

DOT US Department of Transportation  
PHMSA Pipeline and Hazardous Materials Safety Administration  
OPS Office of Pipeline Safety, Accident Investigation Division (AID)

**Principal Investigator** Julie Halliday  
**Director** Peter Katchmar  
**Date of Report** 8/13/2019  
**Subject** Events Contributing to Natural Gas Outages on National Grid's Distribution System in Newport, Rhode Island

**Operator, Location, & Consequences**

**Date of Failure** 01/21/2019  
**Commodity Released** None  
**City/County & State** Newport, Portsmouth, Middleton - Rhode Island  
**OpID & Operator Name;  
Unit # & Unit Name**

- 288 Enbridge (Algonquin Gas Transmission – Spectra Energy Partners); 1931 Boston/Westwood Division Office MA/RI
- 13480 Niagara Mohawk Power Corp; 49011 National Grid Providence LNG
- 19160 Tennessee Gas Pipeline; 75224 Div F/Hopkinton District South - MA/RI
- 35635 National Grid Gas; State Jurisdiction – No Unit ID

**SMART Activity #** 164488  
**Milepost / Location** Towns of Middleton, Newport and Portsmouth, Rhode Island.  
**Type of Failure** Non-Release; Incorrect Operation; Equipment Failures  
**Fatalities** 0  
**Injuries** 0  
**Description of impacted area** Entire towns, High consequence areas  
**Total Costs** Unknown. National Grid did not submit an incident report to PHMSA for LNG plant automatic shutdown or the large-scale gas outage.

## Summary Report – [Rhode Island Natural Gas Outage]

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### **Executive Summary**

On Monday, January 21, 2019, National Grid United States (NG) shut in an intrastate natural gas distribution system due to inadequate system pressure that resulted in 7,100 customers in the communities of Newport, Portsmouth, and Middleton, Rhode Island (NG's Newport system), to lose gas service. The impacts of the outage caused Rhode Island Governor Gina Raimondo to declare a state of emergency in Newport County and activate the National Guard to assist the customers without gas service.

Enbridge's Algonquin Gas Transmission (AGT) pipeline system supplies NG's Newport pipeline system via Enbridge's Portsmouth Meter and Regulator station (M&R). The Portsmouth M&R is at the tail end of an AGT subsystem system, the G-System. The G-System supplies other NG gas distribution pipeline systems including the Narragansett Electric Providence Area system (Narragansett system). During colder weather, National Grid's Providence LNG plant (NG LNG) provides supplemental gas to the Narragansett system.

A historic cold front moved into the area late on Sunday, January 20, 2019, and temperatures dropped from 27 °F to 1 °F by 6:00 AM<sup>1</sup> on January 21, 2019. Enbridge recorded the single highest daily delivery (or send out) on the AGT system in the previous 10-year period. NG and other local distribution company's (LDC) gas usage exceeded the amount of gas nominated<sup>2</sup> (overtakes) for transportation through AGT system. Customers on the G-System were among those with significant overtakes.

On January 21, 2019, several companies experienced operational upsets, which compounded the impact to system pressures from overtakes. At 3:45 AM, there was an interruption in the power supply to NG LNG that triggered an automatic emergency shut down (ESD) resulting in multiple equipment failures and limited vaporization capabilities until 9:00 AM. NG LNG's sudden shutdown had an immediate and severe impact on the inlet pressure at the Portsmouth M&R. The source of supply shifted from NG LNG to the G-System. In response to the dropping system pressures, Enbridge attempted to bring on several of Enbridge's compressor station units, including one at Burrillville at 4:47 AM, near the head of the G-System. The compressor unit could not be remotely brought online, and AGT dispatched a technician to resolve the issue in the field. At 6:21 AM, Enbridge attempted to increase gas supply into the AGT system by raising the flowrate of gas from AGT's Weymouth M&R. Due to a meter configuration error, the flowrate decreased. At 8:45 AM, Enbridge Gas Control contacted NG LNG to notify them of the meter issue and first learned, five hours after NG LNG's ESD, that there were unspecified problems at NG LNG. At 10:06 AM, NG began receiving no gas calls, and around 10:30 AM they began mobilizing portable LNG resources to provide supplemental gas at the Portsmouth M&R. At 11:53 AM, the flowrate from Tennessee Gas Pipeline's (TGP) Mendon interconnect with AGT, a minor supply point near the head of the G-System, dropped to zero as the compressor was offline. Due to timing, this event had a minor impact to pressures on the AGT system. At 5:50 PM, due to outages dispersed throughout the Newport system and the portable LNG unit not being ready to go into service, NG decided to shut in the Newport low-pressure system.

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<sup>1</sup> All times are in Central Standard Time (CST)

<sup>2</sup> The nomination process is how those who want to transport gas request space on the pipeline.

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The US Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) and the State of Rhode Island's Division of Public Utilities and Carriers (RI-DPUC) jointly investigated the events leading to the gas outage with the intent to identify the cause to prevent recurrence. RI-DPUC regulates NG's Newport gas distribution system and PHMSA regulates NG LNG's Providence LNG plant, AGT, and TGP's gas transmission systems. PHMSA's report does not cover NG's distribution system operations.

In addition to data and records requests, PHMSA and RI-DPUC requested Enbridge perform What If Scenario Analysis (WISA<sup>3</sup>) using hydraulic network modeling software to predict system behavior under various conditions. Enbridge's AGT gas transmission system, like most large gas transmission systems, has flexibility as to how it can operate under various conditions while meeting contractual requirements for pressure delivery and daily/hourly gas nominations. When operating near capacity, the flexibility of the system becomes limited and is increasingly more sensitive to overtakes and to operational upsets. The WISAs demonstrated that if any one of the three failures had not occurred, there would have been adequate pressure to maintain customers in NG's Newport system.

PHMSA concluded that the low pressures at Portsmouth M&R that led to the loss of gas to customers in NG's Newport System were due to (1) overtakes by NG and other customers on AGT's G-system, (2) the Weymouth M&R's meter configuration error, and (3) the NG LNG ESD and equipment failures. PHMSA's investigation identified areas for operators to improve including operational readiness, contingency and gas supply planning, ultrasonic meter inspection and testing procedures, timely intercompany communication of operational issues, and a potential system enhancement.

### System Details

Enbridge's 1,140 mile AGT system has a stated capacity of 3.12 billion cubic feet/day (Bcf/d)<sup>4</sup> and supplies major markets including Boston, Providence, Hartford, and Cape Cod. While the AGT system is bidirectional, the compressor stations compress the gas from southwest to northeast. The pipeline has a maximum allowable operating pressure (MAOP) of 958 psig and a maximum operating pressure (MOP) of 900 psig on the mainline. The pipeline infrastructure ranges from 6" to 36" in diameter. There are over 100 M&Rs on the AGT system that supply local distribution companies and power plants. Enbridge designates subsystems within the AGT system

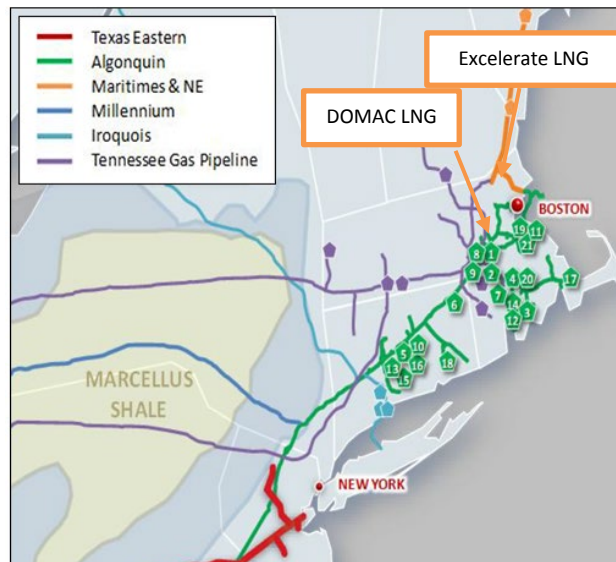


Figure 1: Interstate Transmission Pipelines in Northeast US

<sup>3</sup> WISA is a modeling technique used to yield various projections for some outcome based on selectively changing inputs.

<sup>4</sup> <https://www.enbridge.com/map#map:infrastructure>

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by letters. AGT's subsystem supplying NG's distribution system that experienced gas outages is the G-System.

Figures 1 and 2 show AGT's receipt points - from northeast to southwest:

- Maritimes & Northeast (M&N) pipeline
- Exceletrate Energy's Northeast Gateway Deepwater LNG terminal
- Distrigas of Massachusetts LNG Plant (DOMAC)
- TGP Mendon
- Iroquois Pipeline - Brookfield
- Millennium Mainline Pipeline (Millennium) - Rampo
- TGP Mahwah
- Texas Eastern Transmission (TETLP) – Wanaque
- Columbia – Hanover
- TETLP – Hanover
- Transco – Centerville
- TETLP – Lambertville

At the northeast end of AGT's system, gas from M&N and Exceletrate combine to supply Enbridge's Weymouth M&R in the I System and continues into the mainline.

DOMAC operates Everett LNG import terminal. DOMAC feeds AGT's J System through a 16" pipeline. While DOMAC offsets gas supply needs for the J System from AGT's mainline, DOMAC gas does not flow into AGT's mainline.

