



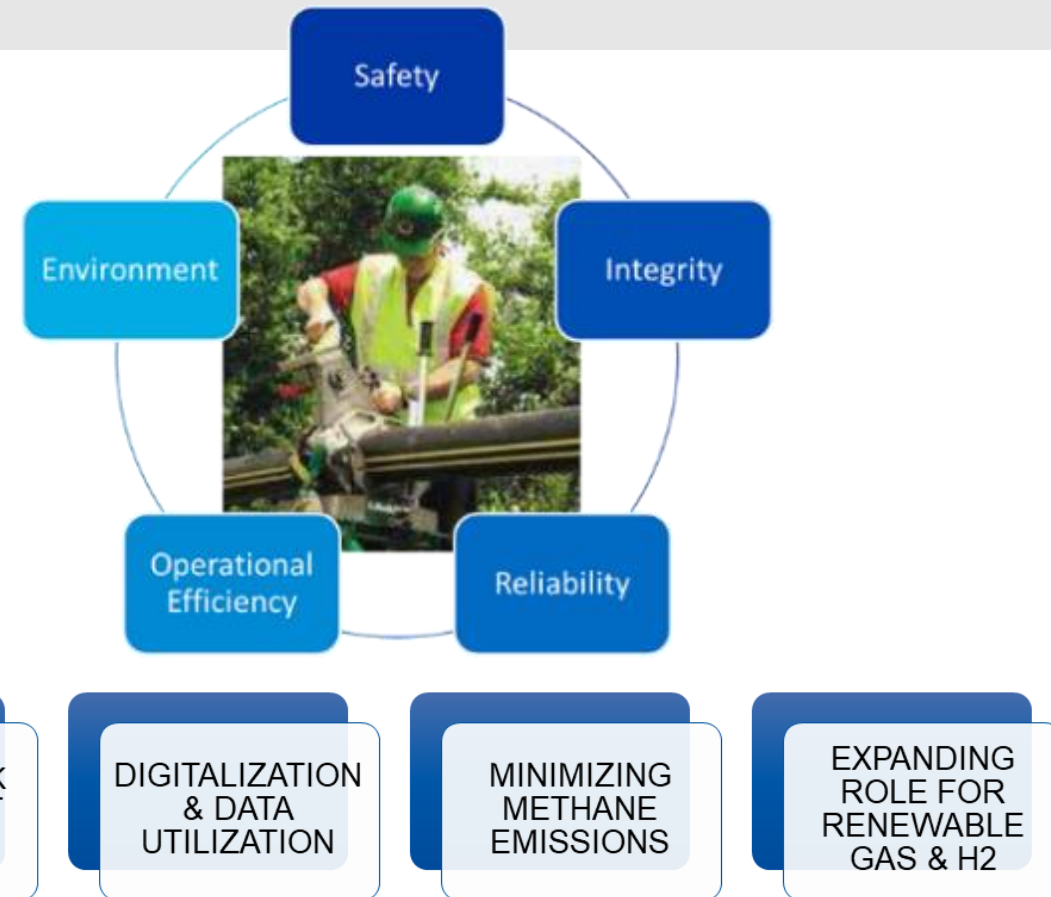
GTI Energy Delivery – Research and Technology Overview

Dennis Jarnecke | GTI - Sr. Director | djarnecke@gti.energy

WI PSC Pipeline Safety Seminar | February 7, 2024

GTI Energy - R&D Program

- GTI has an expanding R&D portfolio focused on industry priorities:
 - **Safety, Integrity, Reliability, Operational Efficiency, and the Environment**
- Collaborative R&D efforts:
 - Highly cost effective
 - Leverages collective intelligence and experience of funders to develop the best possible solutions

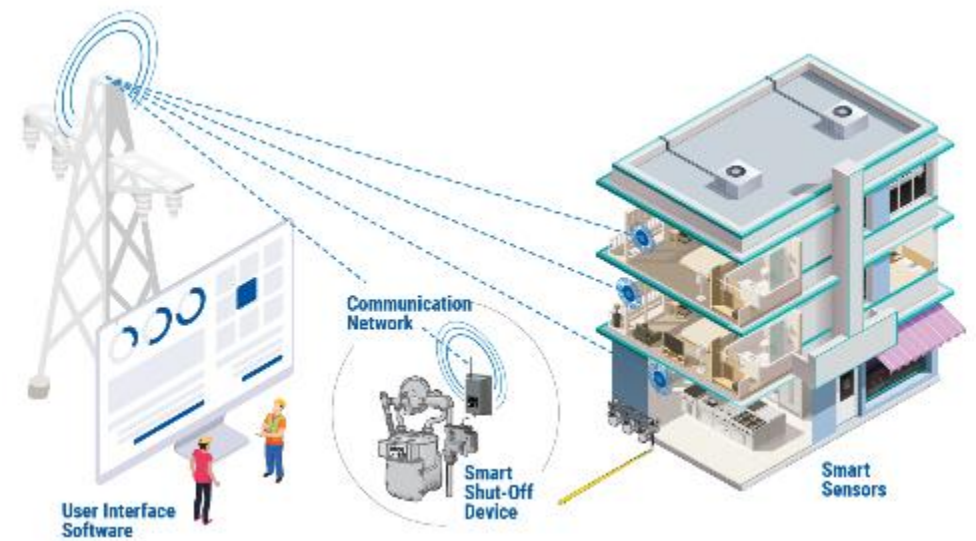
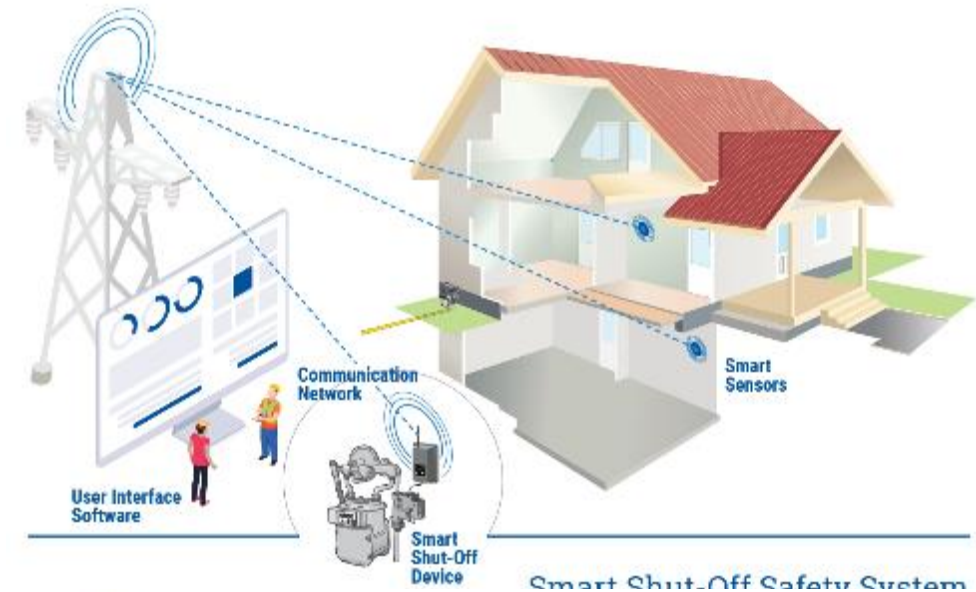


