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Evaluation of the Gas Outage During the Cold Weather Event, Early February, 2011, from the Industry Segments Outside the City Gates of the Local Distribution Companies

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The events of the first week of February, 2011, during the winter storm that impacted New Mexico and most all the surrounding states, have been studied from many different perspectives by various companies, industry segments, and government entities. My evaluation will focus on:

1. The upstream gas producers in the field that supply gas to the local distribution companies.
2. The midstream gas gatherers and processors who clean up and transport gas out of the field.
3. The gas storage operators who provide backup supplies of gas to customers.

4. The interstate gas pipeline companies who take gas from the various segments in the field and deliver gas to the city gates of the local distribution companies.

Methodology

In evaluating the various events around the above industry segments, I have relied on my over 30 years experience in the oil and gas business (resume attached), my contacts within the industry, and personal interviews of the people most closely involved with the specific actions and situations around the events during the cold weather event in early February, 2011. Many people were reluctant to speak with me; therefore I have collected the information without identifying companies or personnel by name. This degree of anonymity was necessary to collect honest, objective information on the events around and leading up to the cold weather event. Personnel within all segments mentioned above were interviewed, and several companies and officials were interviewed within each segment so that a majority of the business segment companies is covered ensuring broad, common consensus and objectivity. Much common ground was identified,

and many suggestions for improvement were mentioned, which I will summarize, along with my observations, later in this report.

I also read and studied the numerous cold weather event reports and chronologies provided to the PRC by the regulated entities in New Mexico, as well as the transcripts of testimony to various government officials and groups from various company officials called to testify before the groups about the cold weather event. I was also in communications with the FERC, Texas Railroad Commission, and ERCOT personnel studying and developing recommendations concerning this cold weather event.

Historical Background

The cold weather event of early February, 2011 was severe, but certainly not unprecedented in New Mexico history. The coldest event in recent history happened during the first week of January, 1971. In that event, temperatures in northern New Mexico got as low as -47 degrees in Santa Fe, and -17 degrees in Albuquerque, and the low temperatures lasted for several days well below zero. There were three deaths reported during that event, and gas service was out in some northern New Mexico communities. Gas pressure was also very low in most all of Albuquerque during the event. The primary

reason for the gas shortage was due to wellhead freeze-ups in the producing areas, shutting off gas supplies in the field. Electrical service was not much affected by the cold weather, demand was up but for the most part, electrical service stayed online during this early January, 1971 event. Of course, in 1971, the population and thus the demand for gas and electricity was much smaller than today. But, as the population of the state doubled from 1970 to 2010, gas production in New Mexico more than kept pace, more than doubling since 1970.

In 1971, the situation in the producing areas were also different than today. The fuel used for powering gas compressors and gas plants was almost entirely natural gas. Since gas was the substance being transported, the cheapest, most available, most logical, and most plentiful fuel to power facilities in the field was of course, natural gas. Today, electric power off the grids has become quite common in the oil and gas fields to power the compressors and gas plants. All these situations are somewhat different between the early February, 2011 event and the early January, 1971 event; I will also explore reasons behind these differences later in my report.

Examination of the Upstream Gas Production Segment

In speaking to the upstream gas production personnel familiar with field operations during the cold weather event of early February, 2011, there are different situations that emerge between the San Juan Basin and Permian Basin producing areas. Challenges and events differed somewhat between these regions. In the San Juan Basin, wellhead freeze-offs were more commonplace due solely to low temperatures, especially with low flow rate wells that have higher liquids contents in their flow stream. At the peak, it appears perhaps 20% of the gas production was offline due to the cold weather freezing wellhead streams and thus shutting wells in. The characteristics of the San Juan Basin wells are also somewhat unique. They are remote, very widely scattered apart, and few are within reasonable distances of electric power sources for winterization possibilities such as heat tracing. These wells also tend to have larger percentages of water in their flow streams, making them more prone to freezing as temperatures drop below freezing and stay there for extended periods. The remote, scattered nature of the wells put large strains on the limited personnel trying to reach the wells and restore production. Electrical service in the San Juan was never a problem during the cold weather event that is quite different than the Permian Basin region.

