GTI ENERGY
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Sponsors:

PHMSA
Pipeline and Hazardous Materials Safety Administration

AGA
American Gas Association

OTD
Operations Technology Development

DOT-PHMSA Contract: 693JK32210008POTA

Best Purging Practices for Minimizing Methane Emissions

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PHMSA Project Debrief Meeting | June 5, 2024

Agenda

Part 1 (40 min)

- GTI Energy Introduction
- Project Objective and Tasks
- Task Summaries
- TAP Group Summary
- Identified Purging Alternatives and Challenges
- Examples of Best Practices related to purging operations
- Vacuum Purging Work being done by GTI Energy
- Implementing Best Practices and Guidance into the AGA Purging Manual

Part 2 (20 min)

- Open Discussion and Questions

GTI Overview

Serving the Energy Industry Since 1941

- Independent, not-for-profit research, technology development and deployment organization
- Areas of research include energy production and conversion, energy delivery, and end-use
- Technology development focus on safety, improving efficiency, and reducing emissions
- Research Facilities
  - 18-acre campus near Chicago
  - Laboratories in Agoura Hills, CA and Davis, CA
  - Pilot and demo facilities worldwide

400+

EMPLOYEES

Our Capabilities

GTI is addressing global energy and environmental challenges across the energy value chain

Supply

Expanding the supply of natural gas and renewable energy

Conversion

Transforming natural resources into clean fuels, power, and chemicals

Delivery

Ensuring a safe and reliable energy delivery infrastructure

End Use

Promoting the clean and efficient use of energy resources

Operations Technology Development

GTI ENERGY

Mission

- Identify, select, fund, and oversee research projects resulting in innovative solutions and the improved safety, reliability, and operational efficiency of natural gas systems

Goals

- Enhance safety
- Enable operational excellence
- Minimize environmental impact
- Provide good science

OTD
Operations
Technology
Development

OTD Members

Serving 75 million gas consumers in the U.S., Canada and France

OTD Operations Technology Development

GTI ENERGY

Research Foundation	Southern California Gas Company, A Sempra Energy utility	Pacific Gas and Electric Company	ATMOS energy	SOUTHWEST GAS
Ameren FOCUSED ENERGY. For Life.	conEdison	CenterPoint Energy	Entergy	PEOPLES GAS NATURAL GAS DELIVERY
INTERMOUNTAIN GAS COMPANY	NYSEG RG&E	National Fuel	AVISTA	MiSource
NW Natural We grew up here.	Dominion Energy	Oklahoma Natural Gas. A Division of ONE Gas	ENBRIDGE	Washington Gas A WGL Company
Nicor Gas	TECO PEOPLES GAS AN EMERA COMPANY	DUKE ENERGY	spire	nationalgrid
Liberty	Black Hills Energy	GRDF		

Background

- Operators are making efforts to reduce emissions and avoid purging natural gas during operations
- Situations where purging is necessary are practically inevitable, so purging alternatives need to be implemented into normal procedures, for both large and smaller volumes of gas.
- Operators are seeking guidance for implementing these purging alternative practices safely and effectively.

Project Objectives & Tasks

Full Objective: The objective of this project was to establish best purging practices for the elimination or avoidance of methane emissions during pipeline construction, commissioning, and maintenance. This project will provide a comprehensive literature survey that identifies and details various methods to reduce and/or eliminate methane emissions due to purging and/or blowdown procedures. The technology survey will focus on already existing methods, improvements to these methods, and new technologies and techniques. The different alternatives will be described in relation to the operating scenario and environment as described in American Gas Association or AGA XK1801 "Purging Manual." Included will also be operational recommendations and guidance to determine the best practices associated with each technique and method. The review of potential alternatives will also include economic examples and methane emissions avoidance quantification calculations to provide context for comparing the feasibility and benefits of different methods.

There will be an impact on safety with the implementation of these finding as the government and the natural gas industry are working to minimize methane emissions and move to achieve decarbonization and climate change goals. Avoidance of methane emissions from purging operations have both economic benefits for operators and environmental benefits for the community. Using alternatives to venting natural gas into the atmosphere also provides a safer work environment for pipeline and gathering system operators.

Problem:

As the NG industry searched for alternatives to venting, operators are seeking guidance around which purging alternatives can be used in different scenarios.