Smart Safety Shutoff System

Smart technologies and wireless communications can help reduce risks from leaks and other natural disasters

Work with stakeholders, manufacturers, and vendors to determine the best products for use for the four main components of a Natural Gas Smart Shutoff Safety System (residential and commercial building):

- 1. Smart Sensors:** methane detector (RMD), temperature (fire) sensor, water sensor, etc.
- 2. Smart Shutoff Valve:** stand-alone valve and/or integrated meter valve, etc.
- 3. Communication:** Cellular, AMI, LPWAN (LoRaWAN), e.g.
- 4. User Interface Software:** allows the gas utility to view hazards and take corrective actions, including the shutting off of the natural gas supply to the building.

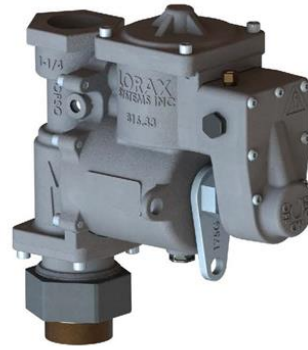


Smart Shutoff System Development & Pilots



Safety System Equipment

- Lorax Smart Valve & Honeywell Smart Meter
- New Cosmos RMD
- eLichens RMD
- Embedded Works Fire Detector
- LoRaWAN Tektelic Gateway
- Web Browser Based: ThingsBoard User Interface Software



LORAX
SYSTEMS INC.



Honeywell | Smart Energy



DeNova Detect
By New Cosmos USA, Inc.



eLICHENS



EMBEDDED WORKS
Embedded in IoT



TEKTELIC
communications



ConEdison Efforts (per Rick Trieste – R&D Manager)

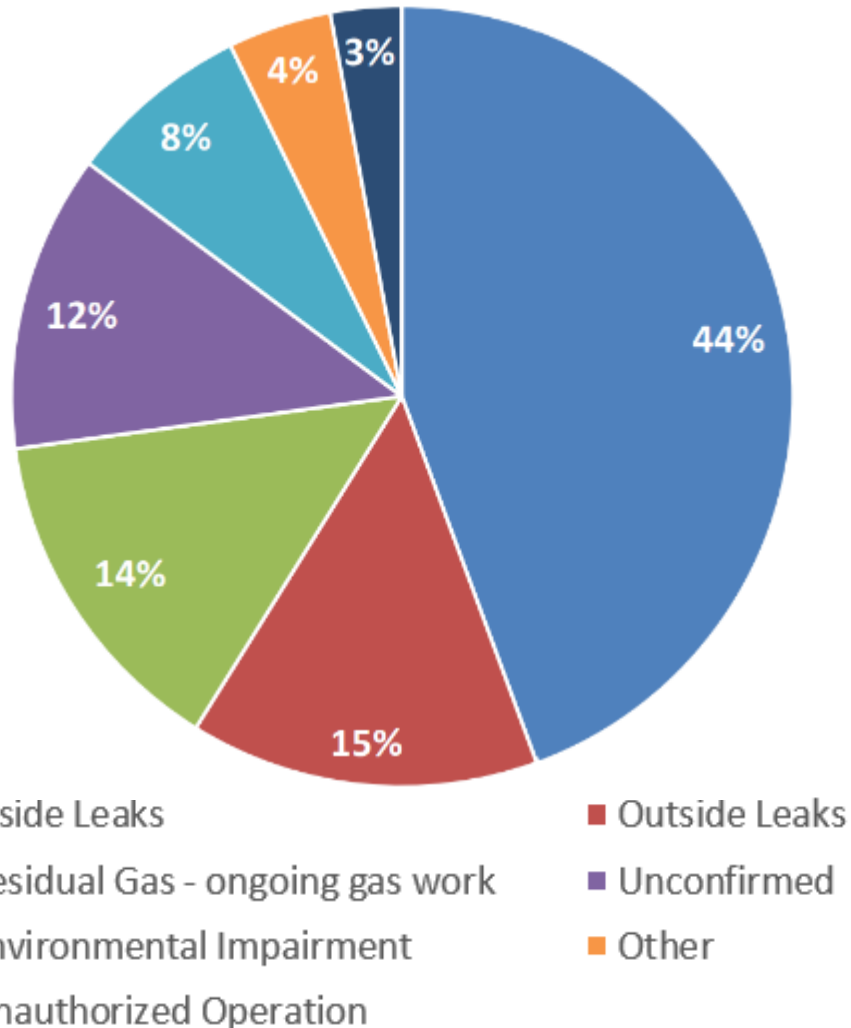


Detect > AMI Enabled Natural Gas Detectors

- Company asset 7 yrs.
- Battery powered - 5 yrs.
- 10% LEL alarm (0.5% gas-in-air) exceeding UL 1484 minimum alarm requirement!
- Developed emergency response protocols
- Created new leak type – GLA