The situation in the Permian Basin differed in many ways. Wellhead freeze-ups were much less commonplace due solely to low temperatures. Some wells did freeze-up at the wellhead, but it was typically due to having to be shut-in due to lack of gas gathering and processing plant capacity due to electric outages shutting down compressors and plants necessary to process and transport the gas. As the flow stream is shutdown, the fluids in the wellhead and flow lines are much more likely to freeze. Therefore, when the midstream gas gatherers and processors lose their plants and compression, wells will freeze up. When the wells freeze up it is very difficult to get them back on stream when the midstream plants and compression come back online. Many times those wells had to be re-entered and brought back to flow with costly, time-consuming remedial well operations, as they tended to "load-up" with water when shut in when flow was stopped. This aggravated the lack of supply from the field even when electric service was restored after even a short outage. It appears more than 25% of production was effected by these above mentioned circumstances, and perhaps as much as 50% was down at the peak of the electric outages.

Examination of the Midstream Gas Gathering and Processing Segment

As with the upstream producing segment, the midstream gas gathering and processing segment had differing circumstances between the San Juan and Permian Basin producing regions. The San Juan experienced no downtime or interruptions due to the cold weather or electric supply issues. Almost all the midstream segment in the San Juan uses natural gas as a fuel, with hardly any electrical compression or electrical dependant plant operations. Electricity from the grid is used for control and monitoring operations in the plants, however, all this electrical control has backup gas fired generation for emergency power, as was the industry standard just a decade ago in most all production areas. Thus the dependency of gas supply to electrical supply is very low to non-existent.

The Permian Basin, on the other hand, has developed a large and growing dependency of gas supply to electrical power supply. There many plants are totally dependent on electricity for both compression for gathering/delivery and plant operations, without much existing on-site gas fired backup electric generation. In addition, many of the Permian gas plants are unable to vent or flare gas when a plant goes down for even a short period due to environmental regulations and fines. Thus when electric service is down for

even a short period of time, the plant is shutdown, and gas producers are told to shut in their wells, creating a domino effect as described above in the producer segment examination. The plant also takes much time to start back up when electricity is restored, and since gas can't be flared or vented due to more stringent environmental regulations, the wells connected to the plant must be shut in. After the plant is up and running, gas supply cannot be quickly restored due to wells loading up with fluids and plugging or wellhead fluids freezing if the temperatures are below freezing. This was a main factor of limiting gas supply from the field during the weather event.

Gas compression being converted to electric compression is also a significant trend and factor leading to the increased dependency of gas supply on electricity supply. This trend has been established over the last 10 years or so due to increased regulations on air emissions (CO2 along with other gases) and monitoring requirements from state agencies in New Mexico and Texas and the Environmental Protection Agency. Operators find that replacing older gas equipment with new electric compressors greatly simplifies their regulatory filings and requirements going forward, and thus lowers costs, but at the same time makes the gas supply much more vulnerable to electric outages and interruptions.

Examination of the Gas Storage Operations Segment

This segment operates primarily in the Permian Basin for the examination of this event. The storage operators range from independent oil and gas companies to interstate pipeline companies. The storage consists of mostly depleted gas reservoirs (though salt formations are also used) that have been used to store gas during lower demand periods and the gas removed from storage to sell or supply to customers during peak periods of gas usage. This would seem to be an ideal way to replace gas supply lost in the producing areas during extreme cold weather events or other supply disruptions. However, some gas storage operations are dependant on the same electrical grid that has made the field midstream operations vulnerable to electric supply interruptions. Without on-site backup or primary gas fired compression to move the gas from the storage reservoir to the interstate pipelines and local distribution company customers, electric outages cripple these gas supplies and render them ineffective in dealing with a gas supply emergency. The storage operators are subject to the same increasingly stringent environmental air emissions regulations from the same government agencies as the production and midstream operators. They have moved to electric compression for exactly the same practical reasons the midstream

companies have over the last ten years, driven by increased government regulations. The storage operations not converted to electric compression performed very well during the weather event and provided much needed additional gas supply to make the gas outage less serious than it could have otherwise been.

Examination of the Interstate Gas Pipeline Segment

This industry segment is the large diameter, high pressure gas pipeline grid that crisscrosses New Mexico and transports gas from the field producing regions to the city gates of the local distribution companies that operate in New Mexico. These pipelines are the lifeblood of the gas supply to the state and the many customers within the state. Primarily, these pipelines have large compressor stations along the routes of the pipeline to maintain pressure and thus deliverability of gas from and to customers along the line. These compressors are almost all gas fired units with hardly any electric dependency, save for some smaller compressors and control functions which typically have on-site emergency gas fired backup redundancy. These systems were designed for reliability and independent operations separated from the electric grid precisely because of the kind of electric disruptions seen during the cold weather event.