TGP Mendon is a minor interconnect supply near the head of AGT's G-System (see Figure 2), and contributes to AGT's ability to raise pressures in this area. Historically, TGP has been able to receive

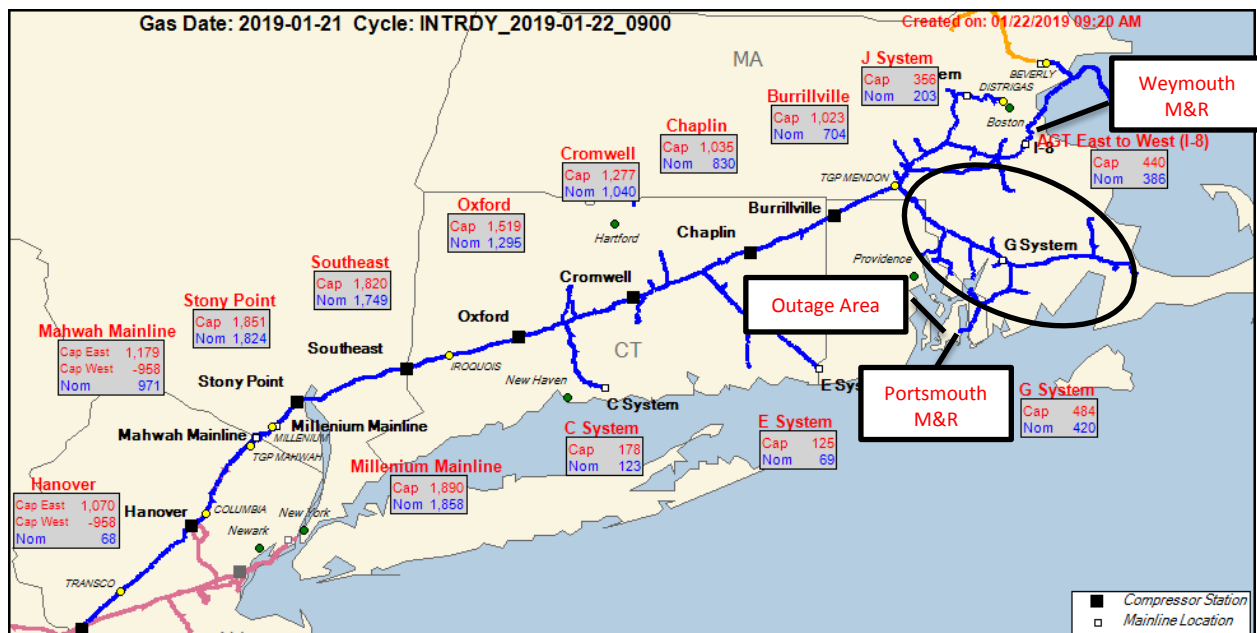


Figure 2: AGT Capacity Map Jan. 21, 2019

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additional gas at their Dracut station and move the gas to the Mendon interconnect since both interconnects are on the TGP system. On January 21, 2019, Enbridge believed TGP did not have the ability to route extra gas to Mendon because of earlier communications between TGP and AGT.

Figure 2 shows the location, operational capacity, and nominations on January 21, 2019, at the AGT compressor stations. Burrillville compressor station is the closest to AGT's G-System so is the most significant in its ability to raise pressures at the head of the G-System. Burrillville compressor station is slightly closer to the G-System than Weymouth M&R. Both are about 90 miles.

The Lambertville compressor station is at the southwest end of the AGT system. At Lambertville, AGT connects with two branches of the TETCO pipeline system. The TETCO systems merge into a single path toward New York City.

As shown in Figure 3, the NG's Portsmouth M&R is the sole source of supply to the Newport system. The Portsmouth M&R is at the end of the G-System.

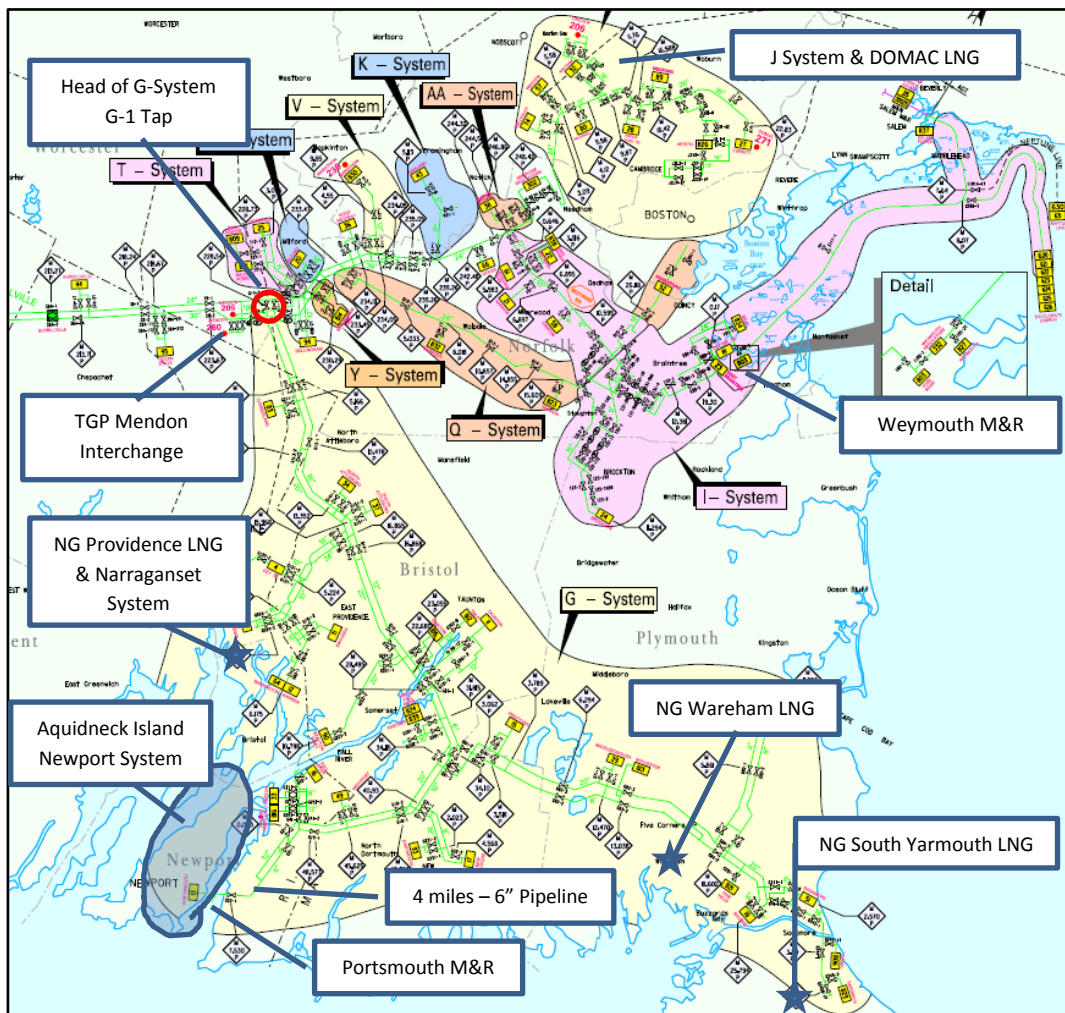


Figure 3: AGT's G-System Details

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The Portsmouth M&R, supplied by a single 4 mile - 6" pipeline, is the most sensitive point on the G-System to low pressures, and takes the longest time to recover pressure. On January 21, 2019, this section of pipeline experienced a pressure drop of about 200 psig.

AGT's G-System and NG LNG (in service since 1974) supply gas to NG's Narragansett system. NG LNG is an interstate peak shaving facility where LNG is trucked to the 25-million-gallon storage tank. There are three vaporizers that re-gasify the LNG into NG's Narragansett system. The LNG is used to maintain pressure in the system and to offset the amount of gas supplied by AGT. G-System expanded over the years predicated on NG LNG's gas storage assets being operational during peak send out: Providence LNG, Wareham LNG (in service since 1974), and South Yarmouth LNG (in service since 1975). Several power plants are directly connected to AGT's G-System but they were not being supplied gas at the time of the outages.

### **Events Leading up to the Failure (CST)**

On January 21, 2019, customers on the G-System used more gas than they nominated on gas day 20 during the early morning hours (the gas day 20 is from 9:00 AM CT January 20 to 8:59 AM CT January 21). January 21, 2019, was a Monday and a federal holiday, Martin Luther King Day. Due to customers' change in normal weekday routine, gas usage was atypical. High flow rates lasted for a few hours longer than typical as residents staying at home instead of going to work or school.

NOTE: Asterisk (\*) denotes information provided by RI-DPUC. Approximate natural gas conversion: 1 Dekatherm (Dth) equal to 1 Million British Thermal Units (MMBtu) equal to 1 Thousand Cubic Feet (Mcf).

**The following is a timeline of events:**

#### **Sept. 10, 2018**

- 7:11 AM – Enbridge's remote terminal unit (RTU), an electric device that transmits telemetry data, logs show that the RTU units were changed and the incorrect K-factor is entered into meter 2 at Weymouth M&R.

#### **Nov. 14, 2018**

- NG LNG's Providence LNG plant experiences an unexplained automatic shutdown. The plant operators restarted plant immediately but did not identify the root cause of the automatic shutdown.

#### **Jan. 20, 2019**

- 4:08 PM – Enbridge posted a Critical Notice to LINK<sup>5</sup> notifying customers of capacity constraint and alerting them of potential impact of low delivery pressure if there are non-ratable hourly takes from the G-System.