Gas Leak Alarm Summary – Dec 2023



- First US utility to install NGDs
- NGDs report alarms to Emergency Dispatch Center
- 223,442 installed
- 3,400 Gas Leak Alarms (GLA)
- 510 Outside leaks
- 43 building fires



*Environmental Impairment alarms are due to building fires or water damage

GTI Smart Meter Product Evaluation

- Two-phase project to evaluate ultrasonic and small diaphragm residential meters.
- Testing includes:
 - Metrology
 - Accelerated lifetime
 - Battery life
 - Safety/shut-off valve
 - Communications tests
 - And more...



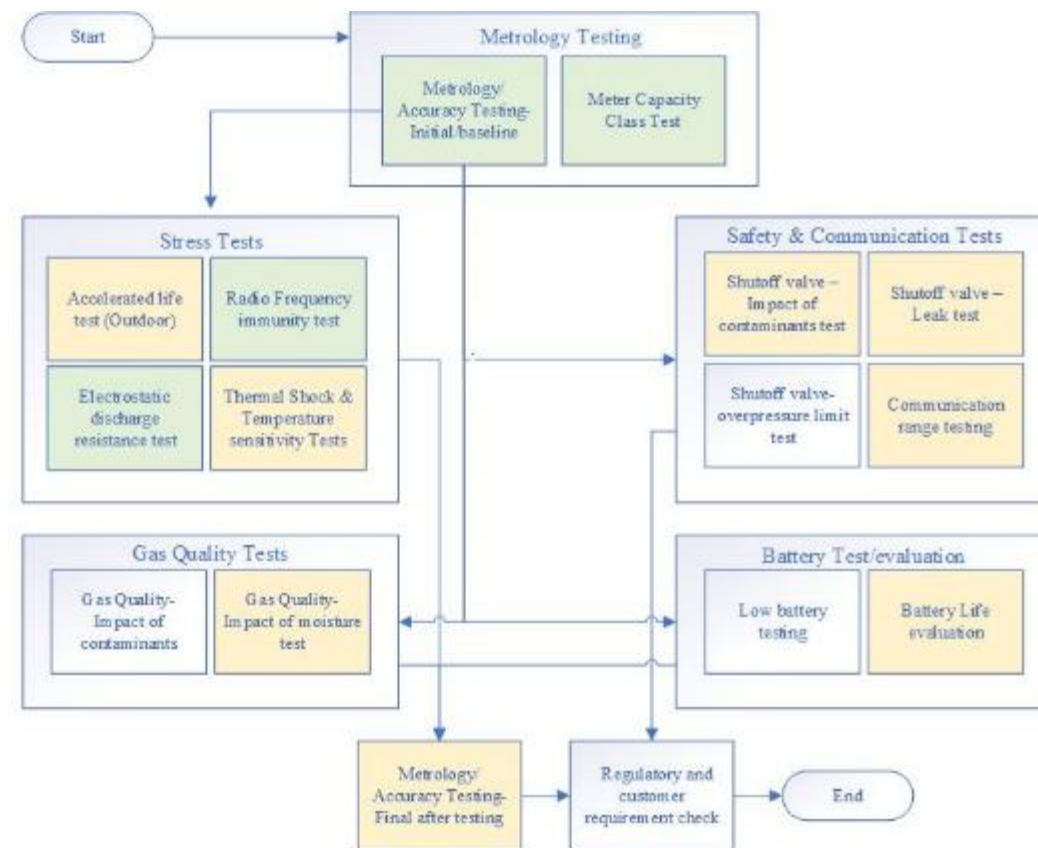
Itron Intelis (USM)



Honeywell AC 250 NXS small diaphragm meter



*Sensus Sonix IQ (USM)**

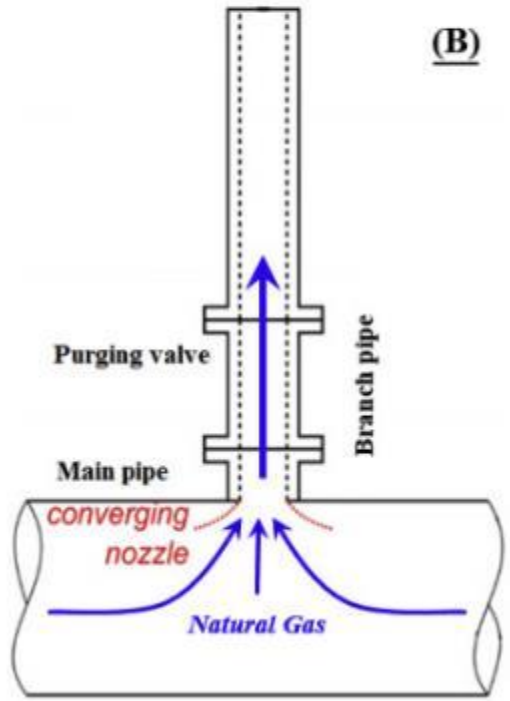


Testing in progress	Testing Complete
Meter models under evaluation: 1. Itron Intelis Ultrasonic 2. Sensus Sonix IQ Ultrasonic 3. Honeywell AC 250 NXS Diaphragm	

Reducing Emissions



(A)

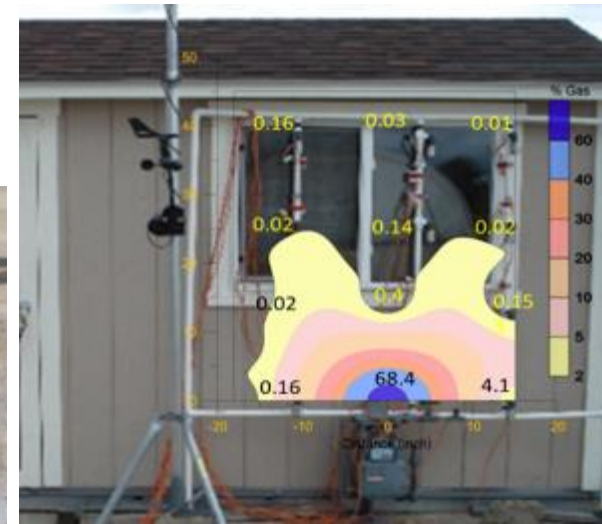


Design / Placement of Regulators – Vent limiting / Slam shut alternatives

Perform research on vent limiting regulators to determine safe clearance allows and installation practices that will provide a gas utility more options for service regulator installation.