Objective:

Establish best purging practices for the elimination or avoidance of methane emissions during pipeline construction, commissioning, and maintenance.

Tasks:

- Literature Survey
- Technology Survey
- Formation of TAP Group
- Best Practices and Guidance
- Implementation into the AGA Purging Manual
- Final Report
- Knowledge Transfer

Project Scope & Budget Summary

Task	Task Description	Federal	Resource Share	Total
1	Project Scoping and Technical Advisory Panel	$ 33,135	$ 12,344	$ 45,479
2	Literature and Research Review	$ 86,515	$ 21,091	$107,606
3	Examination of Alternative Purging Methods	$ 64,160	$ 45,251	$109,411
4	Best Practices and Recommendations	$ 89,418	$ 0	$ 89,418
5	Final Report	$ 57,897	$ 2,494	$ 60,391
6	Status Reports	$ 29,452	$ 9,820	$ 39,272

Cost Share Budget Table

Cost Category	Cost
Amount Requested from DOT PHMSA	$360,577
Cash Cost Share – OTD	$131,000
Total Program Cost	$491,577

Task 1: Project Scoping and Technical Advisory Panel

- GTI Energy, PHMSA, AGA, and OTD collaborated on a project to identify purging alternatives and best practices.
- The project team held regular Technical Advisory Panel (TAP Group) meetings to collect:
  - Lessons learned from experiences in the field
  - Guidance in choosing which purging alternatives to use in different situations
  - Best practices and recommendations for implementing purging alternatives.

TAP Group Members

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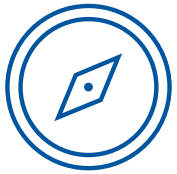
Summary of TAP Group Meetings

1. **TAP Meeting 1:** General Discussion of Purging Alternatives and Techniques

2. **TAP Meeting 2:** Determining Which Purging Alternative is Best in Various Situations

3. **TAP Meeting 3:** Best Purging Practices and How to Best Provide Guidance for Operators



4. **TAP Meeting 4:** Review of Draft Final Report

5. **TAP Meeting 5:** Draft Final Report Comments and Project Closeout

Task 2: Literature Survey

- Literature Survey Objective:
  - Provide a thorough review of published literature as a survey of alternative purging methods.
  - Include information from past, ongoing, and future research projects.
  - Provide guidance and reference to natural gas utility operators who are seeking to minimize and/or eliminate methane emissions during purging operations.

Examples of Included Documents:

- *AGA Purging Manual, AGA XK1801, AGA, 2018*
- *Purging Principles and Practice, AGA XK0101. AGA, 2001*
- *Blowdown Emission Reduction White Paper, AGA, 2020*
- *Methane Emissions from the Natural Gas Industry, Volume 7: Blow and Purge Activities. GRI, 1996.*

Definitions

- **Purging Definitions from the AGA Purging Manual (2001):**
  - **Purge:** The act of removing the content of a pipe or container and replacing it with another gas or liquid.
  - **Purge into service:** The act of replacing the air or inert gas in a closed system by combustible gas, vapor, or liquid.
  - **Purge out of service:** The act of replacing the normal combustible content of a closed system by inert gas, air, or water.
  - **Isolation:** Disconnection from all other equipment or piping of a chamber or space to be purged.
  - **Blowdown**: Although the AGA Purging Manual does not provide a formal definition of "blowdown," the term is used to refer to the act of releasing natural gas from a pipeline system so that work can be done on the unpressurized facilities.

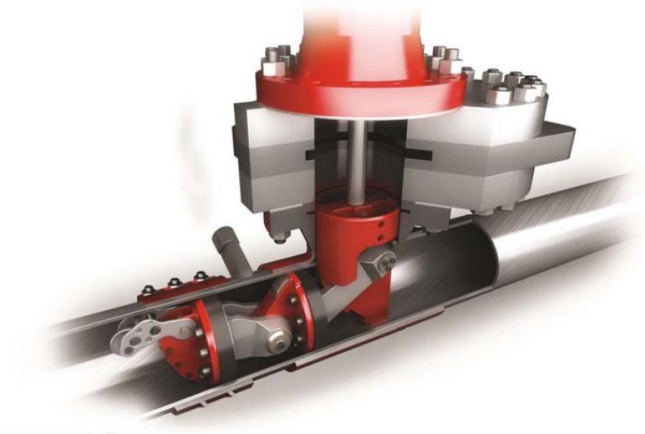
Task 3: Examination of Different Purging Methods