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<sup>5</sup> Portal where natural gas pipeline suppliers post system notices to customers. A portion of the notice states, "Furthermore, AGT requires that customers/point operators on the "G" lateral be aware of the impact non-ratable hourly takes from the system and the impact it could have on system operations. Delivery pressures could reach lower than desire levels to the extent point operators' hourly takes exceed their maximum hourly transportation quantity (MHTQ) based on their scheduled quantities. AGT's "G" lateral is not designed to sustain delivery pressures above contractual pressure obligations if:

1) Point operators' hourly rates are exceeding their MHTQ levels based on nominated quantities or

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- Historically, TGP can receive additional gas at Dracut and move that gas to AGT/Mendon since both interconnects are on the TGP system. On January 21, 2019, TGP asked Enbridge for extra gas at Dracut for their aid and requested that they do not redeliver to Mendon. Enbridge interpreted this as a sign - that TGP would not have ability to assist on gas day January 21.

### Jan. 21, 2019

- Cold weather blankets the Midwest and Northeast resulting in large customer gas usage through large area and takes significantly in excess to the volume of gas nominated.
- 12:14 AM – At Enbridge's request, DOMAC LNG increases send out to 3,000 MMBtu/hr.
- 12:00 AM-1:00 AM – NG LNG vaporized 2,400 MMBtu @ 177 psig. Vaporizers 1 and 2 operational.
- 1:00 AM-2:00 AM – Enbridge –AGT's packing cycle for January 21. Enbridge considered the line pack to be 'reasonable' considering customer hourly takes, eastern supply profile, and horsepower availability.
- 1:00 AM-2:00 AM – NG LNG vaporized 2,600 MMBtu @ 177 psig.
- 2:00 AM – NG's Providence Area M&R takes exceeded the amount of natural gas allocated. This sub-system is normally supplied by AGT M&Rs and is near the head of the G-System. NG's Providence LNG Plant provides natural gas during times of peak usage.
- 2:00 AM-3:00 AM – NG LNG vaporized 2,300 MMBtu @ 174 psig.
- 3:00 AM-3:45 AM – NG LNG vaporized 1,880 MMBtu @ 172 psig.
- 3:30 AM-9:30 AM – Demand on AGT G-System significantly exceeds nominations.
- 3:45 AM – NG Providence LNG plant experienced an automatic shutdown. A frozen suction valve that feeds both boil off gas (BOG) compressors freezes and ceases to send vaporized LNG into the Narragansett system. NG's non-ratable hourly takes jumped dramatically exceeding the amount of natural gas nominated. Pressure begins dropping at the Portsmouth M&R.
- 3:45 AM-5:00 AM – NG LNG - No vaporization, pressure is 100 psig.
- 4:14 AM – Enbridge Oxford Compressor Unit #4 fails to start remotely.
- 4:17 AM – Enbridge Cromwell Compressor Unit #7 fails to start remotely.
- 4:24 AM – Enbridge requests DOMAC to increase flowrate to 4,200 MMBtu/hr.
- 4:47 AM – Enbridge Burrillville Compressor Unit #4 fails to start remotely.
- 4:50 AM – NG LNG restarts Compressor 1.
- 4:57 AM – Enbridge asks TGP if they have their issues worked out and requests TGP to bring the Mahwah supply back up to rate.

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2) Point operators' hourly rates are exceeding 1/24th of the daily nominated quantity for more than 6 consecutive hours (or greater than 6 hours on any gas day)"

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- 5:00 AM-6:00 AM – NG LNG vaporizes 200 MMBtu. Technician and plant supervisor arrive to assist with troubleshooting.
- 5:51 AM – Low temperature reaches 1°F when the historical average is a low of 21°F.
- 6:00 AM-7:00 AM – NG LNG – no vaporization.
- 6:15 AM – Enbridge requests DOMAC to increase flowrate to 7,000 MMBtu/hr.
- 6:21 AM – Enbridge changes the meter set point at the Weymouth M&R to increase the supply of natural gas into the AGT system from 500,000 Dth/d to 700,000 Dth/d. Due to an incorrect K factor programmed into the meter's RTU, flow is reduced to 150,000 Dth/d and the station outlet pressure starts dropping from approximately 850 psig to less than 400 psig at 8:14 AM. Weymouth is about 40 miles upstream from the lateral to G-System.
- 6:54 AM – Enbridge AGT Cromwell Compressor Unit #7 back in service.
- 7:00 AM-8:00 AM – NG Providence LNG Plant restarted but continues to experience issues with two of their three vaporizers; virtually no natural gas vaporized between 4:00 AM and 8:00 AM. Unable to start either compressor.
- 7:11 AM – Enbridge AGT Southeast Compressor Unit #6 fails to start remotely.
- 7:26 AM – NG receives a low-pressure alert at Portsmouth M&R; inlet pressure of 250 psig.\*
- 7:58 AM – Enbridge AGT Cromwell Compressor Unit #8 fails to start remotely.
- 8:00 AM-9:00 AM – NG LNG vaporization rate back up to 2,475 MMBtu @ 179 psig.
- 8:14 AM – Enbridge AGT restores flowrate to pre-event conditions at Weymouth M&R. (Flowrate goes from 150,000 Dth/d to 550,000 Dth/d.)
- 8:31 AM – Enbridge AGT Unit #4 Compressor @ Burrillville and Unit #4 Compressor @ Oxford back in service.
- 8:45 AM – Enbridge Gas Control notifies NG regarding the issue at Weymouth M&R. NG LNG mentions LNG plant was having issues but provides no specific information or informs of shutdown.
- 9:00 AM-10:00 AM – NG LNG plant vaporizes 1,700 MMBtu @ 177 psig.
- 9:00 AM – Inlet pressure at Portsmouth M&R at 97.7 psig, below 100 psig contractual pressure.\*
- 9:06 AM – NG LNG plant shuts down again.
- 9:26 AM – NG bypass regulators in Newport low pressure distribution system and other regulators.\*
- 9:40 AM – Enbridge's Texas Eastern 30" pipeline ruptures and ignites in Noble, Ohio, south of their Bern compressor station. Enbridge felt the event did not impact the AGT system. The Texas Eastern pipeline supply is substantially from the Marcellus Shale. The null point on the line was



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north of the Bern Compressor Station in Ohio and gas was flowing from west to east. This event is not considered a contributing factor to the low pressures in AGT's G-System.

- 9:44 AM – NG LNG starts Compressor 1.
- 9:45 AM – Inlet pressure at the Portsmouth M&R drops to less than 50 psig. NG's National Response Center (NRC) report #1235735 states loss of natural gas supply due to unknown reasons. Report submitted at 9:32 PM.
- 10:00 AM-11:00 AM – NG LNG vaporizes 2,800 MMBtu @194 psig.
- 10:06 AM – NG starts receiving no gas calls.\*
- 10:30 AM – NG begins mobilizing portable LNG operations.\*
- 10:30 AM – NG LNG increases LNG send out into distribution systems supplied by AGT from their other LNG facilities in Wareham and South Yarmouth, Massachusetts, to reduce demand on AGT's G- System.\*
- 10:30 AM – NG requests addition supply at M&Rs supplied by TGP in Rhode Island.\*
- 10:30 AM – Enbridge AGT Unit #8 Compressor @ Cromwell back in service.
- 10:53 AM – Enbridge AGT Unit #6 Compressor @ Southeast back in service.
- 10:55 AM – Enbridge reprograms the RTU, which resolves flowrate issue at Weymouth M&R. Normal operations resume with an outlet pressure of over 900 psig.
- 11:00 AM-12:00 PM – NG Providence LNG vaporizes 5,000 MMBtu @ 127 psig.
- 11:22 AM – Pressure at inlet of Portsmouth M&R reaches low point, 36.4 psig.\*
- 11:23 AM – TGP Mendon compressor station is taken offline operationally but due to the pressure difference between Mendon and AGT system, continued to flow into the AGT system. As the pressure equalized, the flowrate of 6,666 MMBtu/hr continues reducing until flowrate was 0 at 11:53.
- 11:00 AM – NG learns they will not have glycol for the portable LNG.\*
- 11:06 AM – NG shuts off portion of the low-pressure system in Middletown to maintain pressure to larger system in Newport.\*
- 12:00 PM – NG has received >150 no gas calls.\*
- 12:00 PM-1:00 PM – NG LNG vaporizes 3,500 MMBtu @ 125 psig.
- 12:25 – TGP Mendon - After discussions between AGT and TGP gas control, the Mendon compressor station is brought back online and the flowrate resumes to 6,666 MMBtu/hr for the rest of the gas day.
- 1:00 PM – NG has received >370 no gas calls.\*
- 1:00 PM-2:00 PM – NG LNG vaporizes 3,000 MMBtu.
- 2:00 PM – NG has received >650 no gas calls.\*
- 2:00 PM-3:00 PM – NG LNG vaporizes 4,000 MMBtu.
- 3:00 PM – NG has received >965 no gas calls.\*
- 3:00 PM – Pressure on the G-System begins to increase toward normal conditions. Low-pressure system on the island remain unstable.\*
- 3:30 PM – NG plots outage calls and recognizes that they are spread across more segments of the gas system than expected.\*

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- 5:00 PM – NG no gas calls up to 1,250.\*
- 5:50 PM – NG decision to shut in the Newport low-pressure system of >7,000 customers.\*
- 7:28 PM - Newport low-pressure system shut off completed.\*
- 7:30 PM – NG portable LNG vaporizer operational but did not start injecting since system shut off.\*
- 8:32 PM – NG LNG Vaporizer 3 restarted and remains on.\*
- 10:24 PM – NG LNG Vaporizer 2 restarted and remains on.\*

### **Emergency Response**

No emergency response was required on PHMSA regulated facilities as there was no release of gas, fire, explosion, injury, fatality, or property damage. Enbridge made various attempts to increase pressure on the AGT system. Enbridge requested and received additional gas from DOMAC. TGP resumed supply at Mendon M&R at required rate. Although TGP's Mendon M&R supplies gas near the head of the G-system, Enbridge did not request additional supplies because they assumed TGP could not assist due to TGP taking gas from Enbridge at Dracut. Enbridge was unaware of NG's Providence LNG issues until 8:45 AM, five hours after the NG LNG ESD, when Enbridge gas control notified NG of problems on the AGT system.