- Review existing industry practices for vent limiting service regulators, including those in other countries.
- Perform comparative testing between vent limiting and IVR regulators.
- Provide installation recommendations on safe distance allowances to the industry.

PHMSA & OTD funded project



Gas Service Regulators Included in Testing

Traditional IRV Regulators



1813C



Itron B42R



Emerson Fisher
HSR

Vent-Limited Regulators



Honeywell
1843B2-VL



Pietro Fiorentini
FEX



Pietro Fiorentini
FE25



Cavagna S7



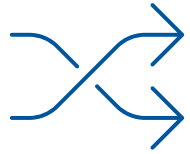
Cavagna S9

Best Purging Practices for Minimizing Methane Emissions – PHMSA Project

- **Objective:** To establish best purging practices for the elimination or avoidance of methane emissions during pipeline construction, commissioning, and maintenance.
- **Need/Value:** The natural gas industry is subjected to increasing pressure to curb carbon emissions. Best purging practices need to be identified to eliminate/reduce methane releases, but also can be reasonably achieved given utility time and resources.
- **Background:** Purging gas is hazardous to the environment, wastes natural gas resources, and produces large amounts of noise and odors in the areas nearby.
- **Deliverables:**
 - List of various methods to reduce/eliminate emissions.
 - A technology survey of existing methods.
 - Whitepaper providing guidance and recommendations.



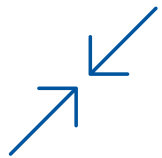
Purging Alternatives Identified



Cross Compression (ZEVAC, GoVAC, or similar)

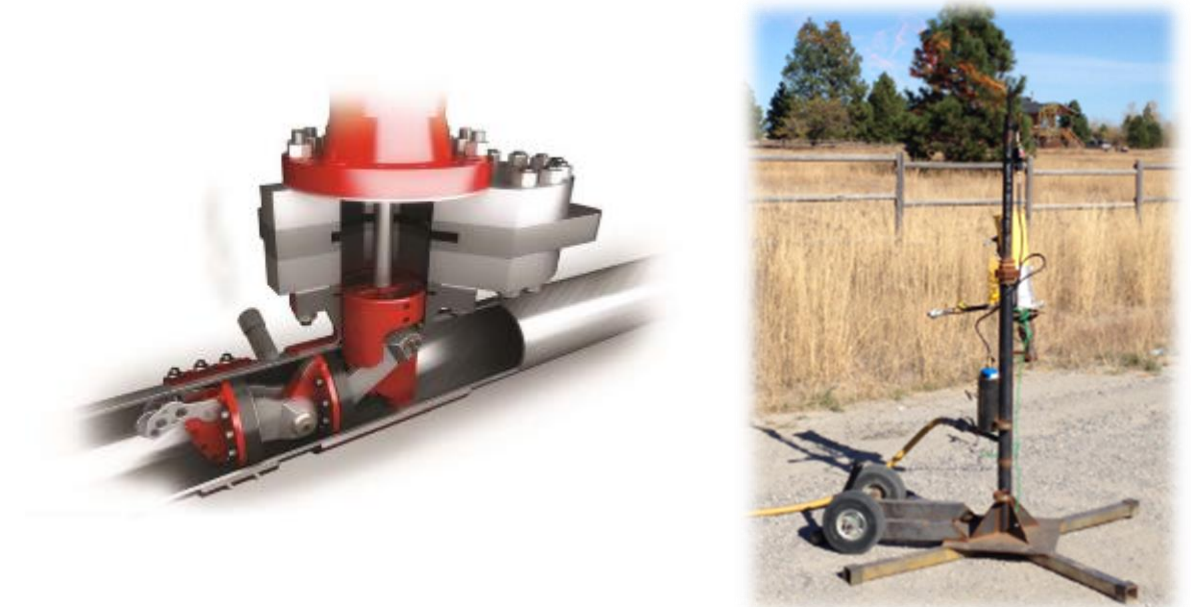


Flaring & Enclosed Combustion



Pressure Reduction Prior to Purging

Use of Stopples to Reduce Volume Purged



Purging a Pipeline Into Service (energize)



- Addressing “operational” methane emissions
- 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.