Immediately after a severe weather event on the week of January 16, 1994 that left many thousands of people without gas in the Mid-Atlantic and Midwest, the NERC and the Interstate Natural Gas Association of America studied the dependency of gas supply to electric supply which emerged during the crisis. Recommendations were developed to improve communications and coordination among electric operators and critical gas supply operations on interstate pipelines. The pipelines also examined where the gas supply system was vulnerable to electric outages and seek to remedy these dependencies as much as possible. These actions helped reduce the critical dependency of the gas pipelines to electricity supply but more work along these lines is necessary.

Though line pressures did fluctuate and drop on the interstate pipelines during the cold weather event, due to lack of scheduled deliveries from the field producers, the lines maintained high pressures throughout the event. However, some local distribution companies, due to the hydraulic designs of their city gate inlets, were not able to take gas off the interstate lines during some periods of lower pressures. These design issues have been recognized and are being studied by the local distribution companies for improvements.

Summary and Recommendations to Reduce the Possibility of a Recurrence of Gas Outages During Cold Weather Events

The events that occurred during the first week of February, 2011 were not unprecedented but are events that happen infrequently, separated by many years and are therefore quite rare. However, the severe impact on people and businesses, thus the economy and society, would warrant changes to the systemic vulnerabilities that have developed in this area, to the extent possible to mitigate the effects when they occur. These vulnerabilities exist both inside and outside the local distribution companies' city gates. My examination outside the city gates indicates a growing and troubling dependency of gas supply to electric supply. This dependency is not necessary nor is it warranted or preferred. The critical elements of gas must be as independent as possible, since the time and effort to relight pilot lights, purge gas lines of air, etc. is overwhelming and hugely labor intensive, especially during a time of stress and damage to people and businesses. Therefore, I offer the following recommendations to reduce and remove this critical dependency:

1. A healthy, diverse, and growing gas supply is critical to provide gas whenever demand is high during emergency events such as cold weather. Additional gas exploration and production should be encouraged to the extent government can create a better environment to grow supply. Additional gas supplies, particularly in northern and far southern New Mexico (where the gas outages were more common and severe) would have been very advantageous to providing gas to more remote areas. But more available gas anywhere in New Mexico would have been very helpful in mitigating the gas outages.
2. Additional gas storage operations within the producing regions, particularly the Permian Basin, would have been very advantageous during an emergency cold weather event. As with additional gas supply from production, storage of most any kind (underground, LNG, CNG, etc.) should be encouraged by government (including FERC) to the fullest extent of their powers. Storage within or very close to New Mexico would be preferred due to operational efficiencies. Care should be taken to ensure this storage is not dependent on electrical supply, or is given critical priority by electric providers.

3. Study and designate where the critical gas infrastructure exists and remove air emissions restrictions that encourage dependency on electric supply on that equipment and operations. Re-evaluate all air emissions regulations within state agencies (and encourage the EPA to do so as well) toward removing restrictions on critical gas supply facilities such as compression, processing, and transportation operations.
4. Allow, without fines or regulations, the flaring of natural gas at gas plants to allow gas flow to continue during plant downtime during cold weather emergencies to prevent well shut ins and plugging.
5. Considering the reality that Recommendation #3 cannot be done overnight, immediately designate the identified critical gas infrastructure highest priority for electric supply so it is not interrupted during electrical outages.
6. To the extent possible, the government should encourage winterization and redundancy in all the critical components of the gas supply chain. This could include tax incentives, removal of blocking regulations that discourage it, or any other means.
7. The potential for miscommunications and lack of coordination among the critical gas segments and the electric providers is high today. It

would be very advantageous to form a network of contacts and personnel to handle communications and coordination during cold weather events. This could be coordinated by the industry associations, like NMOGA, INGAA, NGSA, IPAA, etc., and administered by the PRC and/or similar entity like FERC. Tabletop exercises and regular drills could provide much needed contact and familiarization among all the players in the gas supply chain and allied support industries. This type of council could also meet regularly to discuss issues requiring attention by government regulators and legislators.

