about kind of the historical context of the energy landscape today, relative to other storms, to also talk about infrastructure resiliency, constraints, challenges, market demand, domestic supply dynamics in the wake of Harvey and now Irma and potentially Jose to come.

As Reid mentioned, we've invited two independent experts to join us today to talk about those issues and to answer any questions that you might have. And so we greatly appreciate Guy and Bob for taking their time today in what's a very demanding window. So with that, let me turn it to Guy Caruso. And Guy, if you'd like to share any opening thoughts and after which we'll turn to Bob McNally for his opening thoughts and we'll open the phone lines up and let you ask the two of them whatever questions you'd like about what's going on and their perspective as experts in the energy area. Guy, go ahead.

Guy Caruso: Thank you, Jack. I associate myself with those remarks about the personnel effect of this on both the industry and the consumers out there. I'm going to focus my remarks on the integrative nature of this oil, gas, and electricity sectors that have been hit so hard by Harvey, especially, in South Texas and Southern Louisiana. Harvey has hit all of the sectors from the upstream, midstream, and downstream.

So that has facilitated the recovery efforts, so it's been more of water damage than a windstorm and damage in Harvey relative to Katrina. And I think we've had some -- had some lessons learned and I think we're having a smoother recovery. When you turn to Irma, that I think is going to be a very different risk factor and that is going to affect the petroleum industry mainly because of impact on distribution and marketing.

It's the gasoline, diesel, and jet fuel markets that are at risk from increased demand, for evacuation as well as getting the proper product into the states, mainly by barge and trucks. There's no production in Florida, there's no refineries, so it's a very different risk profile as we look ahead with what might happen in Irma's case.

There's an important role for government to play in this facilitation of recovery. On the federal side, the SPR, there have been three SPR exchanges approved by the Department of Energy aiding with the supply of these refineries that were unable to get direct connection with their previous suppliers. At the EPA level, there've been some lifting -- waiver, temporary waivers of environmental restrictions having to do with volatility of gasoline and ability to put that gasoline into the distribution system as well as ethanol requirements that have been waived in some instances.

38 states have now had some form of a waiver approved. And that has really facilitated, I think, the relatively strong recovery, even though it's still being hampered by some personnel not being available due to their own personal situations. So there are -- many companies are operating at much lower than full staff at this point in Texas and less so in Louisiana.

I think there's an overarching point I'd like to make based on my experience of having been involved with disruptions, whether they be weather-related or politically motivated, such as the Arab oil embargo of '73, '74 when we had price controls allocated -- rigid allocation systems, those in my view and in many studies that have been done about that disruption were part of the problem as opposed to part of the solution.

Today, we have open markets, less restrictions on the movement of (food and add) products, and I think that has shown itself to be effective allocator of supplies even during Katrina, but even more so (with) Harvey, as I mentioned now exporting a significant amount of petroleum products. We're not able to export crude oils, and I think that facilitation of markets is really the important part of this story, and when we look back on this, perhaps several months from now, we will, I think attribute so of it to that.

And my colleague Bob McNally has recently written a book about the global impact of markets on the petroleum industry. So, with that, I'll turn it over to Bob for his opening remarks.

Bob McNally: Thanks a lot, Guy and Jack, and everyone. I'm delighted and honored to be with you. As Guy mentioned, I recently wrote a book on the history and the outlook of boom bust oil priced, so if you'll allow me before we get maybe into the nitty gritty – and Guy covered many excellent points – and (I'll have) a few things to add, but just to step back for a second and think about history, we've been in the modern oil era for about 158 years now, since Drake's first well in western Pennsylvania struck oil.

And from that day until now, if you study and you look at the oil industry, I think what will strike you is how resilient it is, how innovative it is, how it rises to the occasion, how it absorbs blows and challenges and comes back faster often than most expect. And it's really remarkable, some of those first drillers in western Pennsylvania through the great wars we had an ramping up and then dealing with some of the crises in '56, '67 and '73, and now it seems major storms one after the other. And they can be weather related, they can be geopolitical, but the oil industry, again, demonstrates remarkable resilience, and I'll talk a little bit about how we're seeing that today.

Now, for the first 50 years of the oil industry was all about replacing whale oil and stuff and lighting, and the government could really care less. But for the last 100 years, it's been about transportation – primary use of oils in transportation, and the government could care about a little more. And so, if you look at the history really, since about World War I, the government – especially the United States, at the state and federal level, takes oil very

seriously. Whether you're a Democrat administration or republican, I mean, they understand that oil is – ad for the foreseeable future will be the lifeblood of modern civilization, and they act accordingly and they take it very seriously.

When you have these crises, you have government action – the government acts with great concern as they should, whether they're acting wisely or not is a debate for historians and so forth, and guy mentioned '73 and the '70's and we're in a very different place now and I think for the better. But let me just – so with these two ideas, the resilience of the oil industry and then government understanding that again, for better or for worst, oil is the lifeblood of modern civilization, and in crises, we have to see to the quick restoration of capacity, the movement of supplies, et cetera and so forth.

Let's just think about what we've seen since Harvey, and now looking at unfortunately, Irma and Jose. I mean what strikes you is how quickly the Gulf capacity came back. I think we were – we lost at the max, with Harvey two weeks ago, some 25 percent of U.S. refining capacity underwater. No electricity, employees scattered, and now I think this morning, I saw Bloomberg reporters – roughly about only 8 percent is out and in the process of restarting.

Prices, price signals – we're in a market determined oil world now and very different in some ways than the '70's, and price signals came along in result to Harvey and it worked. Gasoline futures prices, before Harvey, they were about \$1.68 a gallon – this is wholesale prices now, not retail – you prices, this is the wholesale price. And at their peak, they surged up to \$2.15, up 28 percent, but today they're down at a – I'm looking at my screen – I think about \$1.66, so below where they were when we started this.

They shut up because of the uncertainty and the outage that I mentioned, 25 percent of refining capacity and folks didn't know how fast it would come back, how long we would have these disruptions. And those price signals were important because they did something they said to Asia and Europe, hey, we need gasoline in the United States, if you've got it, send it over here. Which in a way is kind of a turnaround temporary from the remarkable trends

in the oil market recently and that is the surge in U.S. exports of crude and especially (refining) products.

We also went from nothing years ago to where it's over 6 million barrels a day in recent months, about almost 1 million of that roughly is crude and the rest is finished gasoline and distillate and NGLs and things. So, that's good, we benefited from that trade, but in a crises like this, that we benefit from freely traded and open markets, because now if you've been in Europe the last couple weeks, you saw the prices move in your favor, you booked cargo and sent those – more cargo than normally – and you sent them across the Atlantic heading to our markets to help fill the gap.

But again, as those – as that capacity restarts and those barrels flow from elsewhere, the prices come down. So having a freely traded, open market benefits us in these crises, it makes us more resilient, if you will. Guy mentioned some of the environmental temporary (rivers) we've seen, and indeed. We've seen that on many occasions in recent years. In the last 30, 12 years, both the Obama administration, the Bush administration, now the Trump administration has had to issue temporary waivers of reformulated gasoline and so forth.

We've also seen – and don't quote me on this, because I'm just seeing it on Twitter – but I saw one journalist on Twitter say that the administration apparently has preemptively issued a Jones Act waiver for Irma, which is very important if it's true, and I would expect this, and that's because as Guy mentioned with Florida, it's about getting gasoline into that state when there's no production, no refining and pipelines could be damaged and so forth – and they get a lot of waterborne crude. So that Jones Act waiver, if necessary, and if that's what the Trump administration did, it kind of makes sense in a case like Irma. And apparently they may have done that preemptively.

And then as guy mentioned, the SPR releases, the Strategic Petroleum Reserve release, we can do (broad) drill down and we can do and have done sort of company by company releases, and that's what we did in this case. And that speaks to the importance of having a strategic petroleum reserve and thinking carefully about that reserve, and especially we just sort of mindlessly

sell it off to raise budget revenues, which is what we're in the process of doing. So one wonders if this resort to the SPR maybe makes folks just stop and think for a second and maybe think about maybe having a discussion about how the SPR should be – and reasonable people can differ on that.

But again, Harvey has reminded of the importance of having a government stockpile when you have a major, kind of, severe supply interruption, whether geopolitical, or in this case, weather, where companies just simply weren't able to ensure against that and unable to get supplies. And so, in that crisis, those – even if it's a few barrels – are very, very valuable barrels.

So, again, I think notwithstanding, Irma heading toward us and the damage has been caused by Harvey already, I think we've seen on display recently, some of the characteristics of the oil industry and government – some of the best characteristics and – which have helped us sort of weather the storms, if you will, and come through with relatively manageable impacts. And so that's, I guess, just some initial thoughts, and welcome other comments and back and forth (in) Q&A, thank you.

Guy Caruso: And with that, Operator, if you could please explain the process for the Q&A?

Operator: Certainly. At this time, I would like to inform everybody, in order to ask a question, please press star, then the number one on your telephone keypad. Again, that is star, one, on your telephone keypad. We'll pause for just a moment to compile the Q&A roster.

Your first question comes from Chris Knight from Argus, your line is open.

Chris Knight: Hi, thanks for doing this. This will either be for Bob or anyone else on the panel. With the rumored Jones Act that the senior administrator was talking about, is the idea to get gasoline into Florida before the storm hits, or where on the kind of on the back end once it hits, you want to be able to ship it any way you can?

Bob McNally: That's a great question. This is Bob and I'll defer others who may have more sort of on the ground, minute by minute knowledge. But with the storm, I think suppose to hit now in full force on Sunday, I'm unaware of an issue that

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may involve a cargo that needs to get into there tomorrow, so getting supplies in before hand. That would -- I just don't know.

And it's reasonable that if they're moving that quickly, that may be the case. But certainly anticipating that the damages and certain the ladder is I'm what they're looking at. And I think they want to probably start getting cargo's lined up now for Monday and Tuesday.

But again, I just don't have any knowledge. There may be a cargo they need to get in like now today or something. An opportunistic cargo that can move quickly, that may be the case but I have no knowledge of that. I don't know if any of our friends at API have got any visibility on that.

Male: Yes, I would agree with that Bob. That's most likely to be for the post supply that would be needed to refill the depleted inventories. And the more flexibility the industry has -- it just makes it -- facilitates recovery. Thank you BEM question please.

OPERATOR: Your next question comes from Jen Dlosky from Bloomberg. Your line is open.

Jennifer Dlosky: Thanks for doing this call. I was curious if you could talk a little bit more about the terms that govern some of these (pre) exchanges. You know, of course we have the number of barrels that have been delivered. We know deliveries are ongoing to (Vahara, Marathon, and Placid) but I'd love to hear about you know, what the trigger is for repayment. You know the -- and frankly I'm curious if there's any wiggle room for our (audible) in that process of repaying and replenishing (upfill).

Guy Caruso: Yes I think -- normally you have the exchanges that were done during the time I was at the deal. We've had 30 -- between 30 and 90 days to repay or replenish that. We've had 100,000 barrels you had 90 days to get that 100,000 barrels back to -- back into the (upfill). I haven't seen these specific contracts that were agreed to this time. But that's probably the time frame between 30 and 90 days.

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Bob McNally: Bob here, just to add, yes, not have I seen the specific details of the exchange. I imagine those are publicly available though. But I haven't seen them. I know, you know in the case of Hurricane Isaac, I know there was an exchange of a million barrels. And goh, I'm not even quite sure how long it took. I know it was like 60 or 90 days. Normally it's a -- it's a return within a certain time, and then with an added amount of oil is Premium. I know there was a case for example, yes, usually that's how they do it. It's the -- I believe with these exchanges you're delivering a little more back.

That's your interest if you will. I do know that in the case of -- there were exchanges I think after President Clinton ordered exchanges in September of 2000, I believe there were instances where those were maybe delayed and renegotiated afterwards and so forth. But, there may have been cases where I think the terms can change, I'm not saying they have now, but normally it's a straight forward, here's your oil, get it back to us in three months or two months and with a little bit extra for interest.

Jennifer Dlosky: Got you.

Guy Caruso: The other --

Bob McNally: ... And you know offline I'd be happy to point you to the DOESPR office is usually very responsive and they have a lot of information on their website too. So, I'd be happy to help with that.

Jennifer Dlosky: Thanks Bob.

Guy Caruso: Jen the other thing in that is the -- in during Katrina we asked the international energy agency to activate their sharing system. And we have particularly requested that they make product available that was in surplus in Europe. I haven't heard whether or not the U.S. government is working with the -- I'm sure they're consulting them but I haven't heard any calls for activating the IEA system. That's another way of making more product available.

Jennifer Dlosky: Do you take anything -- I mean if in fact there haven't -- hasn't been any push to use that, is that a -- is there something I should take from that? Is there any instructive -- anything instructive about that?

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Guy Caruso: My impression is that they -- that people who are managing this at DOE feels the recoveries going relatively smoothly, and making the exchanges they've done already with the (Cut off and spec) that their feeling that they're taking a wait and see approach. And it may well be that the lens is puts enough further stress in the system that they may want to fall on the IEA. But as of -- as of last night when I talked to one of the DOE individuals about -- they had not requested that as of yet.

Jennifer Dlosky: Thank you.

Bob McNally: And you know Jen if I could add, and just and Guy's point about you know, not necessarily the IEA not necessarily seeing a cause for a Katrina like release get's to a little bit, I mean again, not to downplay at all the severity of what's happened or will happen, but in some ways it could have been worse in terms of the timing. This hits at the end of Gasoline season with high gasoline stocks, and so again, in a way I think lessens the severity to some degree. And so I think that's yes.

Jennifer Dlosky: Thanks.

Bob McNally: You bet.

Operator: Your next question comes from Casey Logan from News-Press. Your line is open.

Casey Logan: Hey guys thanks for doing the call. This is Casey Logan from the news press, and the USA today network. Here in Fort Myers, Florida, South West, Florida. I'm learning a lot about the macro industry. I don't cover up the petroleum industry specifically, so I'm learning a lot on that. I wondered if you can speak at all to Floridians in particular obviously as you've mentioned we got the Hurricane Irma out there looking like it's going to make land fall, probably Sunday, and impact probably a good deal of the state.

And so, for our area in particular we've had people -- quite a few evacuations and South Florida, South West Florida. People are facing some gas shortages along the way but I guess are able to eventually make their way up. As you

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look at all this, anything you'd like to share particularly you know, what you'd like Floridians to know today, or in the coming days as the Hurricane moves through and then you know goes on up Sunday, Monday and so on?

Bob McNally: Guy you want to go first --

Guy Caruso: One thing I would say is that it's been heartening to see the refinery that produced much of the gasoline that winds up in Florida, coming back on rather steadily in the colonial pipeline, which brings a lot of gasoline into South East and into Georgia, that the supply situation looks reasonably good. Obviously demand is spiked by the evacuation, but that -- the big picture is that overtime there's going to plenty of gasoline obviously in the short run. There could be some sporadic outages in certain retail outlets of the evacuation routes.

Bob McNally: Right. And I would just add to that, again the history and what were seeing right now shows that the oil industry and the government -- the federal government and the state government is going to move heaven and earth to make sure that the energy disruptions are short as possible.

Now they can get oil and gasoline to the stations, and they will as fast as they can. You do need electricity you need the refineries working, and you cant -- you can never be sure exactly when. But you can be sure government and industry are going to work really hard to make sure the supply system can get that gasoline to the communities and so. I think at some point though, and then it's the behavior of the motorist. And I know I've seen officials and so forth make appeals to folks to you know, try and not hoard if you really don't need that gasoline right away. And so I think those are important messages.

That's sort of at the very end of the supply chain. So, everyone has to do their part of the oil industry, the government to make sure that restarts happen and oil products flows from the refineries to the terminals to those gas stations where the public can get to them, and then the public has access to those supplies at that time. And that sort of requires everyone doing their job and so forth.

Casey Logan: Thank you.

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Bob McNally: Yes.

Male: Thank you. Next question, please.

Operator: Your next question comes from Libby George from Reuters. Your line is open.

Libby George: Hi, thanks for that. My question is, I guess, following up on that. When the storm hit, there is a huge amount of oil products available in the U.S. but more than 30 percent of it is concentrated in the Gulf Coast. (Curious if this) – in (PADD 3) District, does this event indicate a need for the stocks to be more evenly distributed throughout the country or more investments infrastructure to be able to get it out?

Guy Caruso: Well ...

Bob McNally: Well – yes, go ahead, Guy.

Guy Caruso: I think, with 25 percent of our refining capacity concentrated in the path of Harvey, it's difficult not to say we couldn't do with more diversification. The problem is, and has been, as you know, that infrastructure development has been blocked in many areas. While ideally, would be nice to have (greater) distribution of both the refineries and the – and the inventory holdings around.

But the reality is, it's been difficult to really get (icing) for many of these facilities and we haven't had a grass-roots refinery built in a long time, although much investment has been made to (de-bottleneck) refineries and make them more efficient. So I think we're – it's a difficult political situation to be able to actually diversify as much as we would like. And one aspect of that is that we did look – when I was at the DOE and I know they've done more work on it since then – the possibility of strategic petroleum reserves and products.

And they have gone forward with a couple of small developments in that – start down that road with heating oil in Northeast and gasoline being talked about. But it's very expensive. And as Bob mentioned, the mood of the

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Congress seems to be more towards selling off our (SPR), as opposed to adding to it.

Libby George: OK. Thanks. And, I mean, can you say anything else about kind of where industry stands in terms of the idea of an (FPR), or for products, or the idea that maybe – maybe, I mean, do some of these products need to be stored more evenly throughout the country? I mean, is there any kind of need for that from the industry's point of view?

Guy Caruso: I do know that there was not that much support for the products when I was looking at that issue, when – during the Bush administration – Bush W. Not sure ...

Bob McNally: Yes. I don't know if Jack, or (Eric), or somebody wants to speak for the industry to that question?

Jack Gerard: I would say generally, Bob, as we – as we've talked about in times past, that – as you guys mentioned earlier in the historical context, we support the broader marketplace (allowing) there's a reason for – (a wealth of) economic reasons et cetera of why that infrastructure is located down in that Gulf Region. Of course, we produce a lot of product off the Gulf, (deep water), (shallow), et cetera.

We refine a lot of it there but there are also refining centers elsewhere around the country. You look up in New Jersey, Philadelphia Corridor, Chicago Corridor, Salt Lakes, some out in (California). So it's got a reasonable diversity the way it is. So rather than try to (manage it), you'll see where supply and demand goes, much like the (Floridian) situation. Our hope is, once again the market will eventually find a supply and demand equilibrium. And that's the broader approach we generally take as industry to those questions.

Libby George: Great, thank you.

Operator: Your next question comes from John Siciliano from The Washington Examiner. Your line is open.

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John Siciliano: Hey, guys. Yes, thanks for having the call. I was just trying to figure out, I saw some reports that the Saudis are pulling back on production amid some of the refinery restrictions in the United States. I was wondering how exports – or, I mean, imports to the U.S. are going to affect any of this disruptions during these storms?