Cross Compression (ZEVAC, GoVAC, or similar)

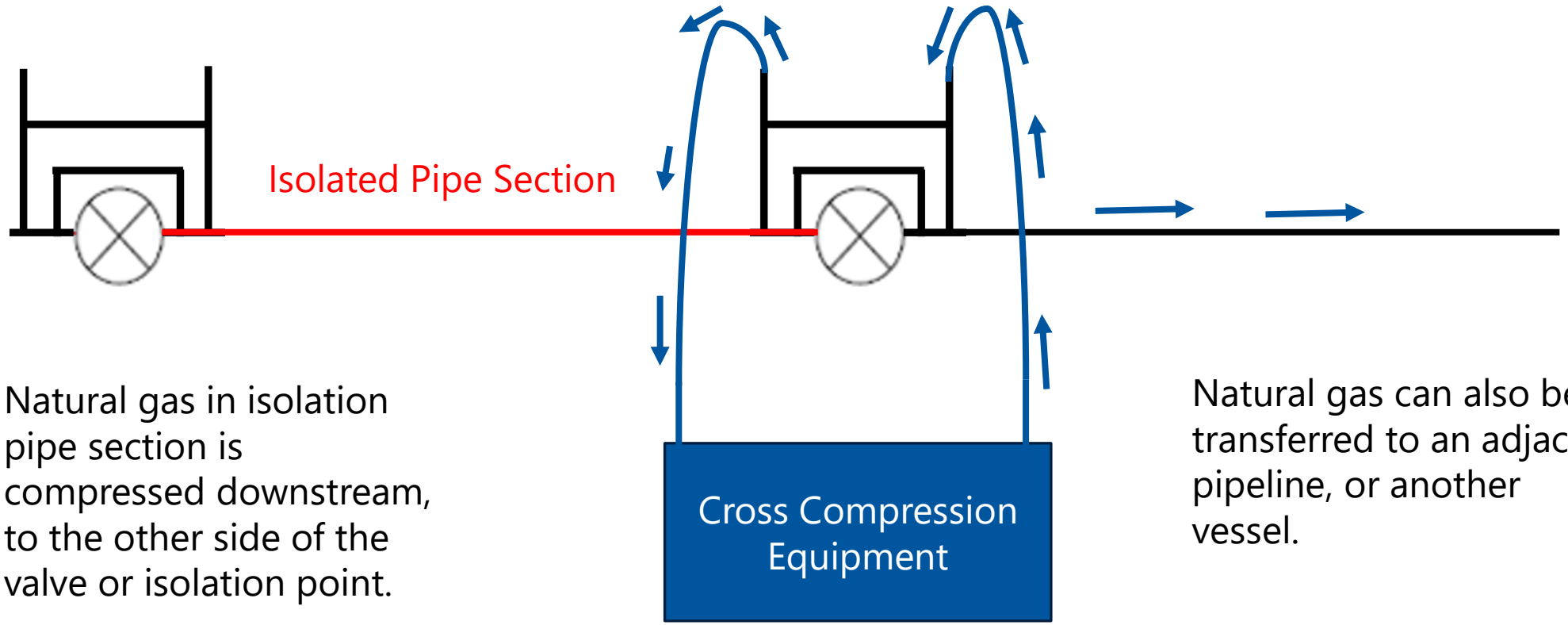
Flaring & Enclosed Combustion

Pressure Reduction Prior to Purging

Use of Stopples to Reduce Volume Purged



Cross Compression (Concept)



Natural gas in isolation pipe section is compressed downstream, to the other side of the valve or isolation point.

Natural gas can also be transferred to an adjacent pipeline, or another vessel.

Cross Compression

- A cross compression system recovers the gas that would have been vented to the atmosphere by compressing the gas in the isolated section of pipe and transfers it to a different section of the pipeline, another nearby pipeline, or storage location.
- Equipment can be sized depending on the volume of natural gas being purged, and the time required to complete the work can be calculated in the project planning phase.

Cross Compression Feasibility

Several challenges with cross compression identified during this project are listed below:

- Increased job time requirement compared to traditional purging / blowdown operations.
- Transportation of equipment to the jobsite.
- Noise of compressor equipment.
- Elevated temperature of injected gas.
- Equipment footprint.
- Emissions from diesel fueled equipment are not as environmentally friendly as natural gas-powered equipment.