The impacts of the outage caused Rhode Island Governor Gina Raimondo to declare a state of emergency in Newport County and activate the National Guard to assist the customers without gas service.

### **Investigation Details**

PHMSA deployed a Senior Accident Investigator to Enbridge's offices in Houston, Texas, to interview employees and gather data to identify the causes that led to the low pressures on AGT's G-System on February 12, 2019. NG-LNG also submitted responses to PHMSA's data requests.

RI-DPUC interviewed NG regarding their actions and subsequent data requests. PHMSA and RI-DPUC met at RI-DPUC's office and held multiple conference calls to share investigation information prior to the preparation of this report. The following issues were identified:

#### **National Grid Providence LNG Plant – Mechanical Problems**

NG owns the Providence LNG facility, which is physically connected and supplies gas at 170- 200 psig into its Narragansett system. The stated total vaporization rate for the three vaporizers is 150,000 Mcfd (6,250 Mcfh), well above the vaporization rate of the plant prior to the shutdown, 2,400 Mcfh. The plant experienced multiple mechanical problems as the result of the ESD. At the time the plant shutdown, NG LNG was staffed with two LNG operators and a security guard. An NG LNG supervisor and technician arrived about 1 hour 15 minutes after the shutdown to troubleshoot the following equipment:

- *Boil-off gas valve:* The boil-off gas valve closed when the plant shutdown and did not open or respond to electronic commands. The relay on the valve failed to reset. The actuator for the valve was not operating. NG LNG removed the actuator and manually opened the valve until the repaired actuator was re-installed on February 20, 2019.

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- *Fuel valves to vaporizer 1, vaporizer 2, and vaporizer 3:* The fuel valves to vaporizer 1, vaporizer 2, and vaporizer 3 froze in the closed position due to ice buildup from the freezing rain. NG LNG melted the ice and manually opened the fuel valves. The fuel valves continued in automatic mode.
- *Burner management system on vaporizer 3:* After January 21, 2019, NG LNG replaced the burner management controller, air proving pressure switch, and ignitor on vaporizer 3.
- *Damper on vaporizer 2:* After January 21, 2019, NG LNG replaced the bolts holding the damper in place on vaporizer 2, which resolved the vaporizer problems.

The plant began vaporizing for the 2018-2019 season starting on November 14, 2018. During December and January, the plant operated 20 and 24 days per month respectively. NG LNG experienced automatic shutdown problems once prior to the January 21, 2019, event and four times since the event (as of March 3, 2019,). Problems included:

- November 14, 2018 – The plant's automatic shutdown system caused an unexplained plant shutdown. The plant operators restarted plant operations immediately after the shutdown.
- January 25, 2019 – Vaporizer #3 shutdown from a burner management fault. The plant technician reset the settings on the burner management system and restarted the vaporizer.
- February 1, 2019 – The plant's automatic shutdown system caused an unexplained plant shutdown. Plant operators restarted plant operations immediately after the shutdown.
- February 9, 2019 – The plant's automatic shutdown system caused three unexplained plant shutdowns. After the first two, NG LNG restarted plant operations immediately. After the third, NG changed the backup battery system for the automatic shutdown system and then restarted plant operations.
- February 10, 2019 – An unknown communications failure caused a plant shutdown. NG LNG restarted plant operations immediately after the shutdown.

NG LNG worked with CHI Engineering, the firm that designed and installed the automatic plant shutdown system, and other engineering firms. The cause of the ESD was failure of the uninterruptible power supply (UPS) that powered the automatic plant shutdown system. There were intermittent interruptions in the UPS. NG LNG transferred the electrical feed for the automatic shutdown system to a different UPS, which has corrected the problem. Since shifting the power supply for the automatic plant shutdown system, NG LNG has not experienced any automatic plant shutdowns. NG LNG will be conducting a test of the system in September to ensure that it is operating properly in advance of the 2019-2020 winter.

### **Enbridge - Incorrect Meter K-Factor**

The Weymouth M&R is flow controlled and consists of filter separators, heaters, two ultrasonic meters, and overpressure protection. An RTU, a microprocessor-controlled electronic device associated with the meter, interfaces the control valve actuator to the supervisory control and data acquisition (SCADA) system. This enables a gas controller to remotely change the meter's flowrate. Every meter has a unique K-factor, the total number of pulses equivalent to one unit of flow, which is programmed into the RTU. RTU's K-factors can be programmed in two different ways: to divide the number of incoming pulses with the K-Factor or to multiply the number of pulses by the inverse of the K-Factor. The technician must be informed of how the K-factor is programmed for a specific RTU model.

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Enbridge's procedures call for ultrasonic gas flow meters to be maintained in accordance with AGA Report No. 9 Measurement of Gas by Multipath Ultrasonic Meters. The AGA Report provides equations for corrected flow where  $k$  = actual cubic feet (acf)/pulse but notes that the meter K-factor is often in units of pulses/acf instead. When that is the case, the factor needs to be inverted to have the proper magnitude and units. The K-factor is rarely changed once a meter is received unless the meter is replaced or calibrated.

Enbridge previously performed monthly testing of RTU's but moved to quarterly testing. Part of Enbridge's inspection procedure is to check the K-factors. The K-factors are time stamped when the changes occurred. On September 10, 2018, Enbridge's RTU logs show that the RTU units were changed. A screenshot in Figure 4 shows a K-factor of 0.3125 on meter 1 and 3.2000 on meter 2 (Note: 0.3125 is the inverse of 3.2000) when the technician was onsite. Technicians report that at times, settings on RTUs have inadvertently changed without the technician's awareness. Enbridge theorizes that the system may go into sleep mode, which disrupts the program before the changes are saved. Enbridge is developing a training sheet for technicians to reduce the potential of recurrence.

Meter 2 is a non-custody transfer meter and is rarely used. On January 21, at 6:21 AM, Gas Control attempted to increase the flow set point at the Weymouth M&R from 550,000 to 700,000 Dth/d requiring capacity through meter run 2. Since the meter K-factor was incorrect, the RTU falsely read too high of a flow and signaled the control valve to throttle back, restricting the flowrate to approximately 150,000 Dth/d. Gas Control saw meter 2 fluctuating drastically and dispatched a technician. Enbridge's technician arrived at 8:10 AM and found the pressure was in a steep decline.

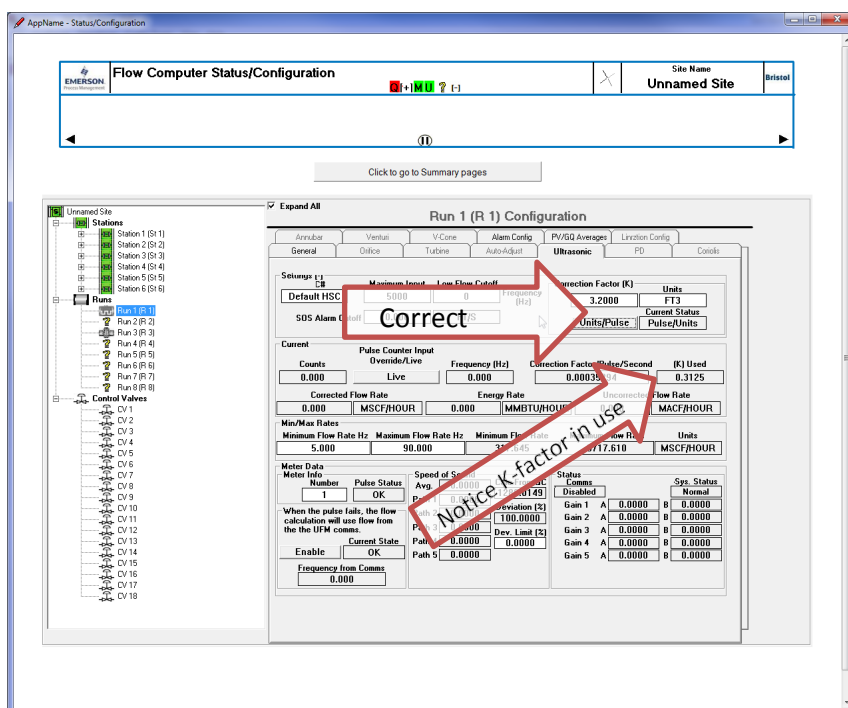


Figure 4: RTU Screen showing incorrect K-Factor

The large drop in pressure caused a control valve rotary spring return actuator to freeze. The control valves were inside a building, but there was not sufficient heat provided by the portable heaters to heat them. The heaters were moved closer to the control valves, which remediated the frozen components. The technician took manual control of the pressure regulator at 8:14 AM and restored natural gas flow to pre-event conditions. The outlet pressure reached a low point of around 375 psig and rose to 800 psig. At 10:55 AM, Enbridge resolved the incorrect K-factor that led to the decreased flowrate and restored the station to normal operation.