Male: Well I think the main issue is the with the ports and terminals. In terms of any actions by any producers, I think that is highly unlikely. I think the Saudi's issue is mainly supplying their Motiva refinery, which is one of the largest in the country, and that sustained significant damage. That may be more related to more to what this – the report you're talking about, John, on the Saudis reducing its shipments. It may just be that a bunch of that was that (over in Motiva) and now there's demand for ...

Male: What if I just make it (three or four), I can't tell the difference?

Male: Yes, that's fine.

Male: (All right), thank you, next question please.

Male: (Oh, I'm sorry) ...

Operator: The next question comes from Devika Kumar from Reuters News. Your line is open.

Devika Kumar: Hi, guys. Thank you so much for doing this call. I just wanted to go back a little bit into the difficulty. Guy, you mentioned that one of the challenges in setting up a strategic reserve of product or gasoline especially, is that it's more expensive.

Can you talk a little bit more about what the pros and cons are to setting up something like this? I know after Sandy, the conversation about this started relatively quickly to set up a reserve of a million barrels here. So I just wanted to know if it's being discussed at all and what the pros and cons of such a conversation would even entail?

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Guy Caruso: Yes, I think cost is number one on the list of the cons. And also, the (incredible) and having enough supply in the right places because you don't want to be moving. You may have a lot of gasoline in California, and if you have a Sandy that affects New Jersey and New York, it's not very useful.

So I think the real problem is, you need enough of it in the right places.

Which it – since it's all above ground for products, that's the most expensive way to store refined products. And it has to be turned over on a regular basis, so that also costs money because you can't leave gasoline in the tank for years because it loses (specification). It goes (off-spec) so you have to rotate your inventory. So it's not difficult. It just costs money to do that.

And it's what the Europeans do in meeting their international agency obligations. They keep most of them in products and they have *parental* organizations that are in place to actually – to turn that product over and keep it fresh for any emergencies. But it's cost then, and having enough at the right places at the right time.

Which is the reason we designed the (SPR) the way we did, was to keep it close to our refining centers and then you can make it into whatever you need at the time you need it. So we've seen the difficulties of that with Katrina, and Rita, and Sandy. But it's still, I think, probably the most efficient way to have a strategic reserve for our system.

Devika Kumar: Right. And if I could quickly follow-up, I just wanted to also touch back on the point where you get – that you had started with, which is that the energy landscape has changed significantly since the last time we had a hurricane of this magnitude. Right? And how the U.S. has kind of become a powerhouse in terms of exports, especially for products, does that change the conversation at all from the last time something like this was discussed?

Guy Caruso: Yes. I think the – two things. One is the renaissance in light tight oil and shale gas has transformed the infrastructure requirements of the U.S. and that certainly affected the midstream in particular. So many of our refineries used to carry product and crude from south to north now we need to – we have reversed a number of those. The refineries were used to running heavier sour

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crudes, now we have this large (feed stock) of light sweet from Bakken and other producers of light tight oil, Eagle Ford.

So these things all make the logistical system a bit more – more complicated and – but it also, by lifting restrictions on exports of – of crude and taking – and the availability of refined products, I think the system is much more flexible and I think the mention of the Jones Act waiver that Bob said may be happening – and would add to that flexibility, if there were a need to move product from the Gulf Coast to Florida or even further up the East Coast, depends on where Irma goes.

So the – it's represented challenges to the infrastructure and investment but it also has added to the flexibility. So I think, on balance, we're better prepared for – during a Harvey disaster than we were even for Katrina only 12, 13 years ago.

Devika Kumar: Alright. Thank you.

Reid Porter: Thank you. We have time for two more questions please.

Operator: Your next question comes from John Funk from "The Plain Dealer", your line is open.

John Funk: Thanks a lot. My question has to do with whether fuel, refined products, were redistributed after Harvey? Meaning, were you able to reverse pipelines – say, move gasoline from Chicago to supply (trucks) in Texas? Or did you use rail or did nothing like that happen?

Guy Caruso: I think it's been – the infrastructure is still under such stress that I don't think much of that has happened, to my knowledge. But I must admit, the companies would be in a much better position to answer that question. But I think the focus has been on the recovery and the restart, which, this time, has been facilitated by lesser damage to electric power facilities compared to Katrina.

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Electric power was out much longer, covering a much wider area during 2004 and '05, after Rita and Katrina. So, probably was less need for that kind of repositioning in the very short term, last two, three weeks.

But, certainly, the incentive was there to do that because of the large spike in prices. So any movement – the incentive, the market incentive was certainly there for that reallocation. So, probably, everything was done that could have been done, given the lack of available facilities due to damage.

John Funk: Thank you.

Operator: Your next question comes from Nick – Sorry Ed Crooks from "Financial Times", your line is open.

Ed Crooks: Hi, good afternoon, thanks very much for taking the call. Yes, just for – wanted to kind of broaden out a thought you just raised. You were talking about – or you've just been talking Rita and Katrina and sort of similarities and differences to what we've been experiencing this year.

And you talked about the industry and everyone – the authorities being better prepared now. Just wondered if you could sort of expand on that, other thoughts that come to mind just in terms of sort of preparedness and were there lessons that were learned from Rita and Katrina that have been useful this time around with Harvey and possibly now with Irma.

Guy Caruso: Yes, I think definitely better prepared. One is the appreciation of the need to deal with all of the energy aspects, including the electricity and may have been circumstances were easier to deal with because of less electric power damage.

But also the better communication between the state and federal authority teams have gone much more smoothly this time and you're not hearing – I – tell (schools) (sort of out school) but I've been out of government long enough now.

I mean, the stories we were hearing right away from – post Katrina was there was enormous lack of communication between states – and I won't name

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names – and FEMA. And that – you're not hearing that this time and I know that's – we don't have access to every bit of information but certainly my impressions are that that was a big reason – one of the big reasons things have gone more smoothly.

Ed Crooks: Right. And that's true of the – sort of the recovery effort in general but also it specifically, has it affected the energy industry you'd say?

Guy Caruso: Yes.

Ed Crooks: Yes. Got you.

Guy Caruso: That's what my – my impression is and what I hear from my industry contacts and – and my contacts back in DOE.

Ed Crooks: Right, got it, thanks.

Jack Gerard: This is Jack Gerard; we've got time for one more. I'm just going to add one thing to that that Guy mentioned, didn't know if Bob wanted to comment on it, but if you go on our website we have a hurricane preparedness booklet and much of that was kind of in the post-Katrina world that was developed. Working with DOE – Guy's experience and his successor and secretaries and all – we actually worked with the previous administration and White House on that.

And it outlines, in many ways, not only kind of the full charts of how our industry functions but it identifies all those areas like the waivers we've talked about today and how we need to focus on those issues quickly to bring maximum flexibility to the market to address concerns as we have the outages as the storm impacts are dealt with.

So, if you want to take a look at that on our website or feel free to call us after the call offline, we're happy to share that with you. But I think that little booklet's probably a good summation of lessons learned and how we're prepared to deal with it now, so Guy's point is probably as smooth – or smoother than it's ever been in terms of an actual disaster like this.

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Ed Crooks: Fantastic, thanks very much, I'll take a look. Sounds interesting.

Reid Porter: Thank you and we have time for one last question.

Operator: Your last question comes from Nick Snow from "Oil and (glass) – Gas", your line is open.

Nick Snow: Well, my question, basically has been answered. I just wanted to thank you guys for having this teleconference, it's been very informative and I should be able to make a pretty good story out of it.

Male: Thanks Nick.

Reid Porter: Thanks. All right, thank you all for joining today's call.

Jack Gerard: Let me thank our guests, in particular Guy and Bob for joining us today. We greatly appreciate you taking some time to help inform the situation that's taking place. Again, our thoughts and prayers are with those in harm's way and I know as we all work together and communicate as best we can, it'll be helpful.

So please don't hesitate to reach out to us. I'm sure Guy and Bob, to the extent they're available, will be happy to answer further questions as well. Thank you all and we look forward to being in touch. Thank you.

Reid Porter: If there are additional questions please don't hesitate to reach to the API media line, that's (202) 682-8114. Thank you.

Operator: This concludes today's conference call. You may now disconnect.

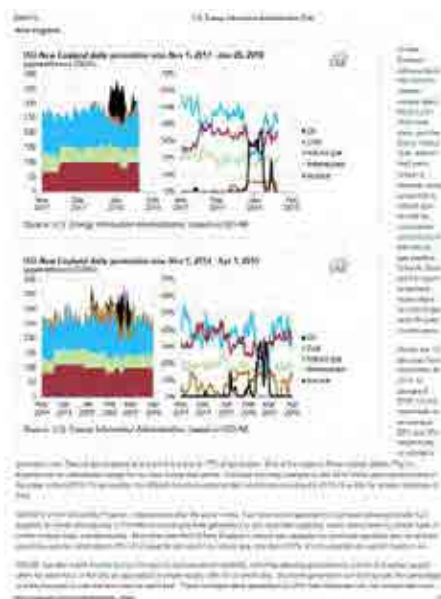
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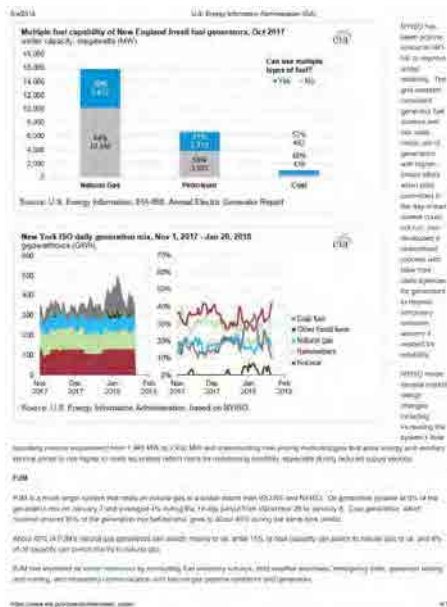
APPENDIX D EIA REPORT ON BOMB CYCLONE



Prepared by RBN Energy LLC for the Natural Gas Council

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ATTACHMENT C

Defense-In-Depth: Cybersecurity in the Natural Gas & Oil Industry



DEFENSE-IN-DEPTH: CYBERSECURITY IN THE NATURAL GAS & OIL INDUSTRY



**OIL AND
NATURAL GAS
SECTOR
COORDINATING
COUNCIL**



“Defense-in-Depth: Cybersecurity in the Natural Gas and Oil Industry” is a product of the Oil and Natural Gas Subsector Coordinating Council (ONG SCC) and Natural Gas Council (NGC).

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American Exploration & Production Council
American Fuel & Petrochemical Manufacturers
American Gas Association
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American Public Gas Association
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Offshore Marine Service Association
Offshore Operators Committee
Petroleum Marketers Association of America
Society of Independent Gas Marketers Association
Texas Oil & Gas Association
U.S. Oil & Gas Association

DEFENSE-IN-DEPTH:
CYBERSECURITY
IN THE NATURAL
GAS & OIL INDUSTRY





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FOREWORD

REGARDING QUESTIONS ON PIPELINE RELIABILITY AND RESILIENCY

Various federal agencies have stated or represented that natural gas pipelines are more vulnerable to cyberattacks than other energy infrastructure. These statements are not based on evidence and have not been substantiated. Threats are shared by the Intelligence Community to cybersecurity experts from natural gas and oil companies, the Oil and Natural Gas Information Sharing and Analysis Center (ONG-ISAC) and the Downstream Natural Gas Information Sharing and Analysis Center (DNG-ISAC) on an ongoing basis, and threat mitigations continue to be incorporated into the cybersecurity programs of companies in the natural gas sector.

There is a misconception between cyber threats and vulnerabilities in the calculation of risk to natural gas pipelines. Companies operating these pipelines are continuously reducing their vulnerability through work with the U.S. Government to evolve their defensive posture inside the methods and frameworks outlined in this paper. Most, if not all, of the largest industry companies – including natural gas pipeline operators – manage cybersecurity as an enterprise risk – the highest designation – with oversight from Boards of Directors and Senior Executives.

Natural gas pipeline companies account for and manage cybersecurity to protect the use of automated digital controls, or industrial control systems (ICS). ICS are not unique or new to pipelines; they are prevalent across the entire energy landscape, including at coal and nuclear power generation facilities.

The National Institute of Standards and Technology Cybersecurity Framework (NIST CSF) has been widely adopted by natural gas pipeline operators. Different segments of the natural gas and oil value chain have adopted additional standards as applicable to their business model, including the ISA/IEC 62443 Series of Standards on Industrial Automation and Control Systems Security.

Furthermore, the natural gas system is highly resilient because the production, gathering, processing, transmission, distribution and storage are highly flexible and elastic – characterized by multiple fail-safes, redundancies and backups. Pipeline companies have in place layers that protect against cascading failure, which also include mechanical controls that are not capable of being overridden through any cyber compromise of ICS.

EXECUTIVE SUMMARY

Cybersecurity is a top priority for the natural gas and oil industry. As the owners and operators of some of the nation's most critical infrastructure, industry companies take seriously the protection of industrial control systems (ICS) and operational technology (OT) – the digital monitoring and/or controls of physical assets – and prevention of energy disruptions that can impact national security and public safety. While industry companies are also responsible for and prioritize the protection of information technology (IT), intellectual property (IP) and personally identifiable information (PII), this report focuses predominately on cybersecurity in the natural gas and oil industry as it relates to the protection of ICS.

Natural gas and oil companies recognize that their assets are the targets of a growing number of increasingly sophisticated cyberattacks perpetrated by a variety of attackers including nation-states and organized international criminals. Companies acknowledge that cyberattacks can present “enterprise risks” – risks that could compromise the viability of a company – and have developed comprehensive approaches to cybersecurity similar to industry's approach to managing safety: robust governance, systematic risk-based management, and multi-dimensional programs based on proven frameworks including the NIST Cybersecurity Framework (NIST CSF), best-in-class international cybersecurity standards including ISA/IEC 62443, and the Department of Energy (DOE) Cybersecurity Capability Maturity Model (C2M2).

Cybersecurity in the natural gas and oil industry applies throughout the value chain, extending from wellheads to pipelines and through to the supply of natural gas to an electric power generation facility or gas utility, or the supply of oil to a refinery and through to the manufacturing of fuels and sales at a gasoline station. Industry works closely with the government agencies responsible for cybersecurity throughout each of these segments – from Coast Guard regulatory oversight in maritime and maritime-facing facilities to Transportation Security Administration (TSA) regulatory oversight of pipelines, as well as bi-directional sharing with the U.S. intelligence community via the Department of Homeland Security (DHS)/NIST's National Cybersecurity & Communications Integration Center (NCCIC), DOE, FBI and others – ensuring collaboration and communication at every point. Furthermore, industry participates in information sharing through ISACs and peer-to-peer learning through trade associations to force multiply individual companies' threat analysis assets and defenses.

The reliance upon proven risk management-based frameworks and public-private collaboration, rather than prescriptive regulation, is the most effective and robust method of bolstering the cybersecurity of the natural gas and oil industry and the critical infrastructure they operate. With the increasing sophistication and adaptiveness of cyber adversaries, it is essential that industry be afforded the necessary flexibility and agility to respond to a constantly-changing threat landscape, and that government and industry continue to partner to share cyber threat intelligence and strengthen cyber defenses.

CYBER THREATS AND CYBERSECURITY: SITUATIONAL ANALYSIS

Natural gas and oil companies share the concerns of policymakers and others regarding the potential implications of a cyberattack on industry assets, and take seriously the responsibility to protect critical infrastructure, provide reliable energy for society and safeguard public safety and the environment. As operators and service providers of energy critical infrastructure in the United States and globally, protecting services from cyberattacks is a top priority.

The natural gas and oil industry faces the threat of cyberattacks from a variety of malicious actors including nation states, criminal organizations and unaffiliated bad-actors seeking to steal intellectual property and/or compromise industrial control systems (ICS), among many other nefarious goals.

Industry has witnessed the evolution of such cyber criminals as well as the advancement of the techniques, tactics and procedures (TTPs) they use, moving from manual operations to more sophisticated and wider-spread machine-to-machine and artificial intelligence automated attacks. There are multiple other attack vectors including insider threats, attacks via supply chain tampering or disruption, and insertion via counterfeits. Cyber threats may be exacerbated through combination with physical attacks or execution during a natural hazard disruption.

Cyberattacks targeting U.S. energy infrastructure are on the rise. The number of reported incidents directed at critical infrastructure rose from 245 in 2014 to 295 in 2015, with a similar count (290) in 2016.¹ Of the reported incidents, roughly 20 percent (59 reported incidents) targeted the energy sector.

Industry companies recognize that they and their assets are the targets of an increasing number of cyberattacks, and protecting these assets — including critical infrastructure, people and the environment — is a significant priority. Industry infrastructure is highly automated, and pipeline operators, terminal owners and utilities alike rely on ICS for monitoring and/or remote control. ICS are not unique or new to pipelines and are prevalent across the energy system, including at coal and nuclear plants. These systems, the digital controls of industrial facilities, include supervisory control and data acquisition (SCADA), process control networks (PCN) and distributed control systems. These systems — controlled and monitored by a trained operator — keep operations up and running. Advanced cybersecurity operations are critical to ensure that ICS — particularly those operating critical infrastructure (CI) — are segmented and thus protected by limiting exposure to attack.²

INDUSTRY APPROACH TOWARDS CYBERSECURITY

ENTERPRISE RISK MANAGEMENT AND DEFENSE-IN-DEPTH

Throughout the course of operations, natural gas and oil companies are faced with a variety of “enterprise risks” – meaning threats that are considered to pose the highest level of risk to a company with potential firm-wide impacts that could compromise the company’s viability. Examples of enterprise risks faced by industry companies include safety hazards; changes in laws, regulations or geopolitical forces that affect the fundamental license to operate; changes in market demand or competition; or other systemic financial risks. Cyberattacks can be considered to pose this level of risk and are thus managed at the same priority level on an ongoing basis.

Cyberattacks can target ICS, seeking to compromise business continuity or cause a potential health, safety or environmental incident. Attacks can also target IT — data on business or enterprise networks — including IP such as sensitive business development information and trade secrets that, if stolen, could impact new ventures and opportunities to grow.

In recognition of the sophistication and dedication of cyber attackers, and the enterprise risk presented by cyberattacks, natural gas and oil companies have developed comprehensive risk-based “defense-in-depth” approaches to cybersecurity similar to industry’s approach to managing the other enterprise risks: robust governance, systematic risk-based management, and multi-dimensional programs based on best-in-class standards and proven frameworks. Industry also coordinates with government partners at all levels.

A layered defense approach provides optimal protection in the rapidly evolving cyber threat landscape, as no one layer of defense or technology will ever be completely effective. This approach creates a landscape that is much more challenging for an attacker to fully penetrate – providing necessary time to implement defensive response measures.

A layered defense approach also incorporates system redundancies and fail safes including the ability to manually operate without ICS.