Cross Compression Best Practices

- "Shutting in the gas"
- Checking for leak-through
- Equipment Maintenance
- Clear communication and job planning
- Safety

Flaring and Enclosed Combustion

- The purpose of flaring as a purging alternative is to combust natural gas instead of releasing it to the atmosphere.
- Combusted methane does still emit a volume of CO_2 to the atmosphere, but this emission has much less global warming potential than venting methane.
- Enclosed combustion is an alternative to flaring that produces no visible flame. These units sometimes employ methods of thermal oxidation that allow for a more efficient combustion of the blowdown gas compared to burning the gas on an open flare stack.

Flaring and Enclosed Combustion Feasibility

Several challenges with the practice of flaring identified during this project are listed below:

- May draw unwanted attention from the public or passersby.
- Can cause false leak calls or odor complaints. This is dependent on the combustion efficiency of the flare stack, which will “vent” some of the natural gas if a portion of the gas is not combusted.
- Potential hazard, especially to nearby buildings or structures.
- Operators are not fully eliminating emissions, but rather converting to a different type of emissions (CO2) that have a lower GWP than methane.

Flaring and Enclosed Combustion Best Practices

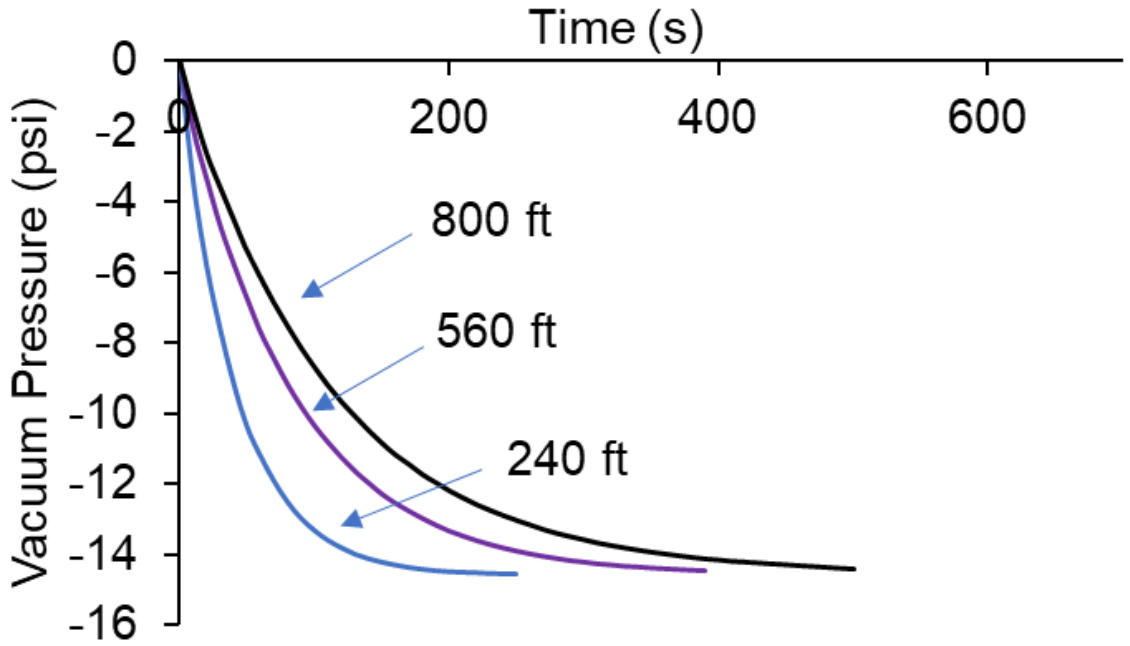
- Communication
- Safety
- Enclosed Combustion
- Flaring in conjunction with cross compression

Purging Into Service: Vacuum Purging Field Demonstrations

- By removing all of the air in a natural gas pipeline with a vacuum, only pure natural gas is introduced.
- When the air is eliminated, there is no longer any mixing of air and natural gas.
- This process also eliminates “trapped air” when purging a line into service – even when various laterals and loops exist.
- Addressing “operational” methane emissions
- Partnering with ULC Technologies to make the “system” field ready
- Demonstrating w/ OTD Utilities