Ameren – October 2023 Field Trial



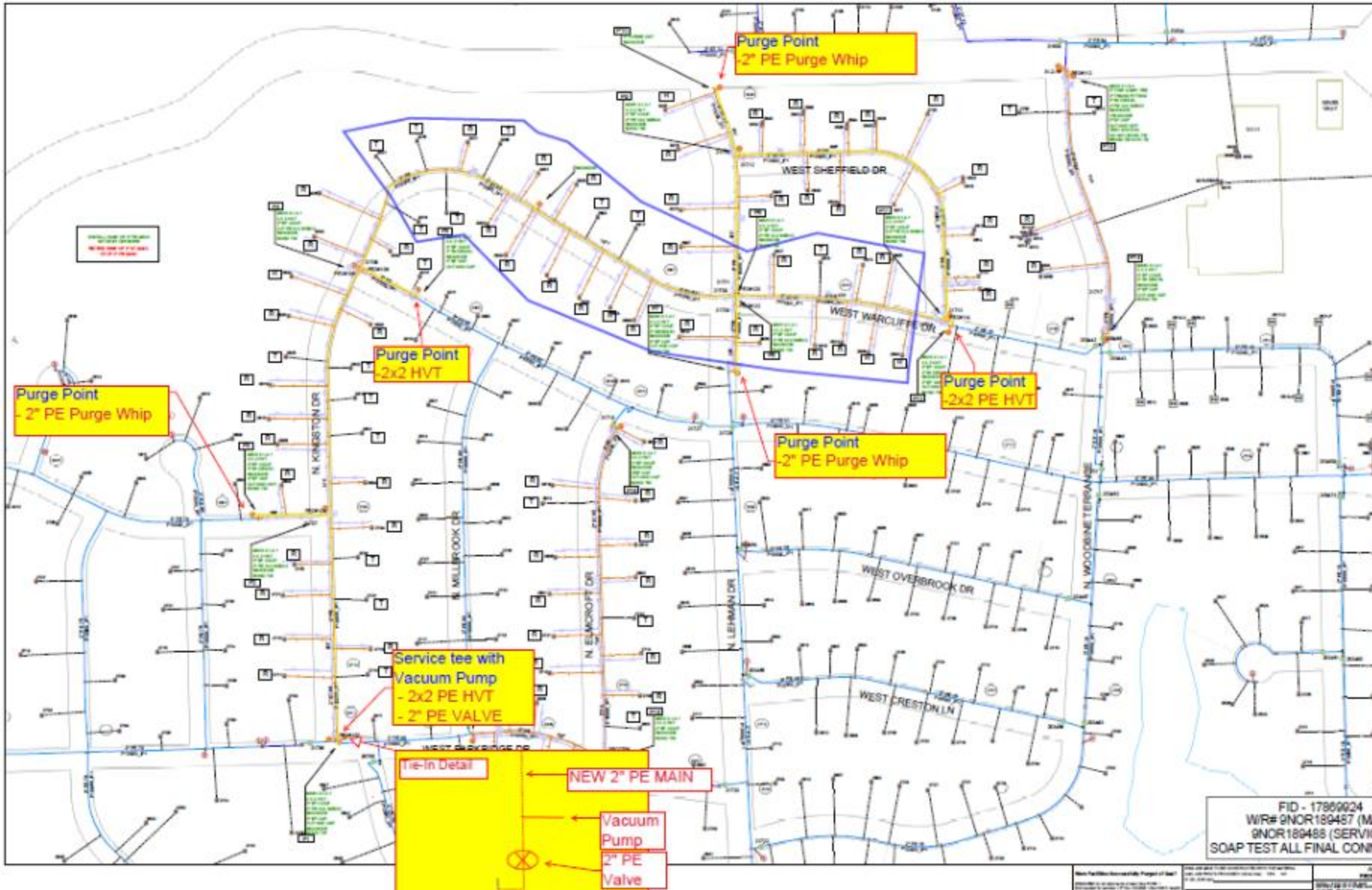
- 7900' of 4" MDPE pipe was installed and purged into service.
- It took approximately 1 hr to obtain -14.41 psig in the new pipe.
- The furthest away purge point was purged first. The purge stack was cracked and the reading was about 90% gas. 100% gas at 20-30 seconds
- The second purge point was then purged. The purge stack was cracked and the reading was 100% gas from the start.



Ameren – October 2023 Field Trial



Ameren – November 2023 Field Trial



- ~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 newly installed 2" PE was connected to the existing live pipe via a HVTT
- In addition, there were 5 additional purge points on the system as well as a section of looped pipe.

Leak Detection & Quantification



- Current project to investigate **NPRM ALDP Performance Rule: 5ppm at 5 feet Evaluation**
 - PHMSA has asserted that all leaks above a threshold (5ppm @ 5 feet) are detectable based on an instrument sensitivity of 5 ppm and that the survey is within 5 feet of the pipeline.
 - There is little to no available research on what leak levels (concentration or flow rate) are detectable with high confidence

Intent of Project:

- Establish the minimal and readily detection level based on current walking survey methods of using a pumped or laser-based leak survey.

Evaluation of Current Advanced Mobile Leak Detection Systems (Ongoing)

- Evaluate the leak detection performance of advanced mobile leak detection systems through a single/double blind study of current commercially available systems.
- Preliminary evaluation of the leak rate quantification abilities of the systems.
- Currently running detailed technology evaluations