In the natural gas and oil industry, Boards of Directors and senior executives establish a company’s acceptable level of risk mitigation to address cybersecurity threats and regularly monitor the effectiveness of the company’s cybersecurity program, allocating additional resources to enhance cybersecurity when it is determined that risks need to be lowered, and re-affirming the priority of company-wide cybersecurity practices and protocols. The natural gas and oil industry’s risk-based approach to cybersecurity also accords with the NIST CSF, described in more detail below.

Industry has a long history of risk management including the development and use of internal procedures to drive continuous improvement and manage the most significant risks. These principles extend to cybersecurity through a focus on maintaining basic cybersecurity practices including ensuring antivirus applications are up to date, mitigation measures such as security patches are applied as appropriate, and the use of powerful system identifications are managed for appropriate usage. Companies routinely make difficult choices to improve security over user productivity, for example restricting the use of removable media devices such as USBs to limit possible infections to the environment introduced via these devices, restricting web use and prohibiting access to personal email from company workstations. Many companies routinely conduct drills with key personnel, such as a simulated data breach, to provide assurances that attacks can be detected, contained and remediated to avoid significant loss. These practices set a solid foundation for further enhancing security capabilities with respect to cyberattacks, allowing companies to focus on more sophisticated and challenging cyber threats.

Industry sets priorities and implements processes to protect the most critical aspects of infrastructure against likely threats; to build redundancy into the system to make it more resilient; to coordinate preparation and response efforts with the government; and to develop contingency plans for response and recovery if operations are impacted.

Companies typically establish cybersecurity programs that can be understood through three fundamental lenses: the critical functions as they apply to leading standards such as the NIST CSF; the components of a system as expressed through all technologies connected to company operations; and the network architecture. These lenses apply to all companies – they are overlapping ways to understand how the natural gas and oil industry implements cybersecurity.

CRITICAL CYBERSECURITY PROGRAM COMPONENTS: A NIST CYBERSECURITY FRAMEWORK LENS

Natural gas and oil companies implement cybersecurity programs that comprise many components. Companies often frame these components through the lens of the NIST Cybersecurity Framework (CSF), a voluntary framework intended to provide a common language organizations can use to assess and manage cybersecurity risk.

Developed in response to Executive Order (EO) 13636 “Improving Critical Infrastructure Cybersecurity”, the CSF recommends risk management processes that enable organizations to inform and prioritize decisions regarding cybersecurity based on business needs, without additional regulatory requirements. It enables organizations—regardless of sector, size, degree of cybersecurity risk, or cybersecurity sophistication—to apply the principles and effective practices of risk management to improve the security and resilience of critical infrastructure.³

FIGURE 1 displays an example of a cybersecurity program based on the NIST CSF deployed across one company. The programmatic areas correspond to the NIST Framework Functions via the color-coded legend.

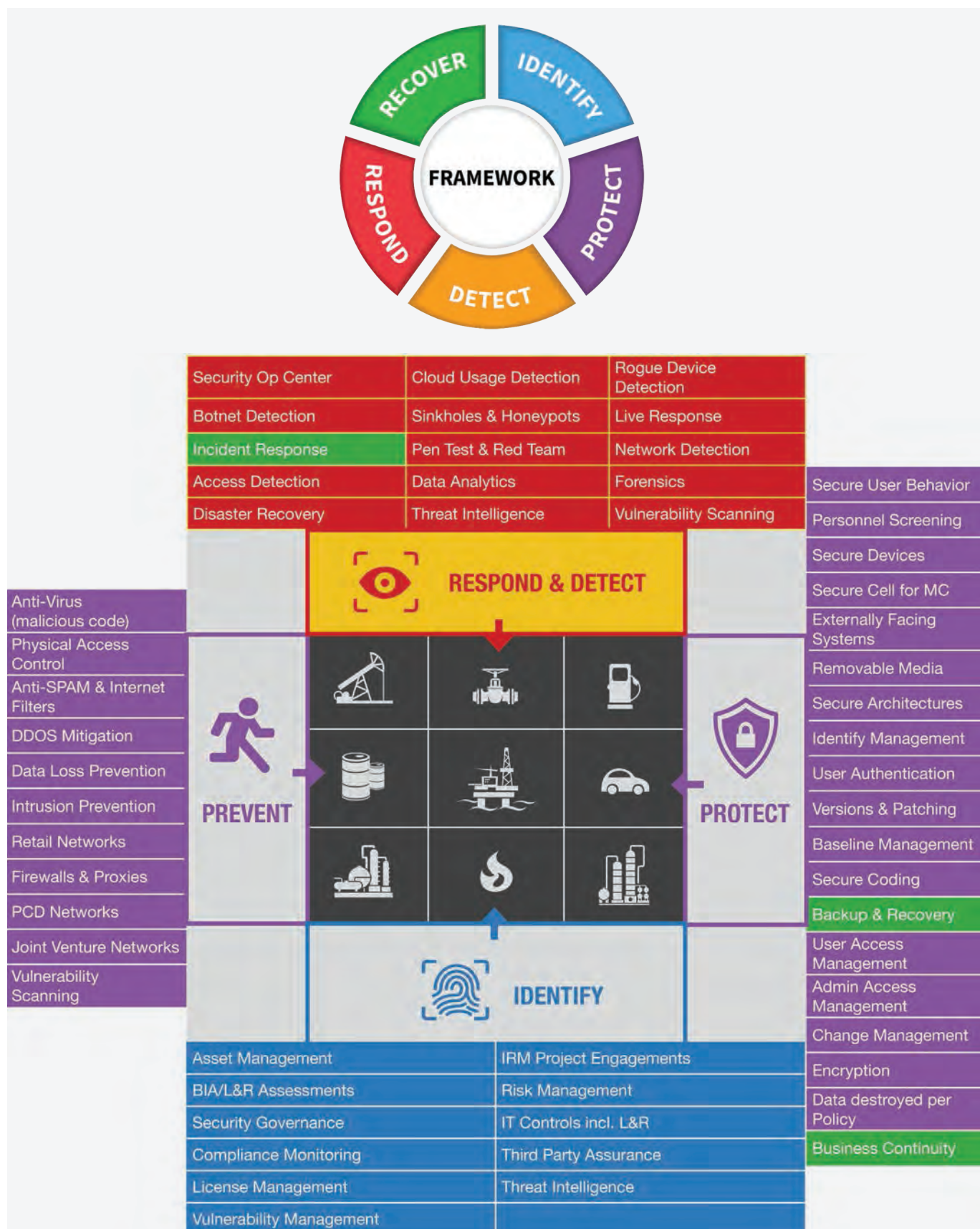


FIGURE 1. Example of cybersecurity programs deployed across one company.

The CSF is designed to complement, and not replace or limit, an organization's risk management process and cybersecurity program. Each individual organization can use the CSF in a tailored manner to address its cybersecurity objectives.

The framework was developed with a focus on industries vital to national and economic security including energy, banking, communications and the defense industrial base. Representatives from these industries – including natural gas and oil companies – participated in the development. It has since proven flexible enough to be adopted voluntarily by large and small companies and organizations across all industry sectors, as well as by federal, state and local governments.⁴

Through widespread industry adoption of the NIST CSF, natural gas and oil companies are able to effectively communicate cybersecurity issues for internal evaluations of capabilities and programs, internal program prioritization, external benchmarking against peers' performance and external evaluation of suppliers and contractors.⁵

As shown in **FIGURE 1**, the five core functions of the NIST CSF provide a base by which natural gas and oil companies – and companies of all sizes in sectors from healthcare to banking to telecommunications and others – can structure comprehensive cybersecurity programs.⁶ A more detailed explanation of the five programmatic areas can be found in **APPENDIX A**.

CRITICAL CYBERSECURITY PROGRAM COMPONENTS: A TECHNOLOGY LENS







Natural gas and oil companies take into account technologies connected to company operations when developing a comprehensive cybersecurity program.

Network Security	Identity & Access Management	Data Protection
Cybersecurity Stack	Certificates	Data Leakage Prevention
Firewall	User – Login/Sign	Database Protection
Proxy	Device	Email Encryption
URL Filtering	Encryption	Key Management
Cloud Access Security Broker (CASB)	Website/App	Report Phishing
SSL Decryption	Authentication Token	Secure FTP/Transfer
Packet Capture	Windows	Email Scanning
Intrusion Prevention System (IPS)	Linux	Data Lake Protection
System (IPS)	MAC	API Security
Virtual Private Network (VPN)	Other	Automated Data Categorization
Web Application Proxy	Authentication	
Load Balancing	Privileged Account Management	
Network Access Control	Directory Services	
On-Prem	Identity Governance & Administration	
Cloud	Access Control/Group Management	
Software Defined Network	Access Reporting	
Field Communications Security	Identity Provisioning & Registration	
	Domain Name Service (DNS)	
	Name Service	
	DNS Management	
	DNS Filtering	
	DNS Security	
	IAM Analytics	
		Application Security
		Static Application Security
		Web Application Security
		Non-Web Application Security
		Mobile Application Security
		RPA/Low Code
		Web Application Security
		IaaS
		PaaS
		On-Prem

FIGURE 2. Example of technologies deployed across one company.

By determining all critical system components and identifying which components apply to the company's ICS, companies are able to segment technologies and implement firewalls where needed.

An example of these processes implemented across a natural gas and oil company is displayed in **FIGURE 2**. In this example, technologies that may apply to the production ICS are designated by a red check. A more detailed explanation of the nine critical system areas can be found in **APPENDIX B**.

<div></div> <div>Protection</div>	<div></div> <div>Endpoint Security</div>	<div></div> <div>Vulnerability Management</div>	<div></div> <div>Threat Protection</div>	<div></div> <div>Forensics & Insider Risk</div>
Intrusion Prevention	Workstation & Data Center; Cloud IaaS; PCN	Dynamic Application Scanning	SIEM	Insider Risk
Intrusion Detection		Web Applications	User Behavior Analytics	User Behavior Analytics (UBA)
Intrusion Prevention		Non-Web Applications	Cybersecurity Analytics	Endpoint Monitoring
Intrusion Prevention		Mobile Applications	Cybersecurity Incident Data Gathering	Forensics
Intrusion Prevention		RPA/Low Code	Investigation Tools	Incident Investigation
Intrusion Prevention		Cloud	Threat Intelligence Platform	<ul style="list-style-type: none">General
Intrusion Prevention		IIOT/Emerging Tech	Threat Intelligence Feeds	<ul style="list-style-type: none">Cloud
Intrusion Prevention		Application Control/Whitelisting	Cybersecurity Incident Tracking	<ul style="list-style-type: none">Mobile
Intrusion Prevention		Behavioral Analysis	Anomaly Detection	<ul style="list-style-type: none">Emerging Tech
Intrusion Prevention		Containment	Log Management	Case Management
Data Breach Prevention/Protection	Exploit Mitigation	Penetration Testing	On-Prem	Incident Evidence Management
Device Security	Secure OS/Apps	Realtime Software & Device Inventory & Validation	Cloud	Customer Evidence Review & eDiscovery
	Device/Pre-boot Control	Vulnerability Feeds	Cybersecurity Orchestration	
	Device Management	Vulnerability Tracking & Prioritization	Cyber Resilience	
	Mobile		<div></div> <div>Risk & Compliance</div>	
	First Party		Governance, Risk & Compliance Management	
	Mobile Threat Defense		Manage Controls	
	Device Management w/ Ability to Wipe		Validate Controls	
	Application Security Management		Compliance Reporting & Analysis	
	Data Leakage Prevention		Risk Assessment	
	Device Management		Problem Management	
	Third Party			
	Application Security Management			
	Data Leakage Prevention			

NETWORK ARCHITECTURE AND SEGMENTATION

Regardless of the structure used for cybersecurity program development, natural gas and oil companies typically buffer ICS from cyberattacks through the use of “defense-in-depth” network architecture.

Natural gas and oil companies segment their systems and implement “demilitarized zones” (DMZ) between industrial controls and internet-facing business networks.⁷ **FIGURE 3** illustrates an example network architecture utilizing the ISA/IEC 62443 series of standards on industrial automation and control systems (IACS) security and a modified “Purdue Model.”

As seen in this example, the ISA/IEC standards provide ICS operators with:

- **CONCEPTS AND MODELS:** a framework for network architecture, including segmentation through zones and conduits.
- **POLICIES AND PROCEDURES:** prompts for companies to put into place a security management system, conduct patch management, and establish internal cybersecurity requirements for suppliers.
- **CYBERSECURITY OF OPERATION OF INTERNAL ICS SYSTEM:** guidance to companies for deployment of cybersecurity technologies, ICS security risk assessment and system design, and internal requirements for ICS security and cybersecurity levels.
- **CYBERSECURITY OF INSTALLED ICS COMPONENTS:** guidance to companies for internal requirements for product development and technical security of ICS components.

Most natural gas and oil companies operate in a cybersecurity landscape consisting of three critical areas: the ICS, internet-facing components and internal networks. Companies architect and manage cybersecurity across these networks to reduce the risk of compromise to ICS from attacks that could flow from the outside-in across these networks.

The computer systems that compose the ICS run the most critical components of operations. These are represented in Levels 0-3 of **FIGURE 3**. Today's ICS environments in the natural gas and oil industry rely on computing technologies for advanced monitoring and/or control of unit processes, such as adjusting valves to regulate pressure or controlling pumps to regulate product flow, located in refineries, petrochemical plants and pipeline/terminal distribution sites. These technologies in turn make operations vulnerable to cyber threats. A widely accepted practice is to ensure ICS remain logically isolated from systems providing control of the unit.

Organizations mitigate the risk of a cyber threat to internal networks from exposure to the public internet by creating a security zone between the ICS and business network that is frequently referred to as the DMZ, represented between Level 3 and Level 4 of **FIGURE 3**. Firewalls within the DMZ serve as “data diodes” allowing specific information to travel from ICS to IT environments while limiting or eliminating information flow from IT environments to ICS.

Level 4 of **FIGURE 3** represents a company's business network or enterprise zone, the environment where users perform functions such as email, collaboration and analytics. It is here that companies hold most intellectual property assets and conduct other internal business transactions. For the natural gas and oil industry, the most valuable intellectual property includes information regarding proprietary technology, breakthrough research, bid proposals and acquisitions and mergers. Industry's cybersecurity focus in this area

relies on early detection and a layered approach to defenses. User awareness training is also a critical focus area as it is highly recognized that no amount of technology will protect against every threat – the end-user plays a large role as a layer in defense.

The natural gas and oil industry relies on internet-facing components such as e-commerce for product purchases along with areas that allow collaboration with business partners. These components, represented in Level 5 of **FIGURE 3**, above, are contained within an area of a company network that is outwardly facing to the public and separated from the internal business network by another DMZ.

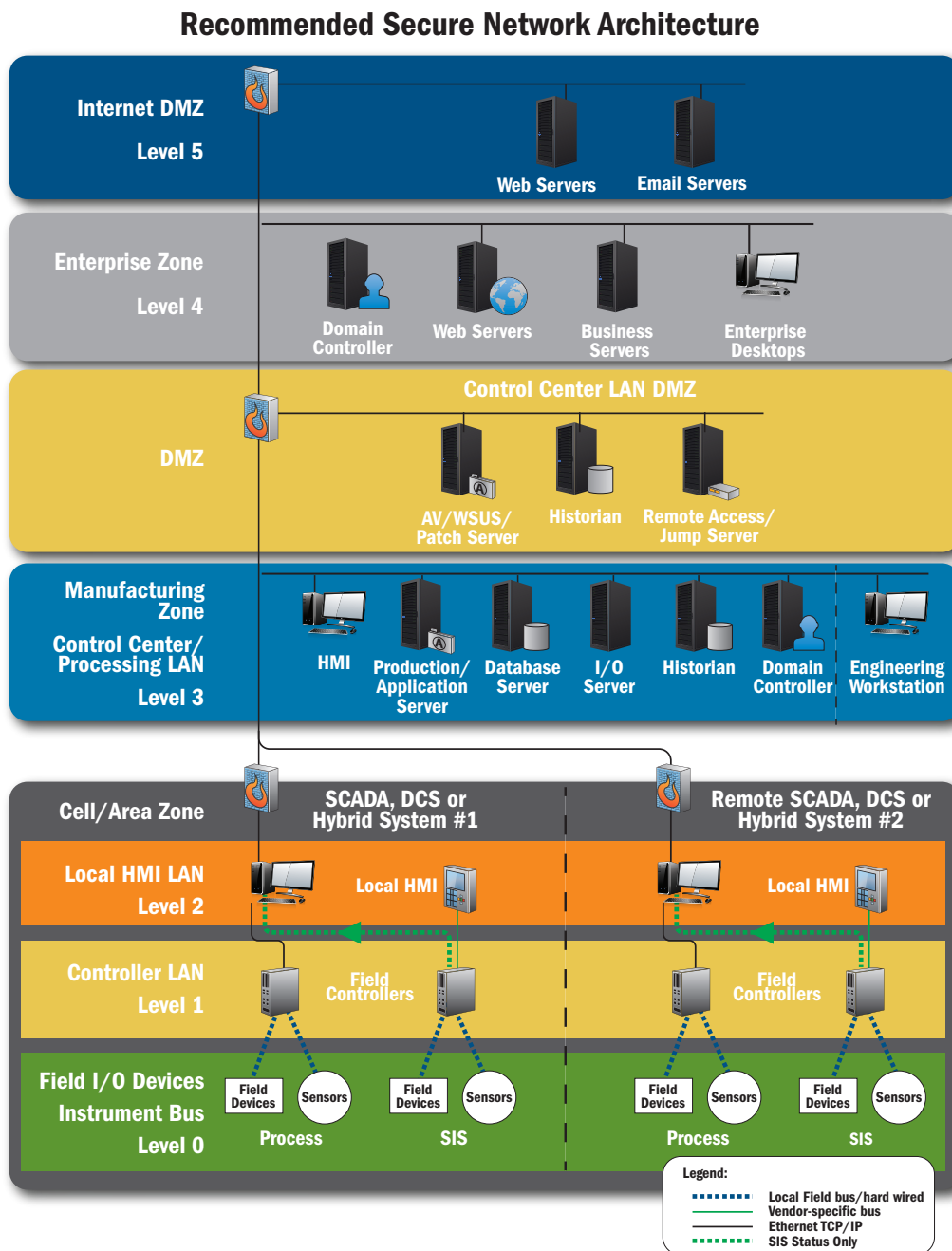


FIGURE 3. Diagram illustrating “defense-in-depth” network architecture.⁸

INCORPORATING LEADING EXTERNAL FRAMEWORK AND STANDARDS

In partnership with the Department of Commerce's National Institute of Standards and Technology (NIST), Department of Energy (DOE) and other U.S. and international standards-setting bodies, the industry orients its cybersecurity programs to the NIST CSF and additional programs such as the ISA/IEC 62443 Series of Standards on IACS Security and the DOE Cybersecurity Capability Maturity Model (C2M2). These tools are complementary and compatible, often cross-referencing from one to the other to guide the industry cybersecurity efforts for protecting ICS and IT.