Time to Purge Pipelines (4-in diameter)

- Dependent on volume of pipe being purged into service
  - –Pipe diameter
  - –Pipe length
- Not dependent on system pressure
- Not dependent on system complexity
- Vacuum purging is likely more efficient than traditional purging practices
  - –No need to segment system
  - –Can backfill installation except for tie-in / purge excavation



Achieving Proper Vacuum Level

- Important to obtain proper vacuum levels
- If not, then will require larger quantities of methane to be vented to the atmosphere
- Approximately -14 psig or greater is required to ensure proper methane concentration (dependent on atmospheric pressure)

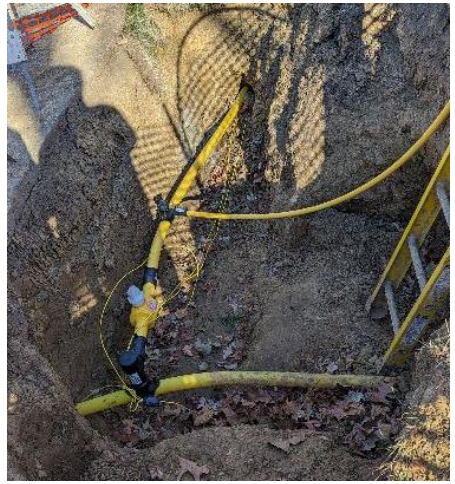
Atmospheric Pressure Expected Given Elevation Above Sea Level			Vacuum Gauge Pressure Range
Elev (ft)	PSI	inHg	PSIG
0	14.70	29.92	-14.60 to -14.70
100	14.64	29.80	-14.54 to -14.64
200	14.59	29.70	-14.49 to -14.59
300	14.54	29.60	-14.44 to -14.54
400	14.48	29.48	-14.38 to -14.48
500	14.43	29.38	-14.33 to -14.43
600	14.38	29.28	-14.28 to -14.38
700	14.33	29.17	-14.23 to -14.33
800	14.28	29.07	-14.18 to -14.28
900	14.22	28.95	-14.12 to -14.22
1000	14.17	28.85	-14.07 to -14.17
1100	14.12	28.75	-14.02 to -14.12
1200	14.07	28.65	-13.97 to -14.07
1300	14.02	28.54	-13.92 to -14.02
1400	13.97	28.44	-13.87 to -13.97
1500	13.92	28.33	-13.82 to -13.92

Summary of Field Demonstrations (Trial 1)

- 7881’ of 4” MDPE pipe was installed and purged into service.
- It took approximately 1 hour to obtain a vacuum of -14.41 psi in the new pipe.
- The 4” PE valve was used to provide a complete separation between the existing live pipe and the new section of 4” PE pipe to be vacuum purged.
- The 4” PE valve was cracked to start introducing gas into the new section of 4” PE pipe. The valve was then completely opened, and the new section of pipe was pressurized to 42 psig.
- The new gas pipe was now energized. With very little gas released to atmosphere, nearly instant full gas reading at both purge points.

Summary of Field Demonstrations (Trial 2)

- ~4,500’ of 2” MDPE pipe was installed as well as 23 pre-tapped services and purged into service.
- It took approximately 13 minutes to obtain a vacuum of -14.44 psig in the new pipe.
- The 2” HVTT was tapped to start introducing gas into the new section of 2” PE pipe, and the new section of pipe was pressurized.
- The furthest away purge point was purged first. The purge stack was cracked and the reading was about 88% gas. After about 40 seconds or so it then read 100% gas.
- The subsequent purge points were then purged. The other 4 purge stacks all had readings greater than 90% gas from the start
- The new gas pipe was now energized. With very little gas released to atmosphere.



Summary of Field Demonstrations (Trial 3)

- ~2,500’ of 2” MDPE pipe was installed and purged into service.
- It took approximately 6 minutes to obtain a vacuum of -14.6 psig in the new pipe.
- The newly installed 2” PE was connected to an existing 4” PE pipe via a HVTT on one end and connected to an existing 6” PE pipe via HVTT on the other end.
- The GTI vacuum purge system was attached to the new section of PE pipe – the GFCP no-blow tapping tool was pre-installed on the HVTT – vacuum pulled on the new pipe (down to around -14.6 psig)
- The 2” HVTT was tapped to start introducing gas into the new section of 2” PE pipe, and the new section of pipe was pressurized to 60 psig.
- The purge stack at the far end was cracked and the reading was about 90% gas. After about 10 seconds or so it then read 100% gas.
- The new gas pipe was now energized. With very little gas released to atmosphere.