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### Customer Usage Exceeding Nominations and Operational Balance Agreements (OBA)

On January 21, 2019, the delivery rate of 3.3 Bcf/d on the AGT system was the highest send out of any day in the system's previous 10-year period. The second highest day was in January 2015 when the send out was 2.9 Bcf/d. The January 21, 2019, record high deliveries occurred between 4:00 AM and 10:00 AM, with the highest deliveries occurring from 5:00 AM-8:00 AM. No interruptible customers received gas on AGT's G-System, including power plants.

#### *Usage Exceeding Nominations*

Customers nominate in advance an amount of gas they plan to take for the next gas day. AGT operates under specific rules to receive an amount of gas into its system that supports the customers' nominations.<sup>6</sup> The AGT G-System is fully subscribed, meaning firm transportation customers have contracts for the entire capacity of the pipeline on peak days. On peak days, there would be no spare capacity in the pipeline to transport additional gas.

Depending on the contract, customers are or are not permitted to take more gas in one hour than 1/24th of the day's nominated quantity. Non-ratable contracts permit takes in excess of 1/24<sup>th</sup>. Their hourly rights entitle takes up to 6 percent of daily nominated for as many as 6 hours, but also require them to take no more than their daily quantity, which means that they have to take less than 1/24th in the remaining 18 hours of the gas day. This contractual and operational variation from 1/24th makes these contracts explicitly "non-ratable contracts."

On January 20, 2019, at 4:08 PM, Enbridge posted a Critical Notice to LINK<sup>7</sup> notifying customers of capacity constraint and alerting them of potential impact of low delivery pressure if there are non-ratable hourly takes from the G-System. On the G-System, total hourly deliveries on January 21, 2019, significantly exceeded nominations from 3:30 AM to 9:30 AM, even with consideration to the permissible higher hourly ratable takes. Link Segment Report indicates that NG holds 54 percent of capacity on the G-System. NG's capacity on the G-System includes customers in Rhode Island and Massachusetts.

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<sup>6</sup> In 1992, FERC Order 636 converted pipeline operators to gas transportation providers and were no longer allowed to buy and sell the gas.

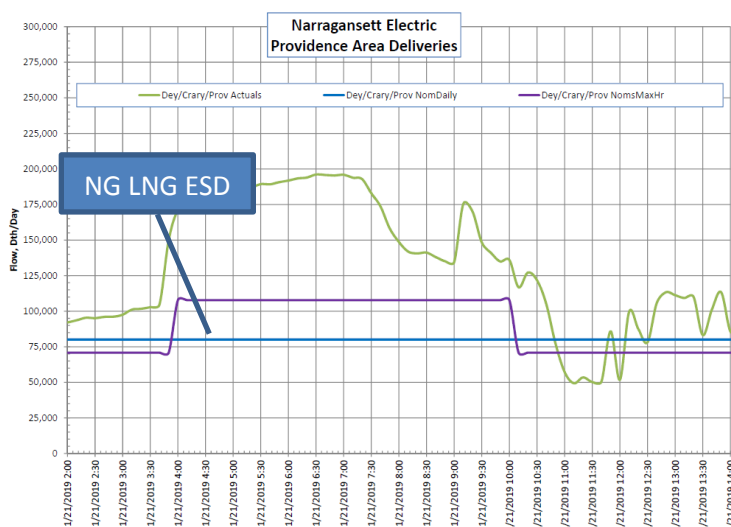
<sup>7</sup> Portal where natural gas pipeline suppliers post system notices to customers. A portion of the notice states, "Furthermore, AGT requires that customers/point operators on the "G" lateral be aware of the impact non-ratable hourly takes from the system and the impact it could have on system operations. Delivery pressures could reach lower than desire levels to the extent point operators' hourly takes exceed their maximum hourly transportation quantity (MHTQ) based on their scheduled quantities. AGT's "G" lateral is not designed to sustain delivery pressures above contractual pressure obligations if:

- 1) Point operators' hourly rates are exceeding their MHTQ levels based on nominated quantities or
- 2) Point operators' hourly rates are exceeding 1/24th of the daily nominated quantity for more than 6 consecutive hours (or greater than 6 hours on any gas day)"

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Figure 5 shows that hourly deliveries to the Narragansett system meters significantly exceeded NG's nominations beginning at 3:45 AM until 10:30 AM (green vs. purple lines). NG LNG malfunctions coincide with the hours of the significantly increased deliveries to the Narragansett system and falling pressures at the Portsmouth M&R (compare with Figure 9). The G-System supplied the gas displaced by the loss of supply from the NG LNG facility to customers in the Narragansett system. The additional supply must travel through the G-System to the Narragansett system and thus incur additional pressure drop leading to lower pressures at the Portsmouth M&R than if the gas had been supplied from NG LNG.



A review of historical data from Enbridge shows there have been multiple days where usage exceeded nominations on the G-System. Enbridge data also showed in addition to NG, other G-System customers exceeded their maximum hourly limit based on their scheduled delivery quantities and hourly entitlements on January 21, 2019, during certain hours.

NG also nominates for gas supply from NG LNG. NG LNG did not meet their nominations for 24 due to the inability to vaporize during the morning of January 21, 2019, from the NG LNG.

### *Operational Balance Agreements (OBA)*

NG stated that their OBA with AGT allows them to balance daily gas receipts and deliveries across all AGT M&Rs in Rhode Island. Enbridge provided that certain NG contracts provide NG with certain limited aggregate delivery point flexibility for the daily contractual delivery point obligations but does not allow NG, without advance notice, to shift delivery volumes among delivery points once gas is flowing during the gas day. NG must nominate the intended daily delivery quantity to each delivery point prior to the gas day, up to contractual entitlements, and to manage to its scheduled and confirmed nominations.

### **Enbridge Compressor Station Weather Caused Issues**

Starting at 4:13 AM and 7:58 AM, several units at Enbridge's compressor stations (Cromwell, Oxford, Burrillville, Southeast) experienced weather related failures to start remotely and dispatched technicians to bring them online. Failures were due to suction and discharge valves timing out due to moving too slowly during the start sequence, ice on vent valves (3), a frozen guide vane actuator, and frozen yard valves.

### **Enbridge Line Pack Prior Events**

AGT packs the system with gas in anticipation of customers' requests for natural gas deliveries based on forecasted demand and gas nominations. When customer takes exceed the amount of gas being delivered into the system, the line pack is drawn down.

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The MAOP of the line is 958 psig and the AGT system was under 700 psig around 6:20 AM, prior to the command to increase the flow at Weymouth M&R. Notwithstanding other operating requirements, it appears the line may have been physically able to be packed with more gas going into the morning of January 21, 2019, but the amount of line pack was considered reasonable by Enbridge. AGT is limited in its ability to pack the line by the amount of gas that had been nominated for delivery on its system. Since NG did not nominate the gas they took, AGT did not pack the line with consideration of the usage. AGT's 'packing cycle' is from 1:00 AM until 2:00 AM.

### G-System Infrastructure

The Portsmouth M&R (MR-00013) is at the end of a single 4 mile - 6" pipeline as shown in Figure 6. A 6" pipeline does not have any appreciable line pack, making the line more sensitive to pressure drop in the G-System.

Figure 7 shows the pressure drop across the 4 mile - 6" pipeline. The blue line is the pressure at the end of the 2-line portion of the G-System, 4 miles upstream of the Portsmouth M&R at valve G21-1 (red circle). The green line is the pressure immediately upstream of the Portsmouth M&R (the end of the 4 mile single 6-inch line to the Portsmouth meter (yellow box 13)). The red line is the flow at Portsmouth meter. There is a nearly 200 psi pressure drop. The drop in pressure at the Portsmouth M&R resulted in the inability to deliver the volume at the flow rate that NG was taking at the time.