The ISO/IEC 27000 family of ISO/IEC Information Security Management Systems (ISMS) standards widely used in the production segment of the natural gas and oil industry. The ISO/IEC 27000 standards are IT-focused and provide detailed guidance to the industry for protecting IT and IP from cyberattacks. Similar standards are used in other segments of the natural gas and oil value chain.

Another standard that has been produced by the natural gas and oil industry, API Standard 1164, is specific to pipeline cybersecurity. Subject matter experts from natural gas and oil companies and from cybersecurity vendors are currently working to update API 1164 to make it complementary to the NIST CSF and other applicable cybersecurity standards, such as ISA/IEC 62443 while still providing pipeline-specific cybersecurity guidance.

NATURAL GAS AND OIL COMPANIES OPERATE TO LEADING CYBERSECURITY STANDARDS AND FRAMEWORKS

API STANDARD 1164

Content unique to pipelines not covered by NIST CSF and IEC 62443; Currently being updated with expected completion in 2019.

NIST CYBERSECURITY FRAMEWORK FOR IMPROVING CRITICAL INFRASTRUCTURE CYBERSECURITY (NIST CSF)

Pre-eminent Framework adopted by companies in all industry sectors; Natural gas and oil companies increasingly orient enterprise-wide programs around NIST CSF.

DEPARTMENT OF ENERGY CYBERSECURITY CAPABILITY MATURITY MODEL: Voluntary process using industry-accepted best practices to measure the maturity of an organization's cybersecurity capabilities and strengthen operations.⁹

INTERNATIONAL ELECTROTECHNICAL COMMISSION'S IEC 62443

Pre-eminent family of standards for industrial control systems (ICS) security; Widely-adopted by production segment of natural gas and oil industry; applicable to any type of natural gas and oil ICS.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION ISO 27000

Leading standard in the family providing requirements for an information security management system (ISMS).

CYBERSECURITY PARTNERSHIP WITH GOVERNMENT

Cybersecurity in the natural gas and oil industry applies throughout the value chain, extending from wellheads to pipelines and through to the supply of natural gas to an electric power generation facility or gas utility, or the supply of oil to a refinery and through to a gasoline station.

FIGURE 4 illustrates the full natural gas and oil value chain.

Industry works closely with the government agencies responsible for cybersecurity throughout each of these segments – from Coast Guard regulatory oversight in maritime and maritime-facing facilities to TSA regulatory oversight of pipelines, as well as bi-directional sharing with

the U.S. intelligence community via DHS/NCCIC, DOE, FBI and others – ensuring collaboration and communication at every point.

Industry-government collaboration on cybersecurity fits within the experience we have working together through an all-hazards approach to prepare for, respond to and recover from a wide array of threats and hazards ranging from natural disasters to cyberattacks. Initiatives and activities undertaken by industry, government or through joint partnerships on cybersecurity, just as for other hazards, include classified briefings to share threat and risk information; organizing structures to improve information sharing; availability of trained emergency responders; threat-specific and function-specific drills and exercise programs; ongoing information exchanges; and situational awareness reports.

A list of the regulatory bodies covering the natural gas and oil industry, and the relationship between those bodies and industry, can be found in **APPENDIX C**.

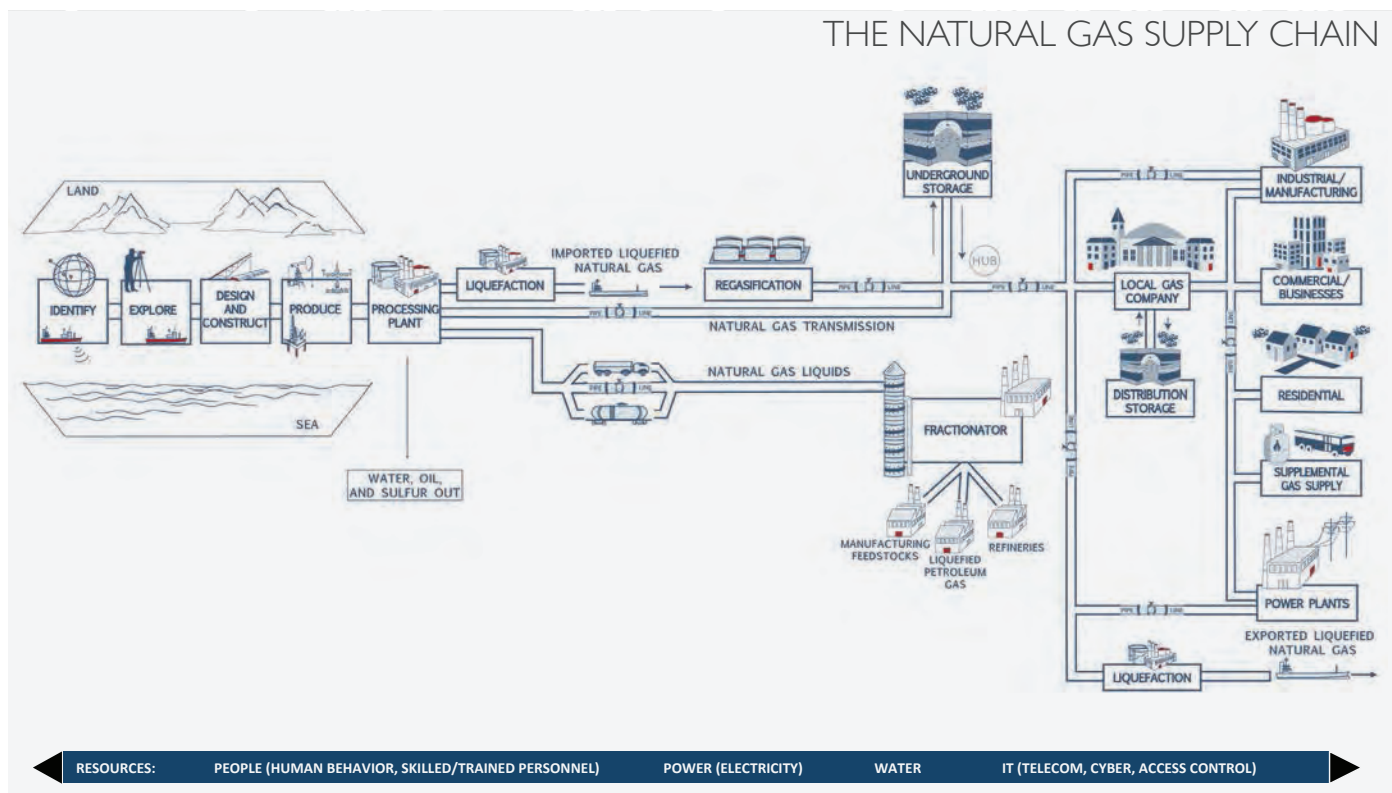


FIGURE 4. Supply Chain Model. Source: API, Oil and Natural Gas Industry Preparedness Handbook, 2013.

INFORMATION SHARING AS CRITICAL CYBERSECURITY DEFENSE

Beyond industry's work with government, companies participate in information sharing through Information Sharing and Analysis Centers (ISACs) and peer-to-peer learning through trade associations to force multiply individual companies' threat analysis assets and provide critical lines of defense.

INFORMATION SHARING AND ANALYSIS CENTERS (ISACS)

In 2015, the natural gas and oil industry was a leading supporter of the first-ever legal framework to govern cybersecurity information sharing. The Cybersecurity Act of 2015 enabled cybersecurity threat indicators to be shared between and among companies and the U.S. Government, established the legal requirements and protections for such sharing, and established DHS as the hub for government and private sector cybersecurity information sharing.¹⁰

While DHS leads the federal government's efforts to secure critical infrastructure, ISACs were created as the Department and other pillars of government recognized the importance of public-private partnerships in mitigating and rapidly responding to crises because of the extent to which critical infrastructure is operated by the private sector.¹¹

Facing threats to our nation from cyberattacks that could disrupt power, water, communication and other critical systems, U.S. Presidents have issued Executive Order (EO) 13636: Improving

Critical Infrastructure Cybersecurity, Presidential Policy Directive (PPD) 21: Critical Infrastructure Security and Resilience, and EO 13800: Strengthening the Cybersecurity of Federal Networks and Critical Infrastructure.^{12, 13} These policies empower the private sector to discuss tactics and procedures that can be leveraged to protect individual companies, the industry and critical infrastructure from cyber attackers, and reinforce the need for holistic thinking about security and risk management.

Implementation of the EOs and PPD drive action toward system and network security and resiliency and enhance the efficiency and effectiveness of the U.S. government's work to secure critical infrastructure and make it more resilient.¹⁴ The Oil and Natural Gas ISAC (ONG-ISAC) and Downstream Natural Gas ISAC (DNG-ISAC) provide a secure and trusted environment for the sharing of cybersecurity information across the natural gas and oil industry.^{15, 16} Specifically, it is through these ISACs that natural gas and oil companies – including many of the nation's largest natural gas pipeline operators – share cyber threat indicators and intelligence with each other and with the U.S. Government, which is the primary mechanism through which DOE and other U.S. national security and law enforcement agencies continue to work together with the private sector to keep U.S. pipelines safe and secure. The structure is outlined in **FIGURE 5**.

NATURAL GAS AND OIL COMPANIES WORK COLLABORATIVELY WITH THE U.S. GOVERNMENT, ENABLED BY RECENT PUBLIC POLICY

CYBERSECURITY ACT OF 2015

Establishing the legal framework for cyber information sharing:

- ⇒ Requires companies to protect information and share according to certain protocols
- ⇒ Provides legal protections to companies when these requirements are met
- ⇒ Establishes DHS as a hub for information sharing, providing a conduit for cyber threat indicators to flow back and forth from the private sector to the U.S. Government, including intelligence agencies
- ⇒ Incentivizes the work of Information Sharing and Analysis Centers (ISACs) such as the Oil and Natural Gas ISAC (ONG-ISAC) and Downstream Natural Gas ISAC (DNG-ISAC)

EXECUTIVE ORDER 13636

Improving Critical Infrastructure Cybersecurity directs the Executive Branch to:

- ⇒ Develop a technology-neutral voluntary cybersecurity framework
- ⇒ Promote and incentivize the adoption of cybersecurity practices
- ⇒ Increase the volume, timeliness and quality of cyber threat information sharing
- ⇒ Incorporate strong privacy and civil liberties protections into every initiative to secure our critical infrastructure

- ⇒ Explore the use of existing regulation to promote cyber security

PRESIDENTIAL POLICY DIRECTIVE-21

Critical Infrastructure Security and Resilience Directs the Executive Branch to:

- ⇒ Develop a situational awareness capability that addresses both physical and cyber aspects of how infrastructure is functioning in near-real time
- ⇒ Understand the cascading consequences of infrastructure failures
- ⇒ Evaluate and mature the public-private partnership
- ⇒ Update the National Infrastructure Protection Plan
- ⇒ Develop comprehensive research and development plan

EXECUTIVE ORDER 13800

Strengthening the Cybersecurity of Federal Networks and Critical Infrastructure Directs the Executive Branch to:

- ⇒ Enhance cybersecurity of federal government networks, including to use the NIST Cybersecurity Framework to manage federal agency's cybersecurity risk
- ⇒ Enhance cybersecurity of critical infrastructure, including to provide support on cybersecurity to critical infrastructure at greatest risk
- ⇒ Enhance cybersecurity of the nation through international efforts in deterrence, protection and cooperation; cybersecurity workforce development; and assessment of national-security-related cyber capabilities.

INFORMATION SHARING RELATIONSHIPS

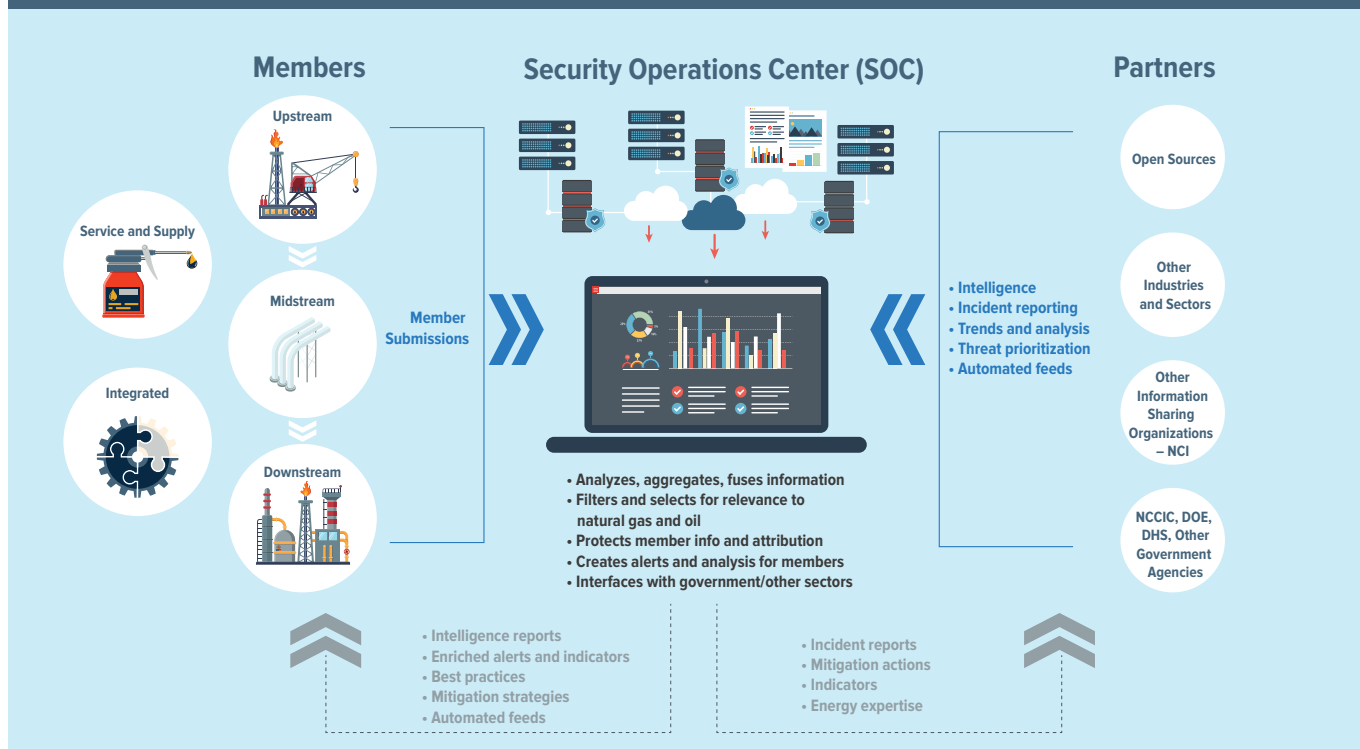


FIGURE 5. ONG-ISAC and DNG-ISAC Information Sharing Relationships.

As illustrated in **FIGURE 5**, the ISAC facilitates the peer-to-peer sharing of cyber threat information between natural gas and oil companies and instituting bi-directional sharing with the U.S. Intelligence Community (IC) via DHS/NCCIC, DOE, FBI and others. This information sharing also extends to the Electricity ISAC (E-ISAC), with the participation of all three ISACs in regular intelligence briefings with DOE and the bi-directional communication with NCCIC.

As the threat landscape is ever-changing and the needs of individual companies vary, ONG-ISAC and DNG-ISAC member companies utilize this framework to communicate leading practices in threat detection and cybersecurity mitigations and provide support where needed. Companies share information related to cyberattacks, threats and vulnerabilities as well as the TTPs of cyber attackers and Indicators of Compromise (IOC).

The ONG-ISAC and DNG-ISAC, as well as the DHS/NCCIC and other government agencies, utilize the Forum of Incident Response and Security Teams (FIRST) Traffic Light Protocol (TLP) to facilitate greater sharing of information. TLP is a set of designations used to ensure that sensitive information is shared with the appropriate audience. It employs four colors to indicate expected sharing boundaries to be applied by the recipient(s).¹⁷ TLP definitions are identified in **APPENDIX D**.

Both the ONG-ISAC and DNG-ISAC facilitate ongoing information sharing through a variety of work products in order to provide the necessary level of intelligence guidance, whether strategic, tactical or immediate, providing a comprehensive structure of support to ISAC member companies. A detailed list of the work products organized by the ONG-ISAC and DNG-ISAC are available in **APPENDIX D**.

This structure allows companies to participate in guided, anonymous information sharing via a threat intelligence platform. The sharing of threat indicators is automated and disseminated in a machine-readable format, providing real-time notifications for near-real-time analyses. Companies have open access to community leaders and security analyst experts, as well as organized intelligence in one central place: federal feeds, third-party vendors, ISAC members and cross-

sector sharing with other ISACs.¹⁸ Ultimately, both the ONG-ISAC and DNG-ISAC allow natural gas and oil companies to quickly detect or respond to threats before they create an enterprise impact; learn from others to decrease overall risk, increase safety and avoid loss of revenue; protect company reputations and position organizations ahead of attackers; and avoid data overload to improve critical decision making.¹⁹

ACTUAL EXAMPLES OF SUCCESSFUL INFORMATION SHARING WITH INDUSTRY PARTNERS VIA ONG-ISAC, DNG-ISAC AND OTHER INFORMATION SHARING MECHANISMS:

- ⇒ **ONG COMPANY A** shares information about an email phishing campaign via ONG-ISAC that **COMPANY B's** Security Operations Center (SOC) has not detected. SOC receives this information and identifies that users at **COMPANY B** received these phishing emails and that a **COMPANY B** user has clicked on the malicious content. From this sharing, SOC identifies a cyber incident that occurred at **COMPANY B** which potentially would have not been detected and was able to contain/prevent other users from also attempting to access the malicious content.
- ⇒ Analysts from **DNG COMPANY F** and **E-ISAC COMPANY G** share watch duty twice weekly. **E-ISAC COMPANY H** shares information about NotPetya ransomware via E-ISAC minutes after its outbreak. **E-ISAC COMPANY G** collaborates with **DNG COMPANY F** to warn DNG-ISAC members, provide members of both ISACs with indicators of compromise (IOCs), and begin to research and publish potential mitigations three hours before the first U.S. Government warning is released.
- ⇒ **ONG COMPANY C** has a direct and open dialogue about security technologies (specifically email security technologies) that have been valuable to them in detecting/preventing cyber incidents from occurring. **COMPANY C** shared this information with **COMPANY D's** SOC. **COMPANY D's** OC passed this information along to the **COMPANY D's** security technology/design team as an input into their alternative evaluation process when they reviewed different email security technologies.
- ⇒ **DNG COMPANY J** analyst researches known personalities, their associates and supporters involved in illegal activities during global natural gas and oil protests. **DNG COMPANY J** determines highest priority targets and shares a threat information package via DNG-ISAC along with successful legal mitigations used by Federal, State, Local, Tribal and Territorial partners. E-ISAC requests DNG-ISAC support to Federal Energy Regulatory Commission security office and averts a potential facility penetration during an important FERC hearing.
- ⇒ **ONG COMPANY E's** SOC detects a cyber incident that is interesting and shares IOC with other ONG companies to identify if this activity is widespread, targeted towards **COMPANY E**, or targeted towards the ONG sector. This information helps **COMPANY E's** SOC and **other companies** in scoping the sophistication/motive of an adversary.