Mid-IR Open Path



Near-IR Open Path

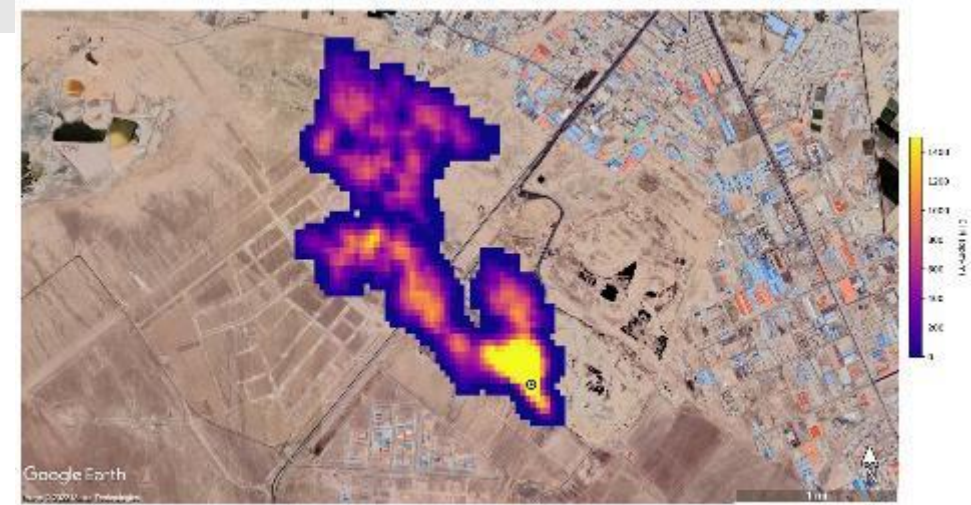


Mid-IR & Near-IR Pumped

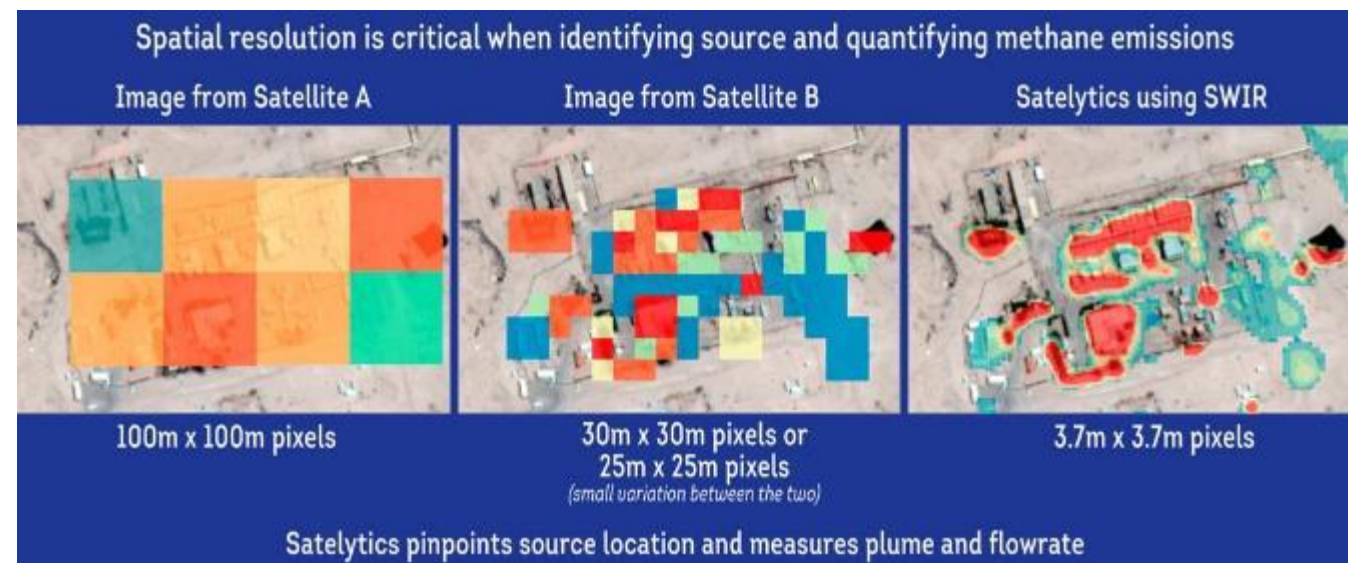


Distribution Leak Detection from Satellites (Ongoing)

- Current conventional knowledge of satellite performance says that satellite detection limits are tons per hour range
- Some satellite companies are claiming they can detect distribution relevant leaks
- Can measure over entire networks in a single day
- Many distribution companies running demos
- Understanding existing emissions prior to test is critical
- Please reach out to GTI Energy to discuss further

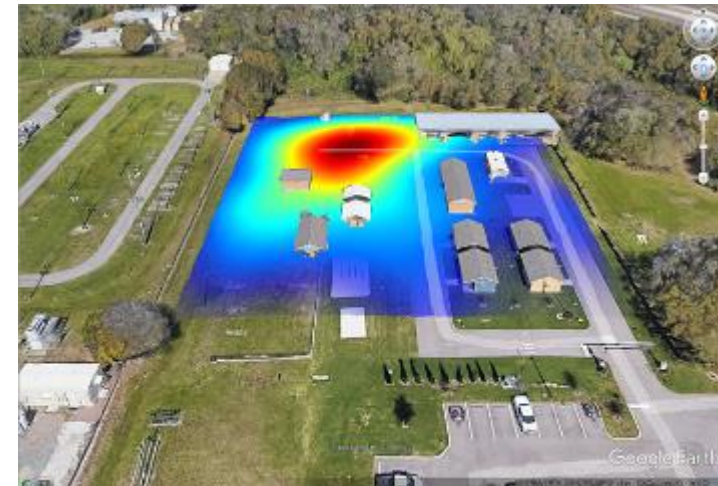


<https://www.nasa.gov/centers-and-facilities/jpl/methane-super-emitters-mapped-by-nasas-new-earth-space-mission/>



Drone Based Methane Detection for Distribution (Recent Projects)

- Fewer use cases currently for drones in distribution
- Leak detection response to natural disasters
 - Hurricanes
 - Floods
 - Landslides
- Leak detection for hard to access areas
 - Wetlands
 - Bridges
 - Water crossings
- Relatively small survey areas



Laser Methane Detectors and Optical Gas Imaging for the Distribution System

Objective

Evaluate potential use case of Optical Gas Imaging (OGI) cameras and handheld laser methane detectors to expedite identification of statistically large leaks in the distribution system.



Project

- OGI cameras are not typically used in Distribution but laser methane detectors are
- This project attempts to join the two use cases for these technologies



Remote Methane Monitoring Tools

- A network of wireless remote methane sensors allows operators to assess and monitor leaks while limiting exposure to hazardous environments.
- User display is accessed via webpage eliminating need to develop separate apps for different mobile devices
- Working with Sensit as the commercializer
- Current Phase of work is focused on commercial prototypes of the 1st Responder survey instrument.