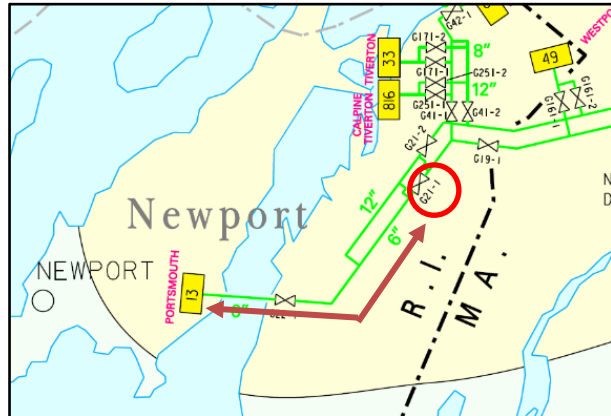


Figure 6: 200 psig Pressure Drop across 4 Mile 6" Pipeline

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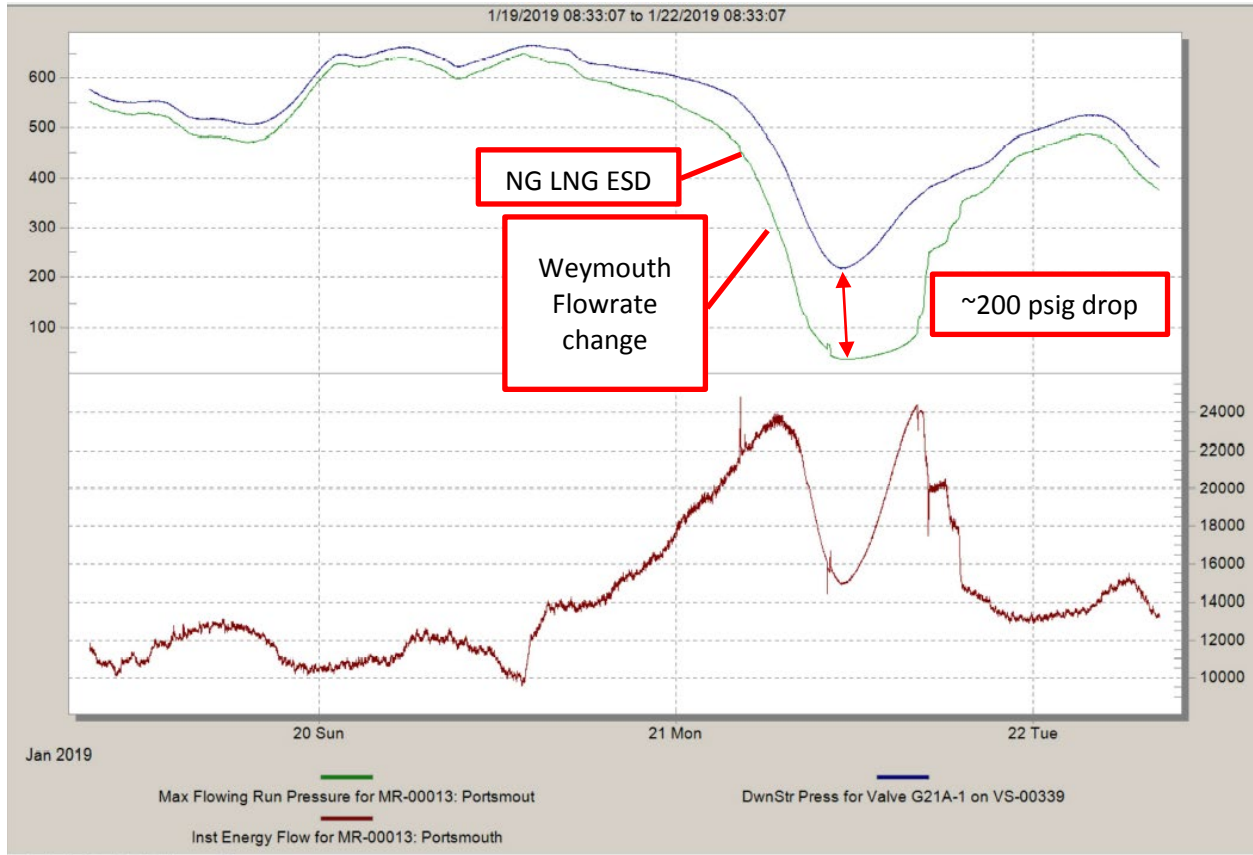


Figure 7: Pressure Drop Across 4-Mile 6" Feed to Portsmouth M&R

As shown in Figure 8, the pressure at the lateral to the G-System head dropped from about 725 psig at 3:45 AM to about 710 psig at 4:47 AM, when Enbridge failed to remotely start an additional Burrillville compressor unit, and then dropped at an accelerating rate to around 675 psig, prior to the Weymouth issue, at 6:21 AM.



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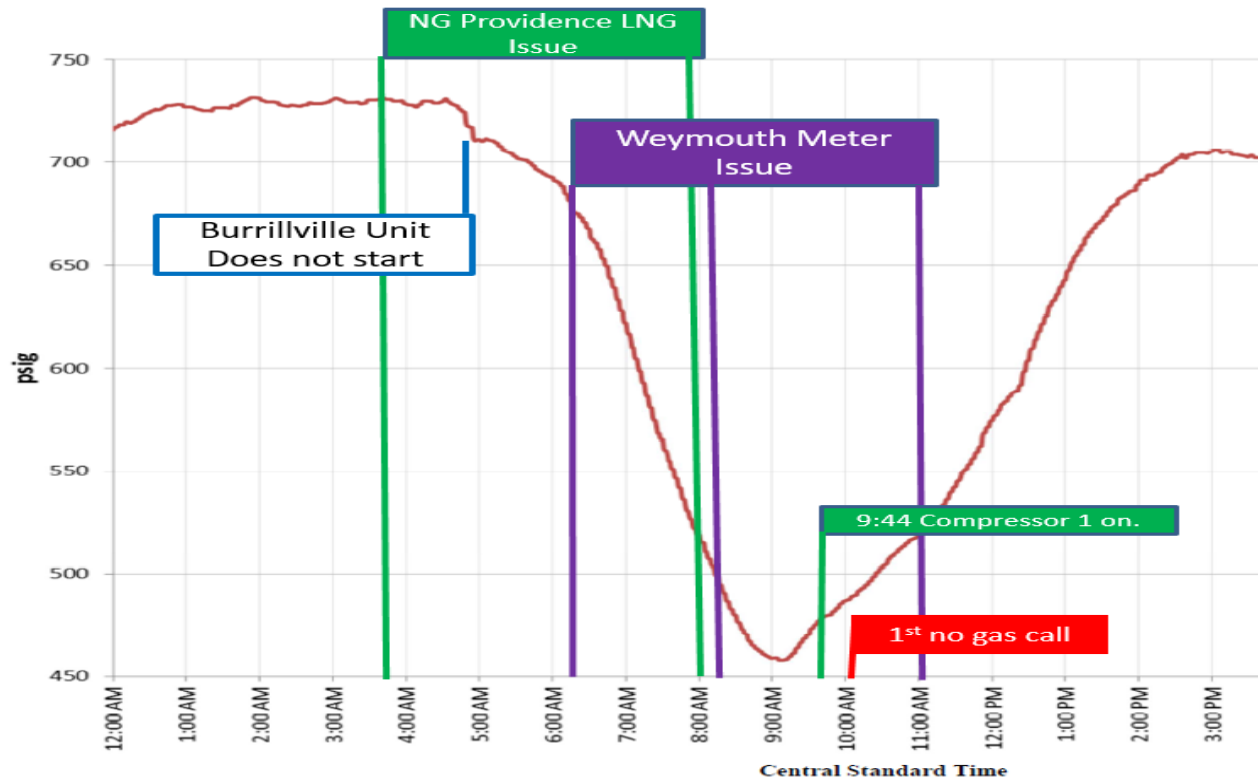


Figure 8: Pressure at the G-System Head (G-1 Tap) January 1, 2019

The Weymouth M&R is about twice as far as NG LNG is from the Portsmouth M&R. Due to proximity, pressure and flow changes at the NG LNG plant will impact the pressure at the Portsmouth M&R more quickly than changes at the Weymouth M&R or the Burrillville compressor station (assuming they occur about the same time).

A review of the pressure at various points in the AGT system over time provides some insight on to how quickly the system reacted to these events. Figures 8 and 9 show that from when NG's Providence LNG plant shuts down until the Weymouth issue occurs (3:45-6:21 AM), the inlet pressure to the Portsmouth M&R dropped precipitously from ~450 psig to ~110 psig and the pressure at the G-1 Tap dropped from 725 psig to 680 psig. NG LNG resumes partial vaporization capacity and Weymouth returns to the prior flowrate around the same time, about 8:00 AM and 8:14 AM respectively, but the pressure at the G-1 Tap does not start to rise until after 9:00 AM, about one hour later. The pressure at the Portsmouth M&R does not begin to recover until around 11:00 AM, after NG LNG brings Compressor 1 back in service (9:44 AM) and Weymouth M&R outlet pressure is raised to 900 psig (10:55 AM).

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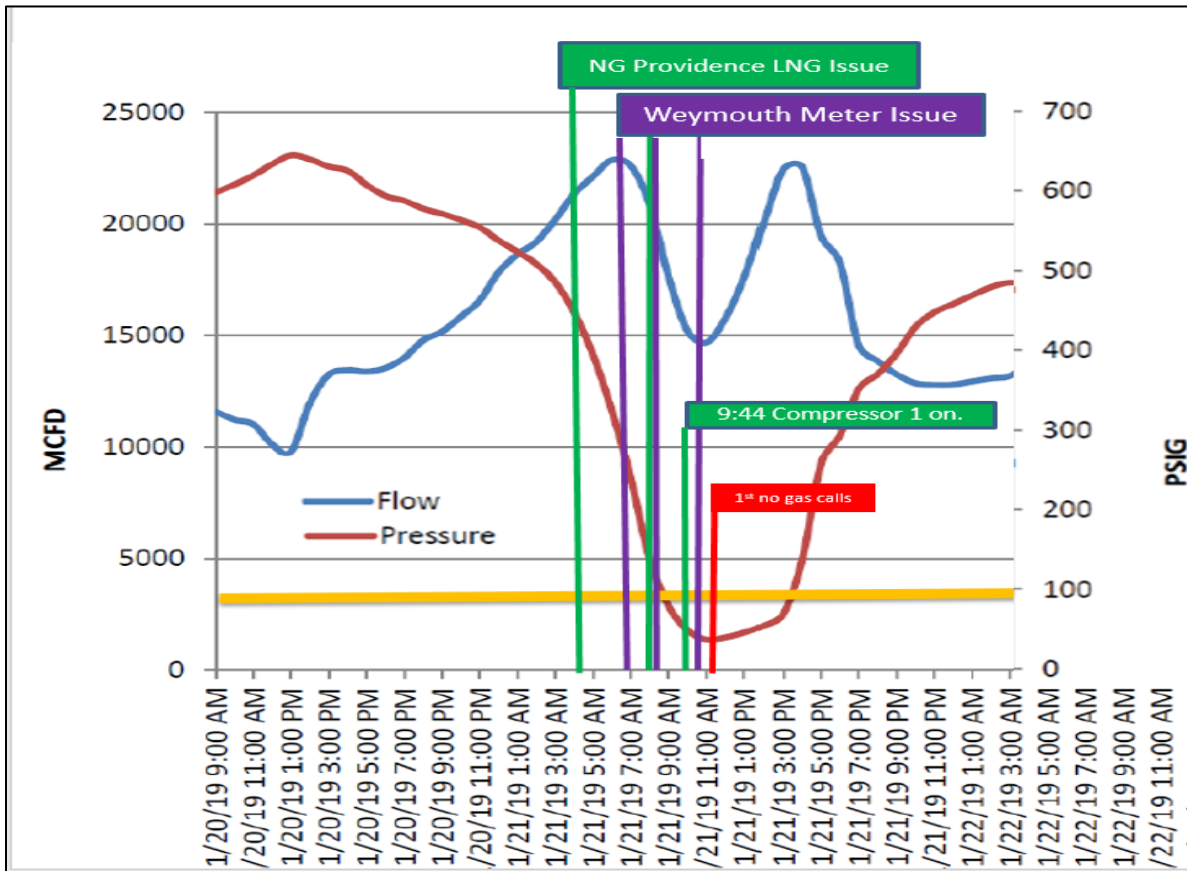