As was identified in **FIGURE 5**, both ISACs also provide a structure for bi-directional information sharing with the U.S. Intelligence Community. Through the hub of the DHS/NCCIC, with reach-back to TSA and DOE as the sector-specific agencies as well as the FBI, the ISACs share incident reports, mitigation actions and indicators of compromise as well as energy expertise. In return, the ISACs receive intelligence, incident reports, trends, analyses and threat prioritization information, and is able to triage that information back to industry.

This process not only ensures that industry and government parties receive the appropriate and necessary information, but ensures consistent messaging, allows for anonymity when needed, and enables the near-real-time dissemination of information.

TRADE ASSOCIATION FACILITATION OF CYBERSECURITY COMMUNICATION AND LEARNING

In support of PPD-21, the owners and operators of natural gas and oil infrastructure, and the industry trade associations that represent them, formalized coordination efforts under the Oil and Natural Gas Subsector Coordinating Council (ONG SCC). The ONG SCC provides a private forum for effective coordination of natural gas and oil security strategies and activities, policy, and communication across the sector to support the nation's homeland security mission through the protection of the sector's critical infrastructure.²⁰

The trade associations that make up the Oil and Natural Gas Subsector Coordinating Council (ONG SCC) represent the vast majority of the natural gas and oil value chain and are committed to the protection of industry assets from cyberattacks. Those associations include:

➤ AMERICAN PETROLEUM INSTITUTE

The American Petroleum Institute (API) is the only national trade association that represents all aspects of America's natural gas and oil industry. API's 625+ corporate members, from the largest major oil company to the smallest of independents, come from all segments of the industry. They are producers, refiners, suppliers, pipeline operators and marine transporters, as well as service and supply companies that support all segments of the industry.

As operators and service providers of energy critical infrastructure in the United States and globally, protecting networks from cyberattacks is a priority of API members. As such, member companies regularly share their leading practices in cybersecurity.

➤ AMERICAN GAS ASSOCIATION

The American Gas Association (AGA) represents more than 200 local energy companies that deliver clean natural gas to homes and businesses throughout the United States. AGA and its members are dedicated to helping ensure that natural gas pipeline infrastructure remains resilient to growing and dynamic cyber and physical security threats. AGA is committed to proactively collaborating with federal and state governments, public officials, law enforcement, emergency responders, research consortiums, and the public to continue improving the security posture of local energy companies and the industry's longstanding record of providing natural gas service safely, reliably and efficiently across America.

AGA and its operators implement security programs and actively engage in voluntary actions to help enhance the physical and cybersecurity of the nation's 2.5 million miles of natural gas pipeline, which span all 50 states with diverse geographic and operating conditions.

➤ **INTERSTATE NATURAL GAS ASSOCIATION OF AMERICA**

The Interstate Natural Gas Association of America (INGAA) is the North American association representing the interstate and interprovincial natural gas pipeline industry. INGAA's 27 members represent the majority of the interstate natural gas transmission pipeline companies in the United States, operating approximately 200,000 miles of pipelines and serving as an indispensable link between natural gas producers and consumers.

INGAA and its members are committed to promoting the reliability of interstate natural gas transmission pipelines. INGAA members implement security programs and take action to ensure pipeline infrastructure remains resilient and secure. As such, INGAA members have signed commitments to following the TSA Pipeline Security Guidelines and NIST Cybersecurity Framework, and engage in information sharing platforms such as the DNG-ISAC.

➤ **ASSOCIATION OF OIL PIPE LINES**

The Association of Oil Pipe Lines (AOPL) represents pipeline owners and operators carrying crude oil, refined petroleum products, natural gas liquids and other liquids. AOPL membership comprises 97 percent of the liquids pipeline industry. AOPL member company leaders share information and lessons about safety and security, including in leadership roundtables and a Pipeline Security Team. AOPL participates in discussions on cybersecurity issues with government representatives and other stakeholders.

➤ **AMERICAN FUEL AND PETROCHEMICAL MANUFACTURERS**

The American Fuel and Petrochemical Manufacturers (AFPM) is a trade association representing high-tech American manufacturers of virtually the entire U.S. supply of gasoline, diesel, jet fuel, other

fuels and home heating oil, as well as the petrochemicals used as building blocks for thousands of vital products in daily life.

AFPM's Cybersecurity Subcommittee was formed in 2005. The 40+ members of the Subcommittee comprise both owner operators and vendors, as AFPM considers both to be industry stakeholders. There is a cybersecurity track at the AFPM Operations & Process Technology Summit each fall and cybersecurity presentations at the AFPM Security Conference. The Subcommittee provides technical information that AFPM uses in legislative and regulatory activities. AFPM members participate in DOE and DHS cybersecurity exercises. AFPM is a participating steering committee member on both the DHS Industrial Control Systems Joint Working Group (ICSJWG) and Cyber Resilient Energy Delivery Consortium (CREDC).

➤ **INTERNATIONAL LIQUID TERMINALS ASSOCIATION**

The International Liquid Terminals Association (ILTA) is an advocate and key resource for the liquid terminal industry. Liquid terminals and aboveground storage tank facilities interconnect with and provide services to the various modes of liquid transportation, including ships, barges, tank trucks, rail cars and pipelines. The commodities handled include a large variety of chemicals, along with crude oil, petroleum products, renewable fuels and other resources.

Terminal companies are continuously evaluating how they protect their most important assets, their critical intellectual property and sensitive customer information. ILTA helps member companies evaluate their cyber defenses and identify and address vulnerabilities.

➤ **INTERNATIONAL ASSOCIATION OF DRILLING CONTRACTORS**

The International Association of Drilling

Contractors (IADC) exclusively represents the worldwide oil and gas drilling industry. The drilling industry plays a vital role in enabling the global economy, and in recognition of this role the industry maintains high standards of safety, environmental stewardship and operational efficiency. Through conferences, training seminars, print and electronic publications and a comprehensive network of technical publications, IADC continually fosters industry education and communication on critical issues including cybersecurity.

CYBERSECURITY-FOCUSED COMMITTEES AND PROGRAMS

API has convened its member companies on cybersecurity for more than 15 years. The Information Management and Technology Committee (IMTC) is comprised of Chief Information Officers (CIOs) from API member companies and serves as a forum for the natural gas and oil industry to address issues in systems technology including computers, communications, and electronic commerce. Key issues that the IMTC addresses include risk management, network security, critical infrastructure protection, information privacy, technological change, and knowledge management. The IMTC provides a forum for natural gas and oil company Chief Information Security Officers (CISOs) to discuss technological innovations, compare notes as peers and interact with policymakers and marketplace leaders regarding developments of common interest.²¹

The IMTC oversees the activities the API Information Technology Security Subcommittee (ITSS), the API cybersecurity-focused committee that has been in place since the early 2000s. The API ITSS is comprised of CISOs and a range of other cybersecurity professionals. The ITSS provides an opportunity for member companies to work together proactively to address areas of common interest to the industry and to demonstrate that the industry is taking prudent steps to protect cyber infrastructure.²²

INGAA convenes member organizations through a Cyber and Physical Security Committee to ensure the physical and cybersecurity of natural gas pipeline systems. On a federal regulatory level, the committee primarily works with DHS, TSA, the Federal Energy Regulatory Commission (FERC), DOE, other agencies and Congress to ensure both the safety and reliability of the nation's pipeline network. This group holds security tabletop exercises and participates in information sharing with the government to stay ahead of cyber and physical threats.²³

AGA's cybersecurity program takes a three-pronged approach to addressing cybersecurity threats to natural gas utilities. The first element, Cybersecurity Assessments, leverages AGA's Peer Cyber Review and Cybersecurity Capability Maturity Model (C2M2) programs to ensure that natural gas utilities of all sizes understand their current cybersecurity posture so that they can prioritize future security investments where they will be the most effective. The second prong, Education and Awareness, is accomplished by fostering a shared understanding of the threat via the AGA-managed DNG-ISAC and by convening utility representatives through AGA's Natural Gas Security Committee to share leading and emerging practices. The third element, Technical and Advocacy Guidance, draws on technical expertise from AGA's Cybersecurity Strategy Task Force to support the development of technical whitepapers, industry standards and policies, and other resources to ensure that all stakeholders - across industry and government - are driving towards a policy and technical environment that supports adaptive and continuous improvement.

AFPM has convened its member companies on a Cybersecurity Subcommittee under an Operational Planning Control and Automation Technologies Committee since 2005. This subcommittee has provided technical feedback on legislation and regulatory efforts. As many current cybersecurity issues need not only technical feedback, but feedback from higher levels within

member companies, AFPM also engages members of a Government Regulations Committee on priority issues related to cybersecurity.²⁴

IADC convenes its member companies through its Cybersecurity Committee to develop digital easy-to-use, practically applicable and tailored cybersecurity guidelines for drilling assets that are built upon existing industry standards and best practices. The committee reviews existing cybersecurity regulations, industry best practices and standards of relevance for industrial control systems and drilling assets, clearly defining the approach for standards to follow and subsequently moving to align with standards that can be practically applied to drilling assets.²⁵

To address the growing risk of cyber threats, ILTA created a Cyber-Threat Resilience Assessment Program to help member companies evaluate their cyber defenses and identify and address vulnerabilities. The program focuses on operating models and skills that help companies build cyber threat resilience into their organization. Companies receive a detailed report that identifies gaps and areas of improvements and practical suggestions. The process also provides an educational and awareness platform for all employees on the topic of cybersecurity.²⁶

CYBERSECURITY-FOCUSED EVENTS

Since 2006, API has convened the annual Cybersecurity Conference & Expo in the United States, which brings together over 600 participants including leading cybersecurity experts from natural gas and oil companies, government, academia and marketplace-leading vendors.²⁷

Since 2017, API has partnered with the International Association of Oil and Gas Producers (IOGP) to convene the annual API-IOGP Europe Cybersecurity Conference.²⁸ This event expands the cybersecurity efforts of U.S.-based API members and promotes trans-Atlantic cooperation.

Additionally, API and ONG-ISAC members regularly attended the CyberStrike Workshop developed by DOE's Office of Electricity Delivery and Energy Reliability in collaboration with the Electricity Information Sharing and Analysis Center and Idaho National Lab (INL). The workshop was developed to enhance the ability of energy sector owners and operators in the U.S. to prepare for a cyber incident impacting ICS. The training offers attendees a hands-on, simulated demonstration of a cyberattack, drawing from recent real-world cyber incidents. The instruction platform challenges course participants to defend against a cyberattack on the equipment they routinely encounter within their ICS. The CyberStrike workshop is a critical tool for actively enabling cybersecurity solutions to understand and manage the multifaceted interdependencies between the nation's energy infrastructure and other critical infrastructure, and to detect and respond within compressed timelines to prevent highly impactful consequences.²⁹

Furthermore, security professionals from AGA's Natural Gas Security Committee, INGAA's Security Committee and the Edison Electric Institute's Security Committee meet jointly twice each year to foster improved coordination across the electric and natural gas subsectors, discuss emerging cyber and physical security trends and share leading practices.



PERSPECTIVES ON POLICYMAKING

VOLUNTARY GUIDELINES AND RECOMMENDATIONS FOR REGULATORY EFFORTS

The reliance upon voluntary mechanisms, including the aforementioned use of proven frameworks and public-private collaboration, rather than compulsory standards or regulations, is the most effective and robust way to bolster the cybersecurity of industry companies and the critical infrastructure they operate. As demonstrated in this paper, industry is already deeply engaged on the issue of cybersecurity and working to stay informed and ahead of our adversaries. With the increasing sophistication and adaptiveness of cyber adversaries, it is essential that industry be afforded the necessary flexibility and agility to respond to a constantly-changing threat landscape and the continuous innovation by cyber criminals.

Natural gas and oil companies support the NIST CSF as the pre-eminent standard for companies' cybersecurity programs and for policymaking globally because it is (a) comprehensive, (b) a risk management approach, (c) scalable to different types and sizes of companies, and (d) widely used across the natural gas and oil industry and other industry sectors.

Cybersecurity regulation must balance the government's interest in guidance and oversight against the risk that static rules will quickly become obsolete. Focusing regulation on one type of attack or business activity could force companies to overweight activities in that direction to the detriment of other needs. This can generate significant unintended consequences stemming from the removal of resources otherwise directed to proactive cybersecurity efforts in order to comply with and respond to regulatory obligations.

Regulatory efforts must also be cognizant that companies operate in many different jurisdictions, whether geographically or by industry sector. Cybersecurity guidance must not be so specific that it cannot accommodate the potential of multiple administrative regimes.

Government must partner with industry to ensure that companies establish and maintain an active and agile cyber defense posture, but it must also recognize the limits of prescriptive mandates in this area and guard against regulatory overreach and the imposition of redundant or conflicting rules.

Industry companies urge policymakers to take a measured and coordinated approach to any potential new cybersecurity laws or regulations for the natural gas and oil industry, ideally based on a common understanding with industry on risks and based on the NIST Cybersecurity Framework.

CONCLUSION

Natural gas and oil companies agree with policymakers and others that cybersecurity of the nation's critical infrastructure is a priority, and take seriously the responsibility to protect it, provide reliable energy for society and safeguard the public and the environment. The industry faces an increasing number of cyberattacks and evolving, sophisticated cyber threats from a variety of malicious actors including nation states, criminal organizations and others. These threats are not unique or new to pipelines; they are prevalent across the energy system, including at coal and nuclear plants.

In recognition of the sophistication and dedication of cyber attackers, as well as the enterprise risk presented by cyberattacks, natural gas and oil companies have developed multi-dimensional "defense-in-depth" approaches to cybersecurity similar to industry's approach to managing risks of safety: a robust governance that integrates Board and executive-level oversight, systematic risk-based management, technology solutions and programs based on best-in-class standards and proven frameworks.

Cybersecurity in the natural gas and oil industry applies throughout the value chain and includes collaboration and communication with government at every point. Companies also participate in information sharing through ISACs and peer-to-peer learning through trade associations to force multiply individual companies' threat analysis assets and provide critical lines of defense.

The reliance upon voluntary mechanisms including proven frameworks and public-private collaboration, rather than compulsory standards or regulations, is the best way to bolster the cybersecurity of industry companies and the critical infrastructure they operate. Cybersecurity regulation must balance the government's interest in guidance and oversight against the risk that static rules will quickly become obsolete. Further, regulation might cause companies to focus their defenses on a limited number of types of attacks or business activities to the detriment of other existing or emerging needs. There also is the risk that such rules might create a window into industry defenses that could be exploited. This can generate significant unintended consequences.

ACRONYMS AND ABBREVIATIONS

DOE	Department of Energy
(AFPM)	American Fuel & Petrochemical Manufacturers
(AGA)	American Gas Association
(API)	American Petroleum Institute
(AOPL)	Association of Oil Pipe Lines
(IADC)	International Association of Drilling Contractors
(ILTA)	International Liquid Terminals Association
(INGAA)	Interstate Natural Gas Association of America
CI	Critical Infrastructure
DDOS	Distributed Denial of Service
DHS	Department of Homeland Security
DHS IP	Department of Homeland Security Office of Infrastructure Protection
DHS ISCD	DHS Infrastructure Security Compliance Division
DHS NCCIC	DHS National Cybersecurity Communications and Integration Center
DHS NPP	DHS National Protection and Programs Directorate
DDMZ	Cyber “Demilitarized Zone”
DNG-ISAC	Downstream Natural Gas Information Sharing and Analysis Center
DOT	Department of Transportation
E-ISAC	Electricity Information Sharing and Analysis Center
FERC	Federal Energy Regulatory Commission
FIRST TLP	Forum of Incident Response and Security Teams Traffic Light Protocol
GRF	Global Resilience Federation
IACS	Industrial Automation and Control Systems
IAM	Identity Access Management
IC	U.S. Intelligence Community
ICS	Industrial Control System(s)
IMTC	API’s Information Management and Technology Committee
INL	Idaho National Lab Electricity Information Sharing and Analysis Center
IOC	Indicators of Compromise
IOGP	International Association of Oil and Gas Producers
IP	Intellectual Property
IPS	Intrusion Prevention System(s)
ISAC/ISACs	Information Sharing Analysis Center(s)
IT	Information Technology
ITSS	API’s Information Technology Security Subcommittee
LNG	Liquefied Natural Gas
NCCIC	NIST’s National Cybersecurity & Communications Integration Center
NCCOE	National Cybersecurity Center of Excellence
NIST CSF	National Institute of Standards and Technology Cybersecurity Framework
ONG	Oil and Natural Gas
ONG-ISAC	Oil and Natural Gas Information Sharing and Analysis Center
OS	Operating System
OT	Operational Technology
PCD	Process Control Domain

ACRONYMS AND ABBREVIATIONS

PCN	Process Control Network
PHMSA	Department of Transportation Pipeline and Hazardous Materials Safety Administration
QPS	Quick Pulse Survey
RFI	Request for Information
SIEM	Security Information and Event Management
SOC	Security Operations Center
TSA	Transportation Security Administration
TTPs	Techniques, Tactics and Procedures
VPN	Virtual Private Network(s)

APPENDICES

APPENDIX A: NIST CYBERSECURITY FRAMEWORK

The five core functions of the NIST CSF provide a base by which companies can structure comprehensive cybersecurity programs. These five programmatic areas are:

- ➔ **IDENTIFY:** The identification and understanding of asset management, business environment, governance, risk assessment and risk management strategy to support operational risk decisions.³⁰
- ➔ **PROTECT:** The establishment of access controls, implementation of cybersecurity awareness training, secure management of data, maintenance and usage of information protection processes and procedures, maintenance and repair of industrial control and information system components, and secure management of protective technical solutions.³¹
- ➔ **DETECT:** The detection of anomalous activity and understanding of the potential impact of events, monitoring of information systems and assets and verification of effectiveness of protective measures, and maintenance and testing of detection processes and procedures.³²
- ➔ **RESPOND:** The execution and maintenance of response processes and procedures, coordination of response activities with internal and external stakeholders, conducting of analysis to ensure adequate response and support recovery activities, performance of activities to prevent expansion of an event, mitigate its effects and eradicate the incident, and improvement of organizational response activities.³³
- ➔ **RECOVER:** The execution of recovery processes and procedures to ensure timely restoration of systems or assets affected by cybersecurity events, improvement of recovery planning and processes by incorporating lessons learned into future activities, and coordination of restoration activities with internal and external parties.³³

APPENDIX B: CRITICAL TECHNOLOGY SYSTEM COMPONENTS

The nine critical system areas that typically comprise a natural gas and oil production company are:

- **NETWORK SECURITY:** Measures taken to protect a communications pathway from unauthorized access to, and accidental or willful interference of, regular operations.³⁴
- **IDENTITY AND ACCESS MANAGEMENT (IAM):** The cybersecurity discipline that enables the right individuals to access the right resources at the right times for the right reasons. IAM addresses the mission-critical need to ensure appropriate access to resources across increasingly heterogeneous technology environments, and to meet increasingly rigorous internal requirements. This security practice is a crucial undertaking for the natural gas and oil industry as it is for any business. It is increasingly business-aligned, and it requires business skills, not just technical expertise.³⁶
- **DATA PROTECTION:** Securing digital data, such as those in a database, from destructive forces and from the unwanted actions of unauthorized users, such as a cyberattack or a data breach.³⁷ Data protection includes user-facing areas such as the reporting of phishing attempts and email scanning as well as system areas like data leakage protection, database protection and automated data categorization.
- **APPLICATION SECURITY:** Measures taken to protect an application or website from attack, including static application scanning of web, non-web and mobile applications as well as web application firewalls.
- **ENDPOINT SECURITY:** The process of securing the various endpoints on a network including mobile devices, laptops and desktops, as well as hardware such as servers in a data center, and addressing the risks presented by devices connecting to an enterprise network.³⁸ Increasingly important with greater use of mobile devices, endpoint security protects the corporate network in addition to allowing the endpoint device to operate outside of the network – accessing the cloud or other services – without being easily compromised.
- **VULNERABILITY MANAGEMENT:** The ongoing practice of identifying, classifying, remediating, and mitigating vulnerabilities, particularly in software as well as firmware.³⁹
- **THREAT PROTECTION:** A category of cybersecurity solutions that defend against malware or hacking-based attacks targeting sensitive data.⁴⁰
- **RISK AND COMPLIANCE:** The investigation of external and internal threats that could compromise assets, and the implementation of effective internal policies for mitigating risks and cybersecurity and remediation measures in organizations.⁴¹
- **FORENSICS AND INSIDER RISK:** Digital forensics encompasses the recovery and investigation of material found in digital devices.⁴² Insider risk management includes activities such as user behavior analytics and/or endpoint monitoring intended to detect potential malicious activities by a current or former employee, contractor or other person who has or had authorized access to an organization's network systems, data or premises.