In summary, I realize some of my recommendations around air emissions regulations will cause some concern about the environment. However, I would point out that no matter which scientific side you support in the uncertain and controversial theory regarding the role of man's CO2 in climate change, using electricity in the oil field, most of which is generated by coal-fired power plants, instead of natural gas is not reducing air emissions of any kind. Natural gas is the cleanest burning fossil fuel, and since it is burned at the site, it is also highly efficient in terms of power generated to power oil field equipment, compared to coal burned to generate electricity that must be transmitted from hundreds of miles away. In

addition, natural gas fired field equipment uses the very fuel that it is being transported, thus has zero dependency on any other fuel to provide gas service to consumers. This simplifies the supply chain, and provides for reliability to a much higher degree than exists today. Considering the damage, pain, and suffering that results from a gas outage, this simplification and reliability is required to improve our society and economy, and it comes at no environmental cost and most likely environmental improvement.

Biography of Michael L. Johnson
Nambe, New Mexico

Michael L. Johnson is currently semi-retired and serving in various philanthropic, corporate board, and advisory roles. Before retiring from Conoco Inc. in late 2002, he served as a Senior Vice President of Conoco Inc, and as Chairman and CEO of Conoco Gas and Power, a division of Conoco Inc. This part of Conoco is an integrated, midstream portfolio of businesses that include gas gathering and processing, gas storage, gas and power marketing, power generation, and natural gas liquids marketing, transportation and storage for all of North America and the Caribbean.

Prior to attending graduate school at Rice University (and after graduating from NMSU), Mr. Johnson served as an exploration geologist in Conoco's uranium exploration efforts in Albuquerque, New Mexico during the summer of 1972. Mr. Johnson spent his first years after graduate school in Conoco's Exploration Department in various individual scientific and first line supervisory roles in the Gulf Coast and Alaska areas. Johnson's earliest managerial experience with Conoco included two years as exploration manager of the Rocky Mountain Exploration Division in Denver, Colorado and one year in the same capacity at Ventura, California, in charge of the West Coast and Alaska Division. In 1986, he was promoted to general manager of administration, planning and finance for the company's North American exploration and production group. He became general manager of exploration for operations in the Mid-East, the Far East, Africa and Latin America in 1988. In 1990, he was named vice president and general manager of exploration and production in Europe and Africa. He moved to Stavanger, Norway, as president and managing director of Norske Conoco A/S (Conoco Inc.'s Norwegian affiliate) in 1993, and oversaw the $4.5 billion Heidrun concrete deep-water platform project, and moved back to the U.S. to manage Conoco's natural gas and power business in 1997.

Johnson has been a member of the American Association of Petroleum Geologists since 1972 as well as the American Geophysical Union. He is listed in the 1993 edition of Who's Who in International Business. He was a member of the board of directors of Phoenix Park Gas Processors in Trinidad and Tobago, and was a vice president of the Norwegian American Chamber of Commerce. He is also a past Chairman of The

Natural Gas Supply Association, past Vice Chairman of the Texas Intrastate Pipeline Association, and the past President of the Houston/Galveston-Stavanger Sister Cities Society. He was on the board and a member of the executive committee of the Gas Technology Institute. He was also a member of The Natural Gas Council of America.

Johnson holds a B.S. degree in geology from New Mexico State University (1972), an M. A. in geochemistry from Rice University (1975) and an S.M. in finance and economics (he was named a Sloan Fellow) from the Massachusetts Institute of Technology (1985). He was chosen as Distinguished Alumni for New Mexico State University in 1997, and received an honorary Ph.D. in Laws from NMSU in 2006.

He is currently Chairman of the New Mexico State University Foundation, and is the past Chairman of the NMSU Dean's Council of Excellence in Sciences.. He currently serves on the Rice University Athletics Advisory Board of Directors, and is a member of the Audit Committee and Board of Directors of Copano Energy LLC. He is also a member of the Board of Directors of Wellkeeper, Inc., in Albuquerque, N.M., and a minority owner. He also serves as an advisory board member for StakeWare, Inc. He also serves on the board of the High Altitude Development District (a high-tech business start-up advisory group for New Mexico) board in Santa Fe, N.M. He has been frequently called upon to testify in Congress regarding gas supply and gas economics, and is a frequent speaker to outside groups on the U.S. gas business and free enterprise as well as science topics like climate change.

A native of Roswell, New Mexico (and a third generation New Mexican whose great-grandfather served on the 1910 Constitutional Convention to write the state's first constitution), Johnson now lives with his wife, Judy (who is the former Chief Financial Officer for the City of Houston and an Albuquerque native), in Nambe, New Mexico. They have two children, a son who is a CPA for Deloitte and Touche in Dallas, Texas, and a daughter who is a recent graduate of the University of Southern California, and is currently in graduate nursing school at NMSU, as a 4th generation Aggie.