Task 4: Best Practices & Recommendations

- **Pre-Job Planning:**
  - Use a calculator to know expected time to complete job
  - Use of tube trailers when nearby injection is unavailable
- **Reducing the volume of gas being evacuated:**
  - Reducing the length of pipeline section to be evacuated
  - Reducing the pressure of the pipeline
  - Creating space in the pipe to allow for injection, especially on low throughput days
  - Requesting gas control lower the pressure in the pipeline prior to cross compression

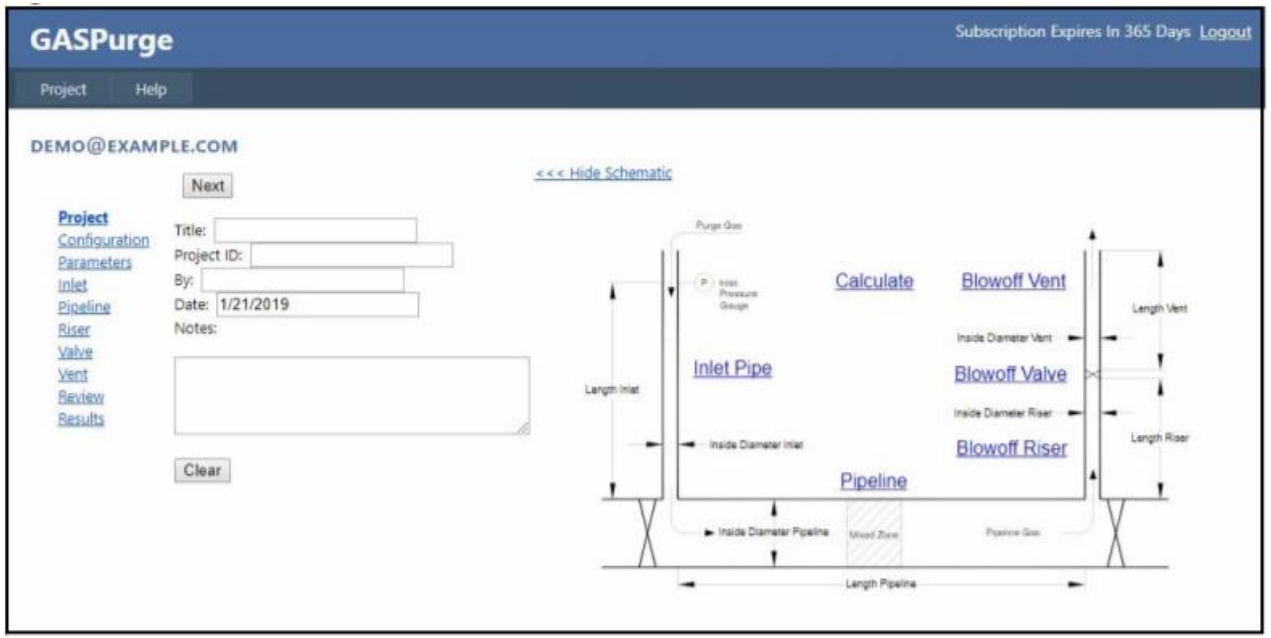
Task 4: Best Practices & Recommendations

- **Time Savings:**
  - Drawing down pressure prior to purging
  - Using more than one compressor to reduce job time
  - Conduct compression operation overnight

- **Documentation and Record Keeping:**
  - Keeping track of emissions reduction efforts
  - CO2 equivalent emissions avoided can be tracked over time to demonstrate progress

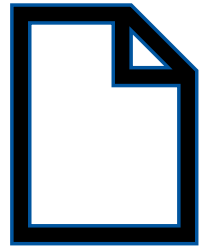
Methane Emission Reduction Tracking

- Methane emissions reduction efforts can be tracked using volume calculation software (i.e. GASPurge™ software).
- The volumes of natural gas that are not emitted can be compared to CO2 equivalents and give operators an idea of how effective their programs are performing.
- Mitigated emissions tracking is a great method of viewing progress over time as well as reporting overall emission reductions