Figure 9: Inlet Pressure and Flow at Portsmouth M&R

### TGP Interconnect at Mendon Issue

Based on SCADA data, on January 21 at 11:23 AM, the flowrate at the Mendon meter fell from 6,666 to 0 MMBtu/hr at 11:53 AM. After discussions between AGT and TGP gas control, at 12:26 PM, TGP brought the Mendon compressor station back online and the flowrate resumed to 6,666 MMBtu/hr for the rest of the gas day. The loss of hourly supply was detrimental to AGT system pressure but did not initiate the pressure drop and occurred after pressure to the Portsmouth M&R could have been recovered in time to prevent loss of gas to customers in the Newport System.

### Modeling 'What If' Scenario Analysis (WISA)

PHMSA requested Enbridge model two WISAs. WISA is a modeling technique used to yield various projections for some outcome based on selectively changing inputs. This modeling was requested to assist PHMSA in gaining a better understanding of the potential impact from operational upsets on the G-System (NG LNG shutdown, customer overtakes) and Enbridge's Weymouth meter configuration error. The modeled scenarios are only applicable to the specific conditions modeled. Changing the location of the demand, supply, or other pipeline attributes can greatly alter the modeled results.

1. The purpose of the first WISA is to forecast the pressure at Portsmouth M&R had the Weymouth meter and Burrillville compressor unit malfunctioned but the gas deliveries were within nominated and contracted volumes. Enbridge modeled the AGT system assuming the conditions:

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- Weymouth meter and Burrillville compressor unit issues occur (actual low pressure at G-1 Tap on January 21, 2019 = 460 psig).
- Deliveries on the G-System restricted to their maximum hourly deliveries (based on their nominations and contracts). The two customers taking gas were NG<sup>8</sup> and NStar.
- Modeled under steady-state conditions.<sup>9</sup>

The model projects the low pressure at the Portsmouth Meter Station to be about 225 psig (red line in Figure 10), well above the minimum contractual pressure at Portsmouth, 100 psig. The model projects that if the Weymouth meter and Burrillville compressor unit issue occurred (inlet pressure to the G-System was 460 psig) but NG LNG's Providence plant met its send out requirements and customer takes did not exceed nominations, there would have been adequate pressure at Portsmouth M&R to maintain the Newport system.

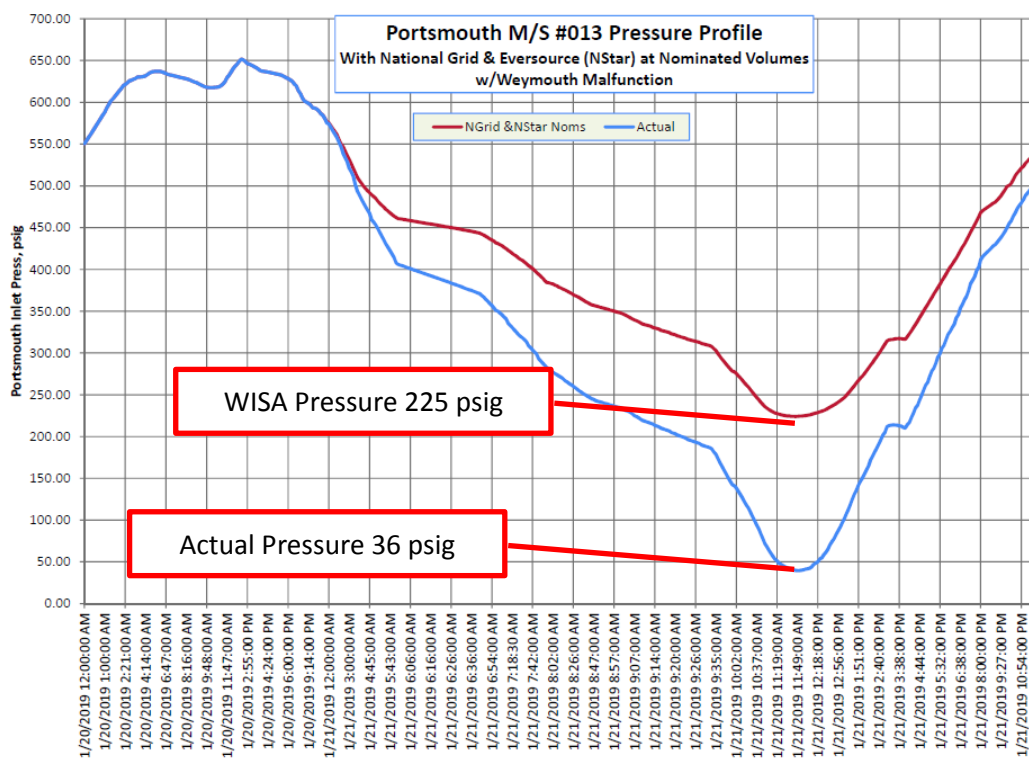


Figure 10: Portsmouth Pressures as Modeled at Nominated Volumes vs. Actual Delivery

- The purpose of the second WISA is to forecast the required pressure at the head of the G-System to maintain 100 psig at the inlet to the Portsmouth M&R under the actual usage/NG LNG shutdown on January 21, 2019. Enbridge modeled the G-System under the following conditions and solve for the pressure at the head of the G-System:
  - Actual gas usage at 6:00 AM on January 21, 2019 (due to NG Providence LNG plant issues and greater than nominated gas usage).

<sup>8</sup> NG represents slightly more than half of the firm usage on the G-System.

<sup>9</sup> Steady state conditions means that the amount of gas going into the system is the same as the amount being delivered to customers. Steady state models the system at a single point in time. The transient models contain terms for the rates of change with time of the dynamic variables: pressure, temperature, density, and velocity. Transient modeling is much more complex and resource intensive.

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- b. Set the inlet to the Portsmouth M&R set at 100 psig (NG's contractual pressure with Enbridge).
- c. Modeled under steady-state conditions.

Enbridge's model under these conditions project that the required pressure at the head of the G-System, the G-1 Tap, would be 709 psig.

PHMSA examined historical send out data to analyze if the G-System had previously delivered a quantity of gas like that on January 21, 2019. In reviewing data from January 1, 2014, until June 14, 2019, there were 33 days with send out on the G-System greater than on January 21, 2019. The data showed that lowest daily average pressure at the G-1 Tap was at or above a minimum of 684 as shown in Figure 11.

The lowest pressure is associated with the highest flowrate, making the daily average pressure typically higher than the peak hour pressure. Using steady-state simulated conditions and past historical G-System data, it seems plausible that the AGT system may have been able to achieve adequate pressure at the G-1 Tap to provide 100 psig at Portsmouth M&R with the additional compressor unit at Burrillville (4:47 AM) or higher flowrates from Weymouth M&R (6:21 AM).

Date	Mainline-G-1 Tap Pressure (Daily Avg.)	G-System Demand for Gas Day (lowest to highest)		Date Time	Mainline-G-1 Tap Pressure	G-System Demand for Gas Day
1/21/2019	669	-432,200		1/6/2018	736	-447,802
12/30/2017	733	-432,648		2/6/2015	696	-448,803
4/2/2017	728	-432,802		3/14/2014	684 (lowest)	-451,409
1/1/2018	741	-434,246		2/2/2018	725	-451,999
12/30/2014	709	-434,258		1/9/2017	723	-452,312
3/4/2016	685	-436,495		1/27/2015	728	-452,411
1/4/2016	718	-437,405		1/10/2015	705	-453,969
1/18/2016	718	-438,769		2/3/2015	702	-455,450
11/22/2018	723	-439,158		1/5/2016	710	-456,015
2/6/2018	730	-440,354		1/6/2015	693	-458,411
2/2/2015	702	-442,442		12/15/2016	719	-458,841
1/7/2018	736	-442,860		1/28/2015	729	-460,811
1/2/2018	739	-443,061		1/9/2014	699	-465,040
3/19/2015	689	-443,170		1/15/2018	730	-465,597
12/29/2017	734	-444,152		1/30/2014	713	-466,080
2/3/2018	721	-445,965		1/14/2018	740	-476,879
1/9/2015	704	-446,740		3/27/2014	709	-494,681

*Figure 11: Pressure at G-1 Tap for 34 Largest G-System Demand, Jan. 1, 2014 through Jun. 14, 2019*

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### 3. Transient Model WISAs

As the data from steady-state modeling did not provide a comprehensive understanding, PHMSA requested additional WISAs using transient modeling software.<sup>10</sup> Enbridge developed a base model and ran six scenarios. Enbridge validated the base case model using SCADA data from January 21, 2019, with additional validations performed by running the model a full day before and after to mimic the pressure profile. The Weymouth flowrate was set at 650 Mmdth/d instead of 700 Mmdth/d, the flowrate Enbridge intended to flow, because gas control's aim is to operate the system with high enough pressure to meet the demand but to not exceed contractual takes. This flowrate supported the 100 psig of pressure needed at Portsmouth M&R to maintain NG customers on Aquidneck Island. The additional scenarios modeled the following:

- a. NG LNG plant operating status (down, operational).
- b. Customer demand on the G-System (actual, estimated if NG LNG was operating (limited flow at AGT M&Rs #10 & 842), at contractual hourly limits based on customer nominations).
- c. Meter configuration error at Weymouth M&R (error, no error).