Leaking Pipe Joint Repair

- LLFA Tape by GTG Engineering was identified as a potential solution for natural gas utility above-ground pipe leak repair.
- The objective for this project is to evaluate the LLFA tape's ability to repair active leaks on threaded pipe fittings at a working pressure of 60-psig.
- The LLFA Tape was evaluated through a series of various tests and conditions (outlined on the following slides) and was found to be an effective solution to address leaking pipe joints



Leak Tape Repair Summary

- The LLFA tape leak repair solution was found to be effective both in immediately repairing above-ground threaded pipe leaks at 60-psig and in retaining a leak-tight seal after the specimens were exposed to various rounds of environmental testing.
- The success of the leak repair is dependent on using proper technique to install the wrap onto the leaking pipe. Users of the product should be properly trained on this procedure.
- The main purpose of this project was to evaluate the LLFA tape product for its use in repairing leaks @ 60 psig up to 1.0 SCFH.
- This product was tested as a long-term above-ground leak repair product. Each gas utility will have to consider whether they consider leaks repaired with LLFA tape as “permanent” or “temporary” repairs.





3rd Party Damage and Un-locatable PE Pipe

- Unlocatable plastic pipe is a great risk for the natural gas utilities.
- Tracer wire that is broken or missing, never installed, inaccessible, and distorted signals from nearby utility lines are all causes for un-locatable PE pipe.

Some of GTI's Related Past Work

- Numerous projects related to
 - Live gas pipe entry systems
 - Locating probes
 - Camera inspection



Hathorn Gas Camera



Jameson Tracer and Direction Tool

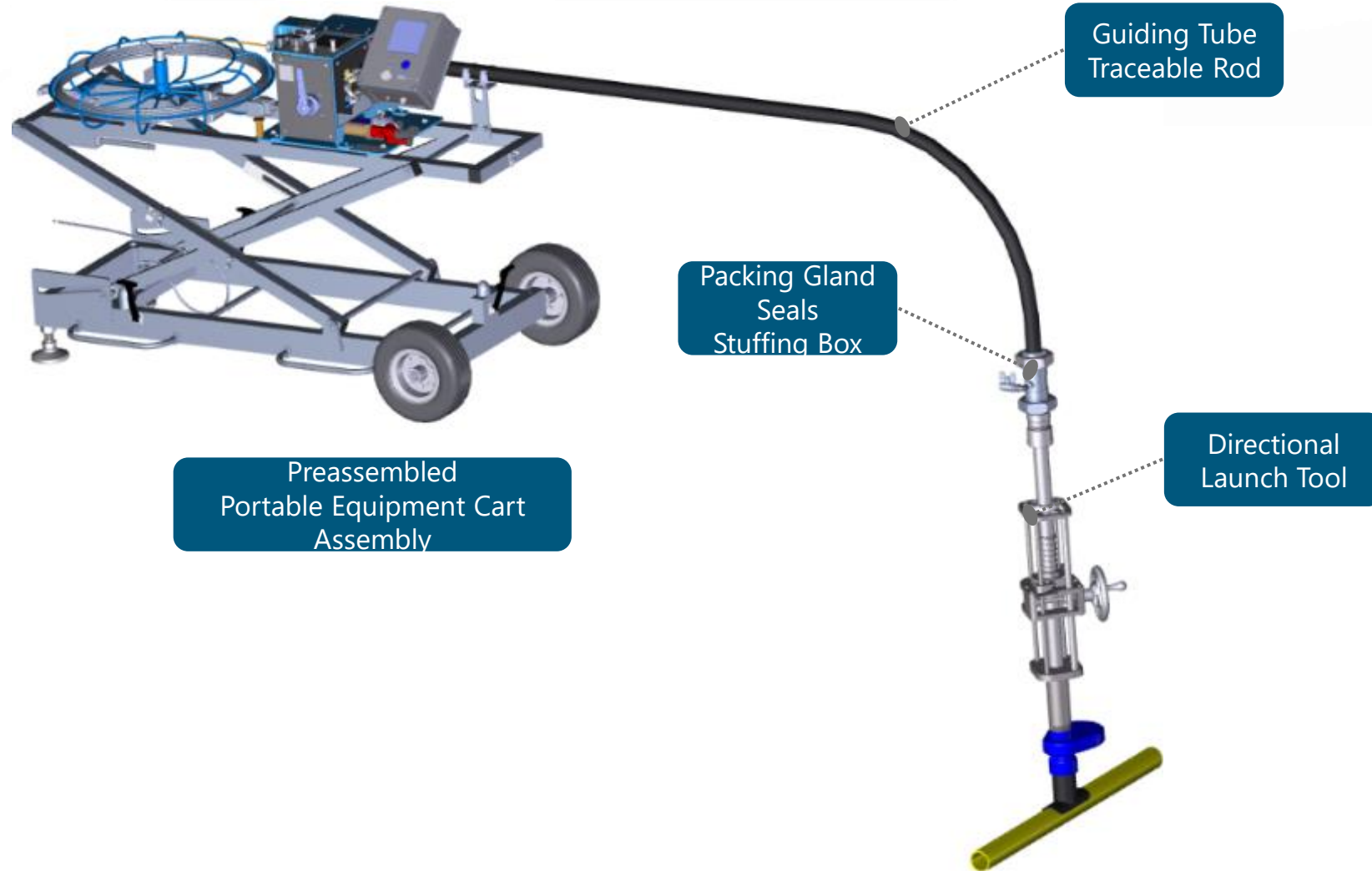
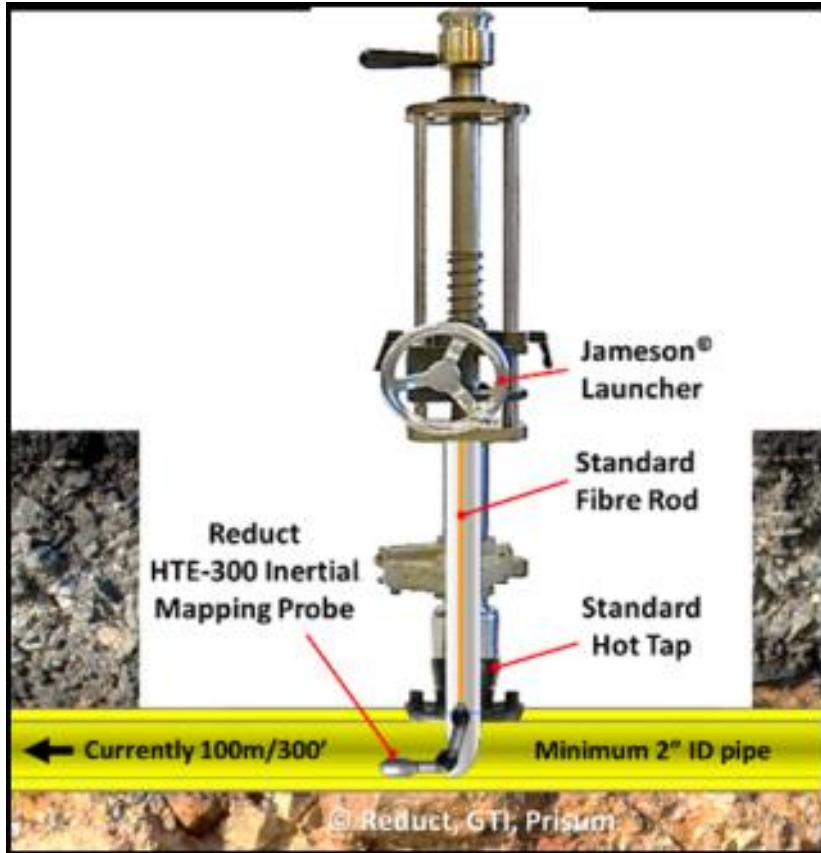
Live Gas Mapping Probe