APPENDIX C: GOVERNMENT AND REGULATORY BODIES COVERING AND/OR WORKING WITH INDUSTRY

Transportation Security Administration (TSA)

Government efforts related to pipeline security are covered by the TSA's Office of Security Policy and Industry Engagement's Surface Division. With the assistance of industry and government members of the Pipeline Sector and Government Coordinating Councils, industry association representatives, and other interested parties, TSA developed the Pipeline Security Guidelines. Utilizing a similar industry and government collaborative approach, these guidelines are regularly updated to reflect the advancement of security practices to meet the ever-changing threat environment in both the physical and cybersecurity realms.⁴³

Natural gas and oil companies provided input to TSA as it developed and updated the Pipeline Security Guidelines. Pipeline operators also partner with TSA through its Pipeline Corporate Security Review program as TSA has completed reviews of all the nation's top 100 pipeline systems, which transport 84 percent of the nation's energy.⁴⁴

Department of Homeland Security (DHS)

DHS leads the Federal government's efforts to secure our nation's critical infrastructure by working with owners and operators to prepare for, prevent, mitigate and respond to threats.⁴⁵ In partnership with industry, the DHS Office of Infrastructure Protection (IP) division of the National Protection and Programs Directorate (NPPD) leads and coordinates national programs and policies on critical infrastructure security and resilience. The office conducts and facilitates vulnerability and consequence assessments to help critical infrastructure owners and operators and state, local, tribal and territorial

partners understand and address risks to critical infrastructure. IP provides information on emerging threats and hazards so that appropriate actions can be taken. The office also offers tools and training to help partners such as the natural gas and oil industry manage the risks to their assets, systems and networks.⁴⁶

DHS operates the National Cybersecurity & Communications Center (NCCIC), which serves as the hub for information sharing of cyber threats to-and-from the US Intelligence Community and natural gas and oil companies, primarily through the ONG-ISAC. Cyber threat analysts in the security operations centers of the member companies of the ONG-ISAC share and receive cyber threat indicators with their counterpart analysts in the NCCIC and in US intelligence agencies.

Industry also works with the DHS Infrastructure Security Compliance Division (ISCD) of the Office of Infrastructure Protection of the National Protection.

U.S. Coast Guard (USCG)

USCG oversees both physical and cybersecurity for the natural gas and oil industry through its authorities under the Maritime Transportation Security Act (MTSA) of 2002. Through MTSA, USCG is tasked with the regulation of all marine terminals used to load or unload vessels that transport unrefined petroleum, petroleum products, or liquefied natural gas (LNG). USCG jurisdiction extends from the first isolation valve inside of the secondary containment of the marine terminal to the vessel.⁴⁷

The USCG's work on cybersecurity also includes a mandate, per the 2018 FAA Reauthorization, for it to create a Cybersecurity Maritime Risk Acceptance Model (Cyber MSRAM).

USCG is developing a Navigation and Vessel Inspection Circular (NVIC) titled “Guidelines for Addressing Cyber Risks at Maritime Transportation Security Act- Regulated Facilities” focused on the prevention of “[c]yber attacks [targeting] industrial control systems [that] could kill or injure workers, damage equipment, expose the public and the environment to harmful pollutants, and lead to extensive economic damage.”⁴⁸ Once finalized, this NVIC on cybersecurity will prompt companies that operate natural gas and oil facilities under USCG jurisdiction to take certain steps to address cyber risks.

In addition, USCG has developed a series of “Profiles” for cybersecurity that provide guidance on implementation of the NIST CSF.⁴⁹ The natural gas and oil industry worked closely with USCG and the NIST National Cybersecurity Center of Excellence to develop cybersecurity Profiles on Maritime Bulk Liquid Transfer – security ICS used to transfer hydrocarbons in a maritime environment – and Offshore Operations – offshore natural gas and oil exploration and production.^{50,51}

Cybersecurity experts from natural gas and oil companies have worked collaboratively with the USCG and their advisors from the NIST National Cybersecurity Center of Excellence (NCCOE) and from The MITRE Corporation to develop the cybersecurity Profiles. Together, these experts co-defined the mission critical objectives of natural gas and oil facilities and operations and defined the aspects of the NIST CSF that should be emphasized by companies to mitigate the risks that a cyber attack could compromise these mission objectives.

Department of Energy (DOE)

Industry works closely with DOE to protect against cyber and physical attacks on U.S. energy infrastructure, ensure worker health and safety and provide training tools and procedures for emergency response and preparedness.⁵²

This partnership is exemplified by industry’s collaboration with DOE to provide rapid response to significant recent cyberattacks including WannaCry and NotPetya. Furthermore, through open communication between industry and DOE’s Office of Cybersecurity, Energy Security and Emergency Response, both parties can better address the emerging threats of tomorrow to protect the reliable flow of energy to Americans and improving energy infrastructure security.⁵³

The natural gas and oil industry also collaborates with DOE by participating in the training and research of the DOE National Laboratories. Cybersecurity personnel from the natural gas and oil industry participate regularly in the ICS Cybersecurity Training offered by the Idaho National Laboratory. Natural gas and oil companies also participate in several DOE-sponsored research projects of the “Cybersecurity for Energy Delivery Systems (CEDS)” and other applied research projects, modeling and studies by various DOE National Labs.





Oil and Natural Gas Subsector Coordinating Council (ONG SCC) and Energy Sector Government Coordinating Council (EGCC)

Industry is fundamentally engaged with the ONG SCC and EGCC, information-sharing bodies that cut across virtually all federal agencies involved in cybersecurity related to the natural gas and oil industry. The ONG SCC provides a venue for industry owners and operators to discuss sector-wide security programs, procedures and processes, exchange information and assess accomplishments and progress toward continuous improvement in the protection of the sector’s critical infrastructure. The EGCC provides a private forum for effective coordination of security strategies as well as activities, policies and communication across the sector to support the nation’s homeland security mission. The EGCC endeavors to serve as a single point of contact to facilitate communication between the government

and the private sector when preparing for and responding to issues and threats resulting from physical, cyber or weather-related occurrences impacting the energy sector.

APPENDIX D: INFORMATION SHARING

Forum of Incident Response and Security Teams (FIRST) Traffic Light Protocol (TLP) definitions:⁵⁴

COLOR	WHEN SHOULD IT BE USED?	HOW MAY IT BE SHARED?
TLP:RED  Not for disclosure, Restricted to participants only.	Sources may use TLP:RED when Information cannot be effectively acted upon by additional parties, and could lead to impacts on a party's privacy, reputation, or operations if misused.	Recipients may not share TLP:RED Information with any parties outside of the specific exchange, meeting, or conversation in which it was originally disclosed. In the context of a meeting, for example, TLP:RED information is limited to those present at the meeting. In most circumstances, TLP:RED should be exchanged verbally or in person.
TLP:AMBER  Limited disclosure, Restricted to participants' organizations.	Sources may use TLP:AMBER when Information requires support to be effectively acted upon, yet carries risks to privacy, reputation, or operations if shared outside of the organizations involved.	Recipients may only share TLP:AMBER information with members of their own organization, and with clients or customers who need to know the information to protect themselves or prevent further harm. Sources are at liberty to specify additional intended limits of the sharing; these must be adhered to.
TLP:GREEN  Limited disclosure, restricted to the Community	Sources may use TLP:GREEN when Information is useful for the awareness of all participating organizations as well as with peers within the broader community or sector.	Recipients may share TLP:GREEN Information with peers and partner organizations within their sector or Community, but not via publicly accessible channels. Information in this category can be circulated widely within a particular community. TLP:GREEN information may not be released outside of the community.
TLP:WHITE  Disclosure is not Limited.	Sources may use TLP:WHITE when information carries minimal or no Foreseeable risk of misuse, in accordance with applicable rules and procedures for public release.	Subject to standard copyright rules, TLP:WHITE information may be distributed without restrictions.

ONG-ISAC AND DNG-ISAC WORK PRODUCTS

PRODUCT	TLP LEVEL	FREQUENCY	DESCRIPTION
Automated Information Sharing*	Amber	Real-time	Machine speed solutions to facilitate the collection of cyber threat intelligence
Daily Cyber Vulnerabilities	Green	Daily	Highlights IT and ICS-specific vulnerabilities
Trusted Third-Party Reports	Amber	Weekly	Publishes trusted third-party reports on relevant sector-specific topics
Case Studies*	White/Green	Quarterly	The ONG-ISAC contributes collective intelligence on a variety of cyber hot topics
Annual Report*	Green	Annually	Highlights ONG-ISAC's activities over a yearly period
Collective Intelligence Report	White/Green	As needed	Technical analysis report of open-source intelligence
Cyber Threat Report	Green/Amber	As needed	Provides details on specific threats to any component or entity in ONG industry
Cyber Incident Report	Green/Amber	As needed	Reports on new/evolving cybersecurity breaches or incidents
Trusted Partner Submissions	Green	As needed	Submitted from cross-sector trusted partners reviewed by the ISACs
Member Submissions	Green/Amber	As needed	Shared immediately for situational awareness within the community
Ad-Hoc Reports	Green/Amber	As needed	Focused on urgent physical and/or cyberattacks impacting the industry
Request for Information (RFI)	Amber	As needed	The ISACs facilitates the exchange of information related to relevant topics
Quick Pulse Survey (QPS)*	Amber	As needed	The ONG-ISAC facilitates the exchange of information related to relevant topics
Bi-Monthly	White	Bi-Monthly	The ISACs contributes technical analysis to the Global Resilience Federation (GRF) bi-monthly report

*Work product specific to only the ONG-ISAC



REFERENCES

1. **Department of Homeland Security**, National Cybersecurity and Communications Integration Center, Industrial Control Systems Cyber Emergency Response Team, "FY2016 ICS-CERT Year in Review", https://ics-cert.uscert.gov/sites/default/files/Annual_Reports/Year_in_Review_FY2016_Final_S508C.pdf
2. **Department of Homeland Security**, "Sector Risk Snapshot," May 2014, <https://www.hsdl.org/?view&did=754033>
3. **U.S. Department of Energy**, Office of Electricity Delivery and Energy Reliability, "Energy Sector Cybersecurity Framework Implementation Guidance", January 2015, https://www.energy.gov/sites/prod/files/2015/01/f19/Energy%20Sector%20Cybersecurity%20Framework%20Implementation%20Guidance_FINAL_01-05-15.pdf
4. **National Institute of Standards and Technology**, News, April 2018, <https://www.nist.gov/news-events/news/2018/04/nist-releases-version-11-its-popular-cybersecurity-framework>
5. **Oil and Natural Gas Sector Coordinating Council**, "2015 Cybersecurity Survey"
6. **National Institute of Standards and Technology Cybersecurity Framework**, Perspectives on the Framework, <https://www.nist.gov/cyberframework/perspectives>
7. **ISA99 Committee**, Manufacturing and Control Systems Security Part 1: Models and Terminology, <http://isa99.isa.org/>
8. **Department of Homeland Security**, National Cybersecurity and Communications Integration Center, Industrial Control Systems Cyber Emergency Response Team, "Recommended Practice: Improving Industrial Control System Cybersecurity with Defense-in-Depth Strategies", 2016, https://ics-cert.us-cert.gov/sites/default/files/recommended_practices/NCCIC_ICS-CERT_Defense_in_Depth_2016_S508C.pdf
9. **Department of Energy**, Cybersecurity Capability Maturity Model (C2M2), <https://www.energy.gov/ceser/activities/cybersecurity-critical-energy-infrastructure/energy-sector-cybersecurity-O-O>
10. **U.S. Government**, "The Consolidate Appropriations Act, 2016," <https://www.congress.gov/bill/114th-congress/house-bill/2029?q=%7B%22search%22%3A%5B%22%5C%22cybersecurity+act+of+2015%5C%22%22%5D%7D&r=2>
11. **Department of Homeland Security**, Executive Order 13636, "Presidential Directive 21 Fact Sheet," <https://www.dhs.gov/sites/default/files/publications/EO-13636-PPD-21-Fact-Sheet-508.pdf>
12. Ibid.
13. **White House**, Executive Orders, "Presidential Executive Order on Strengthening the Cybersecurity of Federal Networks and Critical Infrastructure", <https://www.whitehouse.gov/presidential-actions/presidential-executive-order-strengthening-cybersecurity-federal-networks-critical-infrastructure/>
14. Ibid.
15. **Downstream Natural Gas Information Sharing and Analysis Center**, <https://www.dngisac.com/>
16. **Oil and Natural Gas Information Sharing Analysis Center**, <http://ongisac.org/>
17. **United States Computer Emergency Readiness Team**, Traffic Light Protocols. <https://www.us-cert.gov/tlp>
18. **Oil and Natural Gas Information Sharing Analysis Center**, <http://ongisac.org/>
19. Ibid.
20. **Department of Homeland Security**, Oil and Natural Gas Subsector Coordinating Council, "Governance Principles and Operating Procedures," <https://www.dhs.gov/sites/default/files/publications/Energy-ONG-SCC-Charter-2015-508.pdf>
21. **API Information Technology Committees**, <https://www.api.org/about/organization/committees/information-technology>
22. Ibid.
23. **Interstate Natural Gas Association of America**, Cyber and Physical Security Committee, <https://www.ingaa.org/about/ingaa-committees/29297.aspx>
24. **American Fuel and Petrochemical Manufacturers**, Cybersecurity, <https://www.afpm.org/Cybersecurity/>
25. **International Association of Drilling Contractors**, Cybersecurity Committee, <http://www.iadc.org/cybersecurity-committee/>
26. **International Liquid Terminals Association**, Cybersecurity, <https://www.ilta.org/ILTA/Advocacy/Cybersecurity/ILTA/Advocacy/Cybersecurity.aspx>
27. **API, Policy and Issues**, Cybersecurity. <https://www.api.org/news-policy-and-issues/cybersecurity>

28. Ibid.
29. **Public Power Association**, DOE CyberStrike Workshop. <https://www.publicpower.org/event/session/pre-and-post-conference-seminars>
30. **NIST Cybersecurity Framework Resources**, Identify, <https://www.nist.gov/cyberframework/identify>
31. **NIST Cybersecurity Framework Resources**, Protect, <https://www.nist.gov/cyberframework/protect>
32. **NIST Cybersecurity Framework Resources**, Detect, <https://www.nist.gov/cyberframework/detect>
33. **NIST Cybersecurity Framework Resources**, Respond, <https://www.nist.gov/cyberframework/respond>
34. **NIST Cybersecurity Framework Resources**, Recover, <https://www.nist.gov/cyberframework/recover>
35. **Gartner IT Glossary**, Network Security, <https://www.gartner.com/it-glossary/network-security>
36. **Gartner IT Glossary**, Identity and Access Management, <https://www.gartner.com/it-glossary/identity-and-access-management-iam>
37. **Summers, G. (2004). Data and databases.** In: Koehne, H Developing Databases with Access: Nelson Australia Pty Limited. p4-5.
38. **Digital Guardian**, Data Protection 101: What is endpoint security? <https://digitalguardian.com/blog/what-endpoint-security-data-protection-101>
39. **Foreman, P: Vulnerability Management**, page 1. Taylor & Francis Group, 2010. ISBN 978-1-4398-0150-5
40. **Digital Guardian**, <https://digitalguardian.com/blog/what-advanced-threat-protection-atp>
41. **NICCS National Initiative for Cybersecurity Careers and Studies**, Central Michigan University Training Program on Governance, Risk and Compliance in Cybersecurity, <https://niccs.us-cert.gov/training/search/central-michigan-university/governance-risk-compliance-cybersecurity>
42. **Carrier, B (2001). "Defining digital forensic examination and analysis tools".** Digital Research Workshop II. Archived from the original on 15 October 2012.
43. **Transportation Security Administration Office of Security Policy and Industry Engagement's Surface Division**, Pipeline Security Guidelines, March 2018. https://www.tsa.gov/sites/default/files/pipeline_security_guidelines.pdf
44. **Transportation Security Administration**, "Securing and Protecting Our Nation's Pipelines," 2016, <https://www.tsa.gov/news/releases/2016/07/11/securing-and-protecting-our-nations-pipelines>
45. **Department of Homeland Security**, Executive Order 13636, Presidential Directive 21 Fact Sheet. <https://www.dhs.gov/sites/default/files/publications/EO-13636-PPD-21-Fact-Sheet-508.pdf>
46. **Department of Homeland Security Office of Infrastructure Protection**, <https://www.dhs.gov/office-infrastructure-protection>
47. **Department of Transportation Pipeline and Hazardous Materials Safety Administration**, Marine Terminals Fact Sheet, <https://primis.phmsa.dot.gov/comm/FactSheets/FSMarineTerminals.htm>
48. **U.S. Coast Guard**, <https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Inspections-Compliance-CG-5PC-/Office-of-Port-Facility-Compliance/Domestic-Ports-Division/cybersecurity/>
49. **U.S. Coast Guard**, "Cybersecurity Framework Profiles Overview," 2018, <https://www.dco.uscg.mil/Portals/9/CG-FAC/Documents/Cyber%20Profiles%20Overview.docx?ver=2018-01-10-143126-467>
50. **U.S. Coast Guard**, "Appendix A. Maritime Bulk Liquid Transfer Profile," <https://www.dco.uscg.mil/Portals/9/CG-FAC/Documents/Appendix%20A.%20Maritime%20Bulk%20Liquids%20Transfer%20Profile.docx?ver=2018-01-10-141700-073>
51. **U.S. Coast Guard**, "Appendix B. Offshore Operations Profile," <https://www.dco.uscg.mil/Portals/9/CG-FAC/Documents/Appendix%20B.%20Offshore%20Operations%20Profile.docx?ver=2018-01-10-140108-557b>
52. **Department of Energy**, National Security and Safety, <https://www.energy.gov/national-security-safety>
53. **Department of Energy Office of Cybersecurity**, Energy Security and Emergency Response, <https://www.energy.gov/ceser/office-cybersecurity-energy-security-and-emergency-response>
54. **United States Computer Emergency Readiness Team**, Traffic Light Protocols. <https://www.us-cert.gov/tlp>



ATTACHMENT D

Natural Gas: Reliable and Resilient



NATURAL GAS: RELIABLE AND RESILIENT

APRIL 2019



FOREWORD

In a situation that has become all too familiar, summer in the Northern Hemisphere has been accompanied by devastating hurricanes. In addition to the risks to lives and property, this eventuality is also of paramount concern for the companies that produce and deliver natural gas, which provides essential energy to customers before, during and after these events, and to the brave women and men who respond when our communities need it most.