	NG LNG	Weymouth Meter	NG Providence G System Takes	Others G System Takes	Pressure @ Portsmouth Inlet*	Significance
<b>Base Case</b>	Down	Error	Actual	Actual	38 psig	Actual conditions
<b>Scenario 1 - What if NG LNG did not fail?</b>	Operating	Error	Est. takes assuming NG LNG is operational.	Actual	109 psig	The impact of NG LNG had the third most impact to the pressures at Portsmouth.
<b>Scenario 2</b>	Down	Error	Contract Limit	Actual	151 psig	Scenario 2 and 3 are an inverse of each other. Impact from overtakes by NG (54% of the volume) is about the same as the overtakes by the rest of the customers on the G system.
<b>Scenario 3</b>	Down	Error	Actual	Contract Limit	151 psig	
<b>Scenario 4 - What if Weymouth did not fail?</b>	Down	No Error	Actual	Actual	158 psig	The impact of the Weymouth meter configuration error was the second most impactful to the pressure at Portsmouth.
<b>Scenario 5 - What if there were no overtakes?</b>	Down	Error	Contract Limit	Contract Limit	221 psig	The greatest impact is due to customer overtakes on the G-System.
<b>Scenario 6</b>	Operating	No Error	Est. takes assuming NG LNG is operational.	Actual	211 psig	Demonstrates the impact of the overtakes irrespective of the malfunction of NG LNG and Weymouth.

\*The pressure at Portsmouth inlet represents the lowest pressure experienced on Jan. 21.

Table 1: Transient Modeling Scenario Summary

<sup>10</sup> Enbridge used Gregg Engineering software.

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Conclusions from model predictions:

- If any one of the three factors (overtakes, NG LNG ESD, Weymouth meter configuration error) had not occurred, there would have been adequate pressure to maintain customers on Aquidneck Island.
- Together, scenarios 2 and 3 demonstrate that the impact from the overtakes by NG is about the same as the impact from the overtakes of the other customers on the G-System. Even with the LNG plant shutdown and the Weymouth meter configuration error, if either set of customers had kept their demand to the contracted limit, there would have been adequate pressure.

### Matrix of Events

PHMSA developed the following Matrix of Events to provide objective and comparative measures of the impact of the various events that occurred on January 21, 2019. The magnitude of each event, in order of significance, is dependent on:

- Proximity of the event to the Portsmouth M&R,
- Time the event occurred,
- Volume of gas the event represented, and
- Duration of the event.

The Burrillville compressor unit occurred at 4:47 AM, the Weymouth meter issue occurred at 6:21 AM, and the first no-gas call occurred at 10:06 AM, respectively about 5 and 4 hours later. Both the Mendon interconnect with TGP and the Burrillville compressor station are closer to the G-1 Tap than Weymouth M&R. Detailed system analysis for contingency planning could assist all operators in better understanding of measures that could mitigate outages in the future.

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Matrix of Events Event (CST)	Time Start	Time Resolve	G-1 Tap psig*	Portsmouth psig*	Proximity to Portsmouth	Est. MMBtu	Impact to Lost Gas in Newport
Demand on AGT G-System demand significantly exceeds nominations even before NG LNG plant shuts down. This continues until 9:30 AM. In Providence M&Rs takes jumped significantly at approximately 3:45 AM.*	02:30	9:30	725	500	~20 miles (center of G-System)	18,750	Large – Early, close and large volume
NG Providence LNG emergency shutdown. Vaporization between 4-9 AM was 2,165 MMBtu.*	03:45	9:00	730	450	~47 Miles	28,754	Large – Early, close, sudden, and large volume
AGT Unit #4 Compressor @ Oxford failed to start remotely.	04:14	06:30	725	420	~160 miles	16,865	Negligible – too far
AGT Unit #7 Compressor @ Cromwell failed to start remotely. Started Unit #3.	04:17	05:54	725	420	~130 miles	0	Negligible – too far
AGT Unit #4 Compressor @ Burrillville failed to start remotely.	04:47	06:30	710	405	~70 miles	10,656	Small – Early, too far, smaller volume
Pressure at G-1 reaches minimum modeled required pressure to maintain 100 psig at Portsmouth M&R.			709	After this time, remedial measures taken upstream of the G-System are too late to maintain 100 psig at Portsmouth. Pressure increase would need to occur in closer proximity to Portsmouth.			
AGT increases flowrate at Weymouth M&R 1st stage. s Meter 00332 fluctuated drastically between 1.0 Bcf and 0.4 Bcf. Flow restricted to 150,000 Dth/d (6,250 MMBtu/hr) instead of 700,000 (29,167 MMBtu/hr). (Reduction of 22,500 MMBtu/hr)	06:21	08:14	675	280	~95 miles	42,375	Small – pressure probably already below that needed to maintain 100 psig at Portsmouth, too far to recover pressure in time.
AGT Unit #6 Compressor @ Southeast failed to start remotely.	07:11	08:20	600	200	~185 miles	12,638	Negligible – too far
AGT Unit #8 Compressor @ Cromwell failed to start remotely.	07:58	08:30	520	160	~130 miles	5,912	Negligible – too far
NG LNG vaporization rate back up 2,475 MMBtu/hr.	08:00	09:00	520	160	~47 miles	2,475	Too little, too late
AGT re-establishes stable flow rate from Weymouth M&R 2nd stage via manual control of regulator run to pre-flow rate change (550,000 Dth/d). (Reduction of 6,250 MMBtu/hr)	08:14	10:55	515	125	~95 miles	16,770	Negligible – too late
Modeled pressure to maintain flow to Newport system.				100	After this point, malfunctions may contribute to the duration of the outage but the outage would occur regardless.		
First no gas call in Newport System.	10:06		480 rising	50		N/A	
TGP at Mendon goes to 0 flow.	11:23	12:26	520 rising	45	~56 miles	6,666	No impact – occurred after customers lost.

\*Pressure and MMBtu are approximate, from the chart in AGT Response to PHMSA Information Requests 1-23 Items 4 & 5 and 1-25 Item 3.pdf

\*\*Pressures and MMBtu are approximate, from the chart in AGT RI Slides - PHMSA Teleconference 2-5-19.pdf

Each compressor station MMBTU is derived from the total stated capacity on AGT Capacity Map for Jan. 21, 2019 divided by the number of units.

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### Conclusions

- The untimely automatic shutdown of the NG LNG's Providence LNG plant and resulting shift of supply of gas from NG LNG's Providence plant to AGT's G-System contributed to inadequate gas pressure at AGT's Portsmouth M&R. The NG LNG ESD would have been prevented if NG LNG identified the cause of the ESD that occurred previously.
- NG LNG did not communicate the problems to Enbridge in a timely manner resulting in an inability of Enbridge or other gas suppliers to assist in mitigating the consequences of NG Providence LNG shutdown.
- NG LNG experienced an unexplained automatic shutdown in November 2018. They failed to adequately investigate the event and resolve the problem with the UPS at that time.
- NG and other customers on the G-System relied on supply from AGT when their gas usage significantly exceeded their nominations during the coldest and most operationally sensitive part of the day. Historically, there were multiple occurrences when usage exceeded nominations on the G-System.
- NG had an incorrect understanding of their right to balance gas takes among the various M&Rs on the G-System. They are limited to take the amount of gas nominated to individual M&Rs.
- Based on NG's lack of communication with suppliers about the events on January 21, 2019, it appears that NG may not have a comprehensive understanding of the impact the loss of the NG LNG Providence plant has on downstream systems.
- Enbridge's gas transmission system, like most large gas transmission systems, has flexibility as to how it can be operated while meeting contractual pressure and flow obligations and daily/hourly gas nominations. When operating near operational capacity, the flexibility of the system becomes limited and sensitive to operational upsets or to gas usage exceeding forecasted or nominated volumes.
- Enbridge's equipment does not operate as intendeds impacted pressures on the AGT system. This operational error was preventable or could have been mitigated more quickly had personnel been closer.
- Enbridge's procedures for the inspection and testing of ultrasonic meters in response to their operator error in setting the meter factor did not prevent the incorrect programming of the RTU.
- TGP allowed the flowrate at Mendon to go to 0.
- The 4 mile - 6" pipeline at the tail end of Enbridge's G-System that feeds the Portsmouth M&R experiences a large pressure drop, making it the most vulnerable location on the G-System.
- Even though severe weather blanketed the area on January 21, 2019, causing equipment malfunctions, the large-scale gas outages in NG's Newport low-pressure system were preventable had there been greater operational readiness, contingency planning, system enhancements, and enhanced communication among gas operators.