The Live Gas Pipe Mapping Project was a success!

- The Live Gas Mapping System successfully collected accurate location data on a live gas mains at various utility locations.
- The integrated system can achieve at least 600 ft of pipeline mapping.
 - This mark was an internal team goal and a limitation of lab space to perform testing. The maximum length is still undetermined.
- Mapping campaigns on live natural gas pipes operating at pressures up to 60 psig.
- The system has been tested in 2" and 4" pipes.



Live Gas Mapping System



Intrinsically Locatable Plastic Pipe (ILPP)

LOCATABLE PLASTIC PIPE

Addresses a critical pain point for gas industry

- Significant improvement to worker & area safety
- Higher life expectancy
- Higher productivity in installation

Robust

- **Continuity not required**, if a cluster of tags is removed, the other sections continue to function uninterrupted.
- **Does not provide a path for lightning**
- Corrosion resistant, maintenance free

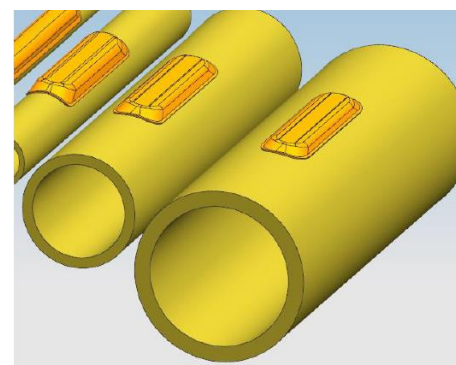
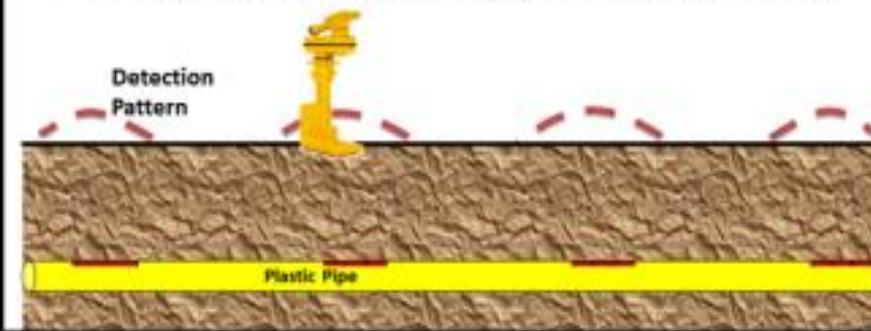
Simple

- **Replaces tracer wire, access points and connections**
- Reduced complexity of locate – **No transmitter connection** needed
- **Utility identification by frequency**

ON PIPE ATTACHMENT

An Intrinsically Locatable Plastic Pipe – System Concept

- A 53.9kHz passive, flexible, rugged & stable resonant magneto-mechanical electronic marking system for Gas plastic pipe.
- Markers attached to outside of plastic pipe at 8ft spacing, give unique detection pattern and positive identification of utility.
- Independent Marker-Locator system provides high accuracy and long life.
- Eliminates Tracer Wire (eliminates related installation, splicing and access)



Natural Gas Safety Devices

- What Can Happen to “At Risk” Meters?



Meter Breakaway – Shut off Device

Vehicle Impacts and Falling Snow and Ice

- Breakaway disconnect/shutoff can be easily installed to protect meter sets and other above ground piping.
- Reduce risk from vehicle collision, seismic events, falling ice & snow, etc.
- Commercially available

Features & Benefits

Ideal For Any High-Risk Meter Sets

- High-Traffic Areas
- High-Snow Areas
- Installation in addition to bollards or where they aren't practical

Immediately seals in the event of a hard impact

**Hajo
Valve**



HaloValve Now Commercially Available



Halo Valve

- www.HaloValve.com
- Available in ¾" and 1" diameters of various lengths and end configurations
- High and Extra-high Pressures



Let's Start the Conversation to Help Address At-Risk Meter Sets.

Contact us to start a discussion on how Halo Valve can help protect at-risk meters. We are available to:

- Discuss your specific objectives and requirements
- Supply you with product samples for evaluation and testing
- Provide detailed product performance specifications



David Jacobson
Global Product Manager
david.Jacobson@opwglobal.com
(513) 816-2769



Benefits of VR Training

- Increased **learner retention**
- Increased **on-demand** training opportunities
- **Remote and multi-user training** and qualification opportunities
- Increased **consistency** of training and