For decades, the natural gas industry has built a vast and reliable infrastructure that has withstood many disasters. Simultaneously, we have built a culture where every employee feels a responsibility for the safety of his or her co-workers, their customers and communities. Our companies and our energy production and delivery systems have been tested in recent years by extreme weather, and we have succeeded.

In preparation for the 2019 Atlantic hurricane season that officially begins on June 1, 2019, the NGC is publishing this report for the benefit of its members, policymakers at every level and anyone with an interest in the safe and reliable delivery of our nation's natural gas abundance.

The Natural Gas Council was formed in 1992, uniting all sectors of the natural gas industry to work together toward common goals. The five full members of the Council—the American Gas Association, the American Petroleum Institute, the Interstate Natural Gas Association of America, the Independent Petroleum Association of America and the Natural Gas Supply Association—collectively represent nearly all the companies that produce, transport and distribute natural gas consumed in the United States. Leadership of the NGC rotates annually, with the American Gas Association leading the Council in 2019.



Introduction

The United States has abundant natural gas resources that enable the natural gas industry to satisfy customer demand. In only a few years' time, the U.S. has become the largest producer of natural gas in the world. Since 2010, production has grown almost 30 percent. Government forecasts expect this trend to continue.¹

At the same time, electric sector demand for natural gas has increased, driven by advanced economics, low-carbon greenhouse gas emissions, and more flexibility due to faster plant start-up time, which are among the same factors contributing to coal-fired plant retirements, as well as the comparatively low capital cost and smaller footprint of natural gas-fired power plants.² The growth in natural gas use for power generation has led some who are unfamiliar with natural gas operations and contracting practices to question the ability of natural gas to serve this market reliably.

For well over a century, customers have relied on natural gas for home heating in the dead of winter. Driven by the core values of safety and pipeline integrity, natural gas system resilience and reliability are engrained in the industry's DNA.

This document outlines the reliability and resilience of natural gas transportation, related regulatory authorities, and the contracting procedures necessary for large volume customers to best meet their service needs.

A Physically Reliable System

In the United States, there are more than a half million producing gas wells spread across 30 states. The growth of major onshore shale gas production has greatly reduced exposure to the effects of hurricanes to off-shore supplies and spot market prices. Onshore natural gas production accounted for 95 percent of total U.S. gross withdrawals of natural gas in 2016, up from 74 percent in 1990.

Because natural gas physically moves slowly through a pipeline at an average speed of 15-20 miles per hour, its flow can be controlled. This allows time for pipeline operators to manage the flow and adjust operations in the unlikely event of a disruption.

The natural gas value chain is extensive and spans from the production well-head to the consumer burner-tip (see illustration on page 2). Mostly underground, America's 2.5 million mile natural gas pipeline network is the safest form of energy delivery in the country³ – transporting approximately one-fourth of the energy consumed in the U.S. Further, this pipeline and storage network is highly reliable. Production can be accessed from virtually all major North American gas-producing regions and securely delivered via a highly integrated pipeline transportation network. Very rarely, force majeure events such as catastrophic weather have the ability to potentially disrupt localized segments of this network, but typically only at above-ground facilities where the pipeline may be exposed and damaged.

Outages are extremely rare and are localized when they occur due to the interconnected nature of the transportation network.

The natural gas value chain includes three major segments:

- **Production & Processing** - Natural gas is found in reservoirs deep within the earth and brought to the surface through production wells. Gathering lines then transport natural gas from these wellheads to processing plants.
- **Transmission & Storage** - Transmission lines transport processed natural gas to large-volume customers (e.g., local distribution companies, natural gas-fired power generation, industrial customers, etc.) or to storage facilities.
- **Distribution** - Distribution lines deliver natural gas to residential, commercial, industrial customers, and natural gas-fired power generators.

Figure 1 on the following page provides an overview of these segments in greater depth.

Compressor Stations: Natural gas compressors pressurize the natural gas for transportation throughout the pipeline network. There are approximately 300,000 miles of interstate and intrastate transmission pipelines in the natural gas pipeline system. More than 1,400 compressor stations are strategically sited every 50 to 100 miles to maintain proper pressure on the pipeline network and guarantee the cross-country transportation. These compressor stations are typically designed with multiple compressor units. This compressor redundancy supports scheduled and unscheduled unit maintenance or repair while minimizing impacts to system delivery.

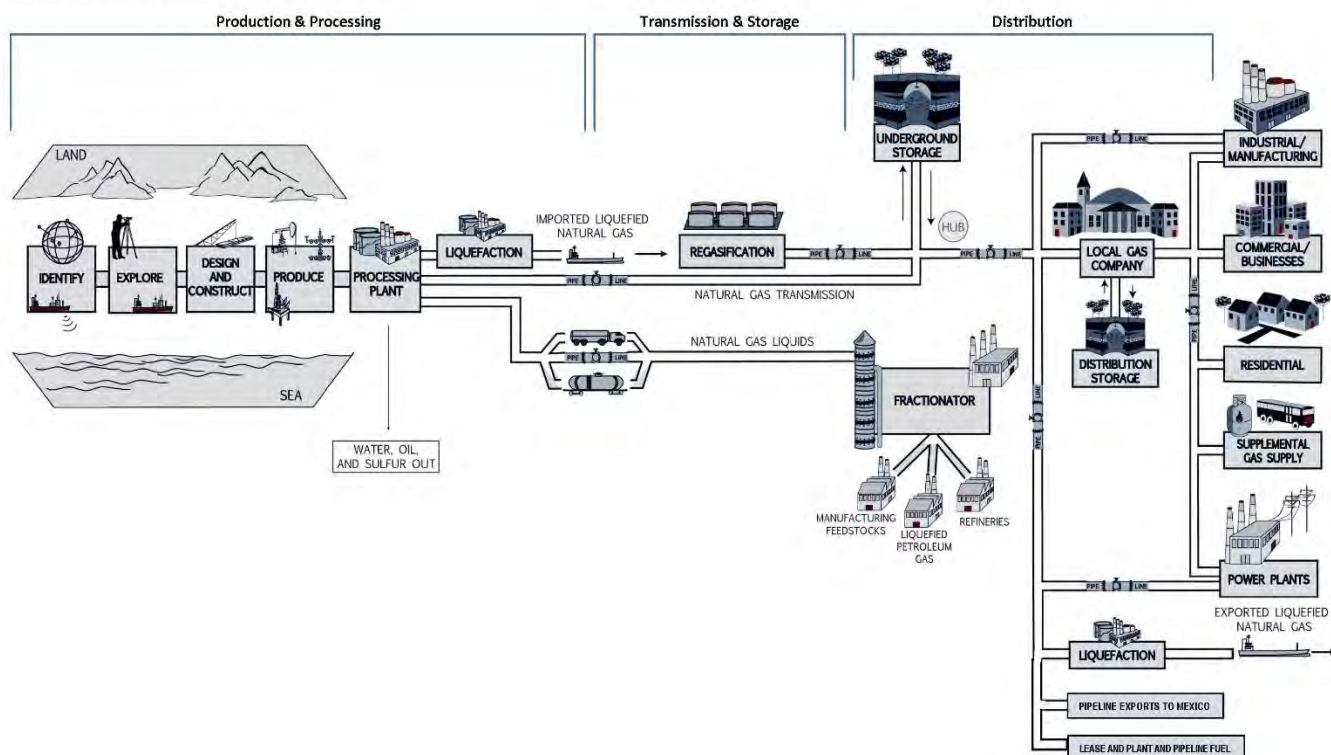
¹ See EIA *Short Term Energy Outlook*, May 2017, and EIA Natural Gas Summary | Custom Table Builder.

² See Leidos (formerly SAIC), *Comparison of Fuels for Power Generation*, 2016.

³ According to data in 2018 National Transportation Statistics (Department of Transportation Bureau of Transportation Statistics, <https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/national-transportation-statistics/220806/ntsentire2018q1.pdf>.)

Figure 1: An overview of the Natural Gas Value Chain

Source: The American Petroleum Industry, Oil and Natural Gas Industry Preparedness Handbook, 2015.



The following operational capabilities minimize the possibility that a pipeline failure has more than a localized impact.

- An extensive network of interconnected pipelines offer multiple pathways to reroute deliveries;
- Parallel pipelines increase pipeline capacity and make it possible to shut off one while keeping others in service;
- Geographically dispersed production and storage ensure supply flexibility;
- A physical property of natural gas known as *compressibility* allows for additional volume of gas molecules to be packed into the pipeline. This excess volume of compressed gas is known as “line pack” and provides a flexible buffer of stored energy to be naturally available in the pipeline system.⁴ The purpose of this buffer is to ensure the capability of the pipeline operations to accommodate changing conditions throughout the day. Though line pack neither creates incremental capacity (the pipe size itself doesn’t change) nor is it a substitute for appropriate transportation contracts, it often can be used to help minimize the impact of short-term supply disruption;
- The combination of physical characteristics of natural gas and the interconnected pipeline system allows operators to control and redirect the flow around any potential pipeline outage (analogous to driving a ‘detour’).

Storage: Another significant physical property that reinforces natural gas’ supply-chain resilience and reliability is the ability to store natural gas after production. The natural gas industry has developed large amounts of storage capacity to supplement gas production on peak days and during winter demand for customers that contract for such service. While natural gas production remains relatively constant year-round, storage enables customers to adjust for daily and seasonal fluctuations in demand.

Natural gas is stored most commonly underground in depleted oil and gas reservoirs, depleted aquifers, and salt caverns. Natural gas can also be stored above ground in storage tanks as liquefied natural gas (LNG) or compressed natural gas (CNG). Storage not only provides a supply buffer but also provides vital operational flexibility should unplanned supply constraints develop in the pipeline and distribution network. LNG and CNG can also be transported by vehicle or vessel to serve remote areas in the event of a supply disruption.

Layers of Protection

The natural gas system – production, gathering, processing, transmission, distribution and storage – is

⁴ The full volume in the pipeline is limited by the pressure permitted by federal pipeline safety regulations (49 CFR Part 192).

highly flexible and elastic. Natural gas delivery systems are mechanical by nature and operated manually if necessary. Control systems help monitor, and in some cases, operate the pipelines and their components to move the gas in a reliable, efficient and effective manner. The system, however, remains largely non-electronic, and most electronics have mechanical fail-safes. Operators manage the internal pressure of the delivery system by controlling the amount of natural gas that enters and leaves the system. This process of increasing or decreasing pressure happens relatively slowly because of the compressible nature of gas. Line pack lessens the immediacy of customer impacts due to an operational abnormality and increases the probability that such events can be resolved before customers are impacted.

Overpressure protection devices, designed to prevent internal gas pressure from threatening pipeline's integrity are layered onto the pipeline control system architecture.

In summary, natural gas service disruptions are rare and generally localized due to the physical characteristics of natural gas and the decentralized nature of the transmission network. Further, built-in pipeline and supply redundancies minimize disruptions that do occur. As noted in a report from MIT⁵:

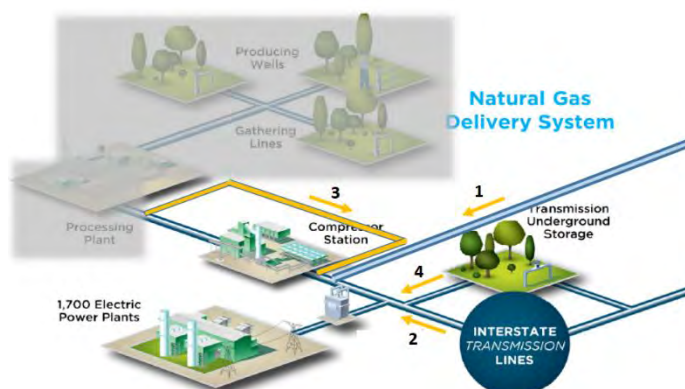
The natural gas network has few single points of failure that can lead to a system-wide propagating failure. There are a large number of wells, storage is relatively widespread, the transmission system can continue to operate at high pressure even with the failure of half of the compressors, and the distribution network can run unattended and without power. This is in contrast to the electricity grid, which has, by comparison, few generating points, requires oversight to balance load and demand on a tight timescale, and has a transmission and distribution network that is vulnerable to single point, cascading failures.

The findings in that MIT report continue to hold true as natural gas pipeline operations and system design remain relatively consistent over the years. Further, production comes from a large population of gas-producing wells, minimizing the potential for single points of disruption. Production companies have an economic incentive to maintain a steady gas flow. To ensure this flow, producers often rely on multiple processing plants and pipeline routing options in production areas, especially when handling high volumes of production.

Multi-Sourced: Another factor contributing to the reliability and resilience of pipelines is that few pipelines in the U.S. are single-sourced. Most have multiple, if not hundreds, of interconnects and supply source points. Figure 2 below outlines the possibilities to deliver supply in the event of a disruption on the system.

- See #1: The major long-haul pipelines continue moving significant volumes of natural gas even when pipeline supply source point is removed.
- See #2: In general, natural gas pipelines are designed to be operated bidirectional. In an extreme or emergency situation, operators can change their system configuration to back-feed a pipeline and continue supplying natural gas to customers.
- See #3: Compressor stations are commonly constructed with bypasses to allow natural gas flow to continue even when the stations are down.
- See #4: Portable LNG and CNG may also be trucked to the market to assist with supply needs.

Figure 2: Natural Gas Value Chain Redundancy




The North America Electric Reliability Corporation (NERC) also conducted an assessment⁶ on natural gas and electric interdependence. The study analyzed the potential impacts to bulk power system (BPS) reliability as a result of a large disruption on the natural gas system. NERC observed that natural gas system disruptions that impact BPS reliability are extremely rare and dependent on a variety of factors. The study found that firm natural gas pipeline transportation, dual fuel capability and ample infrastructure, provides the highest level of reliability for natural gas delivery. Furthermore, diverse natural gas

⁵ Massachusetts Institute of Technology, Lincoln Laboratory, "Interdependence of the Electricity Generation System and the Natural Gas System and Implications for Energy Security," May 15, 2013.

⁶ November 2017, NERC Special Reliability Assessment on Bulk Power System (BPS) Impacts Due to Severe Disruptions on the Natural Gas System

supply sources reduce the likelihood of natural gas infrastructure outages affecting electric generation.



Service disruptions are rare. There is low risk of uncontrollable, cascading outages in the natural gas system, as supply and transportation disruptions can typically be addressed through substitution, re-routing and storage services.

Security – Physical & Cyber

Throughout the natural gas value chain, the industry utilizes a broad portfolio of tools to protect facilities from physical and cybersecurity threats. Recognizing industry's commitment to security and the resilience and redundancy built into pipeline systems, the federal government has opted to partner with industry on cyber and physical security instead of providing mandatory and prescriptive regulations. This partnership is notably reflected by the natural gas pipeline industry's commitment to updating and implementing the *TSA Pipeline Security Guidelines*, which provide a risk-based approach to protecting pipeline infrastructure from cyber and physical security threats.

Physical Security: Fences, routine patrols, and continuous monitoring, as appropriate, help protect above-ground facilities such as compressors, well sites, processing plants, and meter stations. Unmanned aerial systems (UAS), also called "drones", video-monitoring, intrusion cameras, motion-detectors, and biometrics are all examples of technologies deployed to address physical threats. The natural gas industry routinely holds threat briefings and workshops to discuss and improve security and has developed industry guidelines and identified practices to protect facilities and data. Natural gas trade associations and pipeline operators regularly run simulated response/recovery exercises to help prepare for natural or man-made disasters. The industry also works closely with government agencies to share threat information.

Cybersecurity: One of the most important aspects of pipeline cybersecurity is protecting the integrity and operability of pipeline operational technology (OT), primarily industrial control systems (ICS), against cyber compromise. Cybersecurity is a priority for companies that operate natural gas pipelines and other infrastructure and these companies manage cybersecurity risks with Board and Senior Executive oversight. Natural gas companies orient their cybersecurity programs to several key frameworks and standards, including but not limited to: the NIST Cybersecurity Framework, the ISA/IEC 62443 Series of Standards on Industrial Automation and Control Systems (IACS) Security, ISO 27000, NIST 800-82, the TSA Pipeline Security Guidelines, and API Standard 1164.

From a cybersecurity perspective, natural gas functions are divided across an enterprise network (business systems) and an operations network – including process control networks, Supervisory Control and Data Acquisition systems (SCADA), distributed control systems (DCS), and other pipeline monitoring. Network segmentation, or isolating the enterprise networks from the operational network, is a critical cybersecurity defense implemented by natural gas companies. Individual companies deploy a customized portfolio of tools and mechanisms to provide further "defense-in-depth," holistically improving the prevention, detection, and mitigation of successful cyber penetration.

In collaboration with the federal government, companies operating natural gas infrastructure are continuously responding to cyber threats and evolving the sophistication of their defenses. The federal government partners with the industry on cybersecurity initiatives to promote situational awareness, mitigative measures, and response/recovery. Critical infrastructure sectors, including natural gas, use Information Sharing & Analysis Centers (ISACs) to share analysis of changing threats within the sector, other sectors, and federal and state governments.

Regulations & Authorities

Natural gas pipelines are subject to strict pipeline safety regulations mandated by the Department of Transportation's (DOT) Pipeline & Hazardous Materials Safety Administration (PHMSA) and to the pipeline security authority of the Department of Homeland Security (DHS) Transportation Security Administration (TSA).

Figure 3: Natural Gas System Rate Structure



Pipeline Safety: These regulations stipulate engineering, operational, and public safety requirements for pipeline construction and use. Other federal and state agencies regulate various environmental, security, and safety aspects of the natural gas system. As outlined below and in Figure 3, natural gas industry segments are subject to different regulatory regimes – the product of a long evolution

Interstate Pipelines: In 1992, the Federal Energy Regulatory Commission (FERC), which regulates interstate natural gas pipelines, required interstate pipelines to unbundle (i.e., separate) gas commodity sales and gas transportation services, and to provide transportation service on an open access, non-discriminatory basis.

As a result, interstate pipelines exited the gas merchant function and became contract carriers that transport gas molecules owned by third party shippers – roughly analogous to a semi-truck driver transporting loaves of bread to a store. As such, interstate pipeline operators charge for the movement of gas through their systems, while the gas commodity itself must be purchased separately, from gas suppliers – typically producers and marketers.

Local Distribution: Natural gas LDCs are regulated at the state and local level and obligated by public service regulations to reliably meet the natural gas supply needs of their firm customers at regulated rates. These are the customers, such as residential consumers, hospitals, etc., for which the LDC system was built to serve reliably on a “design day” (a forecasted peak-load day based on historical weather).

In the event of an LDC disruption, service priority is typically specified in a public utility commission-approved tariff⁷, as applicable. This may or may not be the case for municipal gas companies, depending on the jurisdiction. Generally, the highest service priority is given to maintaining the operational integrity of the system and/or maintaining natural gas service to designated high priority customers, including “essential human need” and

residential and commercial customers without short-term alternatives. A natural gas-fired power generator relying on an LDC distribution system, particularly on an interruptible basis, needs to consider the LDC’s primary service obligations and plan for the use of alternate fuels or contract for firm transportation or other services the LDC may provide. These contracts and services are described in greater depth on page 6.

Pipeline Security. The amalgamation of the 2001 Aviation & Transportation Security Act (which created TSA within DOT) and the Homeland Security Act of 2002 (which created DHS and moved TSA from DOT to DHS) granted pipeline security authority to TSA under DHS. Since its inception, TSA has strategically chosen to partner with pipeline operators to advance infrastructure security.

In partnership with industry, the Pipeline Security Program, within the Surface Division of TSA’s Office of Security Policy and Industry Engagement, developed Pipeline Security Guidelines (Guidelines). These Guidelines are designed to help operators strengthen their security posture and provide the basis for the TSA Pipeline Security Program Corporate Security Reviews and Critical Facility Security Reviews.

While TSA has authority over pipeline cyber and physical security, a number of other organizations have authority over the security of other elements of the natural gas value chain.⁸

Contractual Obligations

The interstate pipeline industry is contract-based. Pipeline and storage companies contract with customers under the terms of their FERC-approved tariffs. Customers select transportation and storage services (firm or interruptible) based on the level of certainty and reliability that they desire. Firm-service shippers⁹ receive the most reliable service, because they have the highest scheduling priority and are the last to be curtailed in force majeure (or unexpected emergency) situations.¹⁰ Service to interruptible shippers, if scheduled, can be interrupted by

⁷ A tariff is a “collection of rules that defines the relationship between a utility and its customers.” See <http://puc.nv.gov/About/Docs/Tariffs/>

⁸ Post the ONG SCC Doc Online at ongsubsector.org (once approved by ONG SCC)

⁹ A “shipper” is a company who owns the physical product and pays the pipeline company for transport. See <http://www.pipeline101.org/how-do-pipelines-work/who-operates-pipelines>.

¹⁰ FERC gas regulations define “service on a firm basis” as a service that is “not subject to a prior claim by another customer or another class of service and receives the same priority as any other class of firm services.” 18 C.F.R. § 284.7(a)(3)

higher priority firm shippers. Therefore, the level of interstate pipeline service for which a customer has contracted is of paramount importance.

Some large-volume customers (e.g., LDCs, industrial users) purchase gas upstream at or near the point of production and contract separately for pipeline service to transport the commodity to the point of delivery. Others purchase gas at a market center and contract for transportation from that point to their delivery point. Others purchase a bundled commodity and transportation package from marketers, who deliver the gas using the pipeline capacity for which they have contracted. It is the responsibility of pipeline customers to ensure their gas supply reliability by contracting for the portfolio of commodity, transportation and storage that best meet their needs and risk tolerance.

CONTRACTUAL SERVICE TYPES

Interstate pipelines schedule the available transportation system capacity based on a system that includes nominations and confirmations. When necessary, service restrictions are based upon the type of service contracted.

1. "Firm" contracts – customer pays for highest level of delivery of the commodity; on a pipeline, usually the customer pays a monthly charge reserving capacity on the pipeline to transport or store up to a specified amount of gas every day
2. "Interruptible" contracts – customer pays for a lower level of delivery of the commodity which can be interrupted at any time for any reason unless scheduled by the pipeline and past the "no bump" period. The pipeline will schedule the interruptible customers to use the capacity as long as the capacity is available. Capacity is often not available during peak demand periods when higher priority customers are using their capacity. Further, service can be interrupted for higher priority services.
3. Other contract options even include "no-notice" service, which gives capacity on the pipeline throughout the 24-hour gas day.

On occasion, interstate pipelines may not have uncontracted transportation capacity available for sale. Moreover, on the coldest days (i.e., peak days), when weather-sensitive firm transportation customers are using their full contractual entitlements, there likely will be little or no transportation capacity left over to provide interruptible transportation service. These interruptions are unrelated to the disruption of pipeline transportation or the unavailability of the natural gas commodity. Rather, the interruptions are the result of higher priority customers exercising the entitlement to natural gas

transportation on a firm basis for which they have contracted.

Customers that do not hold pipeline capacity often attempt to purchase transportation capacity on the vibrant "secondary market", where firm transportation customers can release their capacity for resale. Independent natural gas marketers also offer gas supply services that can be tailored to meet the needs of different types of buyers.

Interstate pipelines do not prioritize transportation service based on the end use of the natural gas.¹¹ Rather, service priority is a function of the service level the customer has contracted with the pipeline, with firm and "no-notice" services being the highest priority. If large-volume customers, such as power generators, seek the highest level of reliable service, they must contract "firm" or, in some cases, "no –notice" service to ensure pipeline capacity and/or storage service is available when needed.

If a force majeure event reduces available pipeline capacity such that a pipeline cannot provide all scheduled delivery obligation, a pipeline will curtail service base on the priority of customers' contracted transportation service. A pipeline will curtail interruptible transportation contracts first.

Electric generators in the organized wholesale electric markets may need appropriate incentives and cost recovery mechanisms to contract for firm transportation and storage services that may be needed to satisfy their reliability needs.

Many power generators and other industrial and large commercial gas users are connected directly to an interstate or intrastate transmission pipeline. Others are connected directly to LDC systems. The gas customers typically do not purchase gas from the LDC, but rather contract to use that LDC system for transportation of gas that they purchase in the wholesale market.

Large gas users are reminded to consider the entire fuel value chain, taking into consideration congested transportation paths, pipeline contract scheduling, and curtailment priorities when contracting for gas delivery.

Time-Tested Resilience

Decades of operational experience demonstrate the natural gas industry's effective response to historic weather events, notably the 2011 Southwest Cold Weather event, 2012 Superstorm Sandy, 2014 Polar Vortex, and the more recent 2017 Hurricane Harvey and

¹¹ FERC's non-discriminatory open access regulations preclude this.

2018 Bomb Cyclone. During each of these events, natural gas supply and transportation service were provided in an exemplary manner.

History has shown that during these sorts of unprecedented weather events, the natural gas systems fairs well. Natural gas operations are built with resilience upfront and designed to remain in service. To address threats from natural disasters, such as earthquakes, pipeline construction standards are appropriately scaled up in high risk/high consequence areas, relative to those regions with lower risk. Further, pipeline controllers are postured to receive emergency notifications upon detection of earthquakes which include GPS coordinates of the earthquake's epicenter and allow for quick identification of potentially impacted assets and broader operational risk.

In the Face of Storms...

In February 2011, the southwest region of the U.S. experienced historically cold weather (known as the **Southwest Cold Weather Event**) resulting in electric and natural gas service disruptions. Due to the loss of some production to well freezing at a time of increased gas system demand, nearly 50,000 retail gas customers experienced curtailments when gas pressure declined on interstate and intrastate pipelines and local distribution systems. The interstate and intrastate pipeline network showed good flexibility in adjusting flows to meet demand and compensate for supply shortfalls. No evidence was found that interstate or intrastate pipeline design constraints, system limitations, or equipment failures contributed significantly to the gas outages.¹²

Superstorm Sandy hit the Northeast in 2012 wreaking havoc on New York and New Jersey. The use of natural gas-powered microgrids and combined heat and power systems allowed certain businesses and hospitals to remain open.¹³

The **2014 Polar Vortex** weather event stretched across the U.S. and caused total delivered gas nationwide to reach an all-time record of 137.0 Bcf in a single day.¹⁴ Despite the unprecedented performance levels required, the industry honored all firm fuel supply and transportation contracts.¹⁵

Hurricane Harvey flooded Houston in 2017. Natural gas transportation was not disrupted, and the local gas utility distribution systems remained operational in Houston and surrounding impacted area.

The **2018 Bomb Cyclone** or "snow hurricane" slammed on the East Coast in early January during an already severe cold wave and blizzard that had begun in December 2017. Spot gas prices hit record highs, and national prices elevated a degree. Despite impacts on the market, natural gas service was maintained.

Should an "act of man", or anthropogenic event, occur, structural and procedural processes are often already in place. For instance, in areas at high risk of wildfire (natural or manmade), companies typically work with local authorities to have markers in place so that when "firebreaks" are deployed, pipeline safety management can more readily be applied. In addition, all companies have business continuity plans in place to deal with a broad range of disasters.

Unlike electricity systems, which are often designed to shut down under abnormal conditions, natural gas operations are designed to remain in service. Because the majority of natural gas pipelines is buried, interruptions tend to be localized, and widespread recovery is rare.

Specific to the LDC system, should natural gas service be shutdown, the process of bringing the system back online is a labor-intensive, multi-step process; whereby, the gas utility performs integrity tests on each repaired pipeline, visits individual homes and businesses to shut off individual services, re-pressurizes the distribution pipelines, and finally inspects and turns on individual services meters and appliances. For this reason, natural gas cannot be subject to rolling blackouts as can be done with the electricity system. Also, for this reason, LDCs contract appropriately for gas supply and transportation. Often, the pipeline has been repaired; is re-pressurizing and ready to supply natural gas; but, the structures that use the natural gas are not yet repaired or replaced.

Natural Gas-Fired Power Generation

The natural gas and electric systems are each uniquely complex; the systems operate and are regulated differently; and each industry uses its own terminology applicable to its infrastructure as well as physical characteristics of the energy commodity being transported. Gas-electric coordination efforts over the years have helped each industry better understand the other's operations, regulatory structure, and needs. From a practical perspective, the extent to which a natural gas transportation disruption impacts a natural gas-fired electricity generation facility depends on multiple factors, including:

- the availability of alternate natural gas feeds/supplies,
- the drawdown or quantity of natural gas required by the generator during the duration of supply constraint, and/or
- contractual agreements.

¹² "Outages & Curtailments During the Southwest Cold Weather Event," FERC & NERC, 2011

¹³ "How CHP Stepped Up When the Power Went Out During Hurricane Sandy," ACEEE, 2012

¹⁴ EIA, *Market Digest: Natural Gas (2013-2014)*.

¹⁵ See <https://www.ferc.gov/media/news-releases/2014/2014-4/10-16-14-A-4-presentation.pdf>. Also see <https://www.ferc.gov/legal/staff-reports/2014/04-01-14.pdf> Slide 4.

The needs of a generating facility as well as those of the pipeline system that is supplying the natural gas are unique to the markets served, the regional location, and the environmental conditions.

While gas-fired generation demand is growing, it still only represents one-third of the total market for natural gas in the United States. The other two-thirds include direct-use in the residential, commercial and industrial sectors. To ensure gas and electric reliability, stakeholders must:

- develop adequate infrastructure, where it is needed;
- offer firm pipeline transportation and storage services, including enhanced firm services which are flexible to meet their unique needs;
- be provided the appropriate incentives for electric generators to sign up and pay for the firm services they may need to ensure reliability;
- consider dual fuel options;
- understand common and disparate regulatory requirements; and
- consider environmental, safety, and affordability considerations.

FERC has issued orders to help effectuate the coordination efforts between interstate pipelines and the electricity market.

- **Order No. 787** helps facilitate communication of non-public, operational information between electric public utilities and interstate natural gas pipelines to promote reliable service or operational planning. The Order also authorizes interstate natural gas pipelines and electric transmission operators to share non-public, operational information to support the reliability of their systems.
- **Order No. 809** modified scheduling practices of interstate pipelines to better coordinate the wholesale natural gas and electricity markets.

Conclusion

The operational characteristics of the natural gas transportation network in combination with the physical properties of natural gas effectively minimize the likelihood and severity of service disruptions. In the rare event of a disruption, impacts are typically localized and brief. History demonstrates that disruption of firm pipeline transportation and/or storage services resulting from severe weather events are extremely rare.

Bottom line: there is virtually no risk that a single point of disruption will result in an uncontrollable, cascading outage.

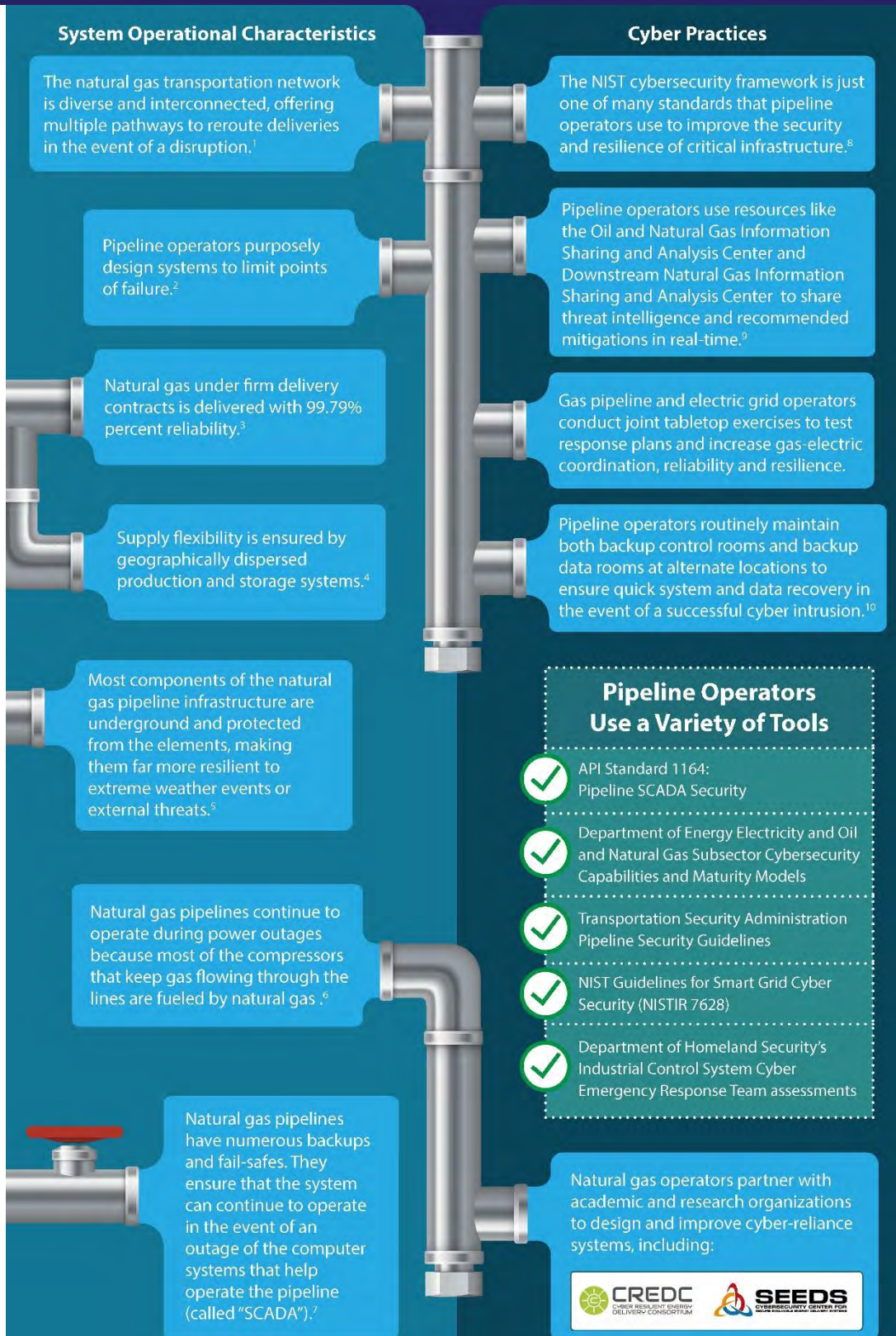
Natural gas delivery systems are mechanical by nature and can be run manually if necessary. Natural gas is moved by using pressure to control the amount entering and leaving the system. Pressure-relief devices are layered into the pipeline infrastructure to prevent internal gas pressure from threatening pipeline integrity. Typically, supply and transportation disruptions can be managed through substitution, transportation rerouting, and storage services.

Cyber and physical security are a priority for industry, and the value chain segments use a portfolio of tools to protect infrastructure from threats. As with pipeline safety, layers of resilience support robust security risk management.

FERC's restructuring of the natural gas industry created an additional level of responsibility on the pipeline customer to contract separately for gas commodity supplies and pipeline transportation, and to determine the level of reliability the customer chooses. In turn, this has encouraged competition, customer choice, and service innovation.

Natural gas service is safe, secure, reliable, and plentiful. The industry has demonstrated its willingness to work with customers, including electric generators, to design new services that meet customers' needs. If capacity is not available, the gas industry will work with customers to design infrastructure expansions. However, reliability is not free. Gas service must be aligned with market incentives for generators to enter into firm service contracts. Operational reliability coupled with contractual continuity of service makes natural gas a secure, reliable, and resilient choice

Is America's Natural Gas Pipeline Network Prepared for Cyber-Attacks?



¹ Interstate Natural Gas Association of America, 2018, Pipeline Security.

² Massachusetts Institute of Technology, 2013, Interdependence of the Electricity Generation System and the Natural Gas System and Implications for Energy Security.

³ Natural Gas Council, 2017, Natural Gas Systems: Reliable & Resilient.

⁴ American Petroleum Institute, 2017, Diversity of Reliability Attributes: A Key Component of the Modern Grid.

⁵ Natural Gas Council, 2017, Natural Gas Systems: Reliable & Resilient.

⁶ American Gas Association, 2014, Natural Gas Pipeline Systems: Delivering Resiliency.

⁷ Massachusetts Institute of Technology, 2013, Interdependence of the Electricity Generation System and the Natural Gas System and Implications for Energy Security.

⁸ National Institute of Standards and Technology, 2018, Cybersecurity Framework.

⁹ DNG-ISAC, 2018 and ONG-ISAC, 2018.

¹⁰ Transportation Security Administration, 2018, Pipeline Security Guidelines.