Tasks 5 & 6: Reporting

- **Task 5: Final Report**
  - The draft final report was made available to TAP group members in December 2023.
  - After addressing all comments from TAP members, the final report was submitted to PHMSA in April 2024.
  - This presentation summarizes the content in the report, but please refer to the final report for more detailed information.
  - The final report is available on the PHMSA website.
- **Task 6: Status Reports**
  - Status reports were provided throughout the project



Knowledge Transfer

- **Status updates and project summaries were provided at the following times:**

American Gas Association Fall Meeting, Engineering Committee

September 2023, Pittsburgh, PA

OTD Spring Meeting

April 2024, Denver, CO

American Gas Association Spring Meeting, Construction Committee

April 2024, Seattle, WA

5 Technical Advisory Panel Meetings

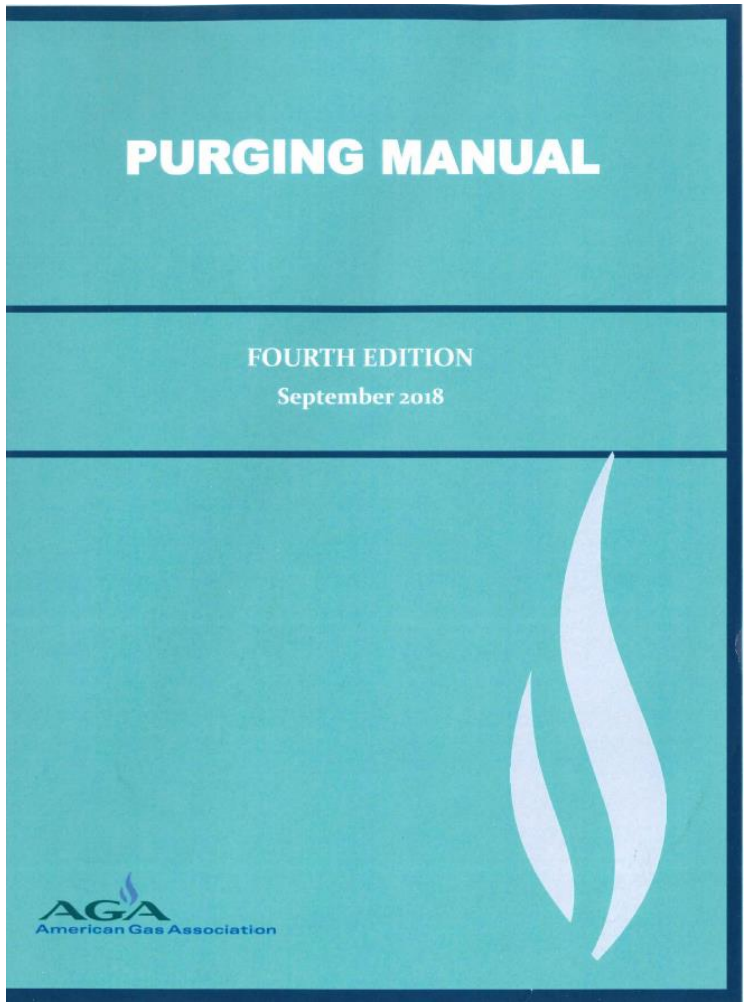
Throughout Project, Virtual

Next Steps

Implementation into the AGA Purging Manual

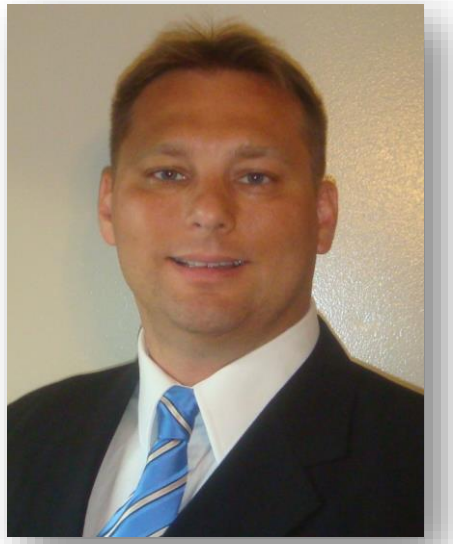
- Continued discussion with the AGA Engineering Committee

Continued vacuum purge demonstrations by GTI Energy



Closing & Contact Information

Please do not hesitate to reach out if you would like to speak further about purging best practices.
Thank you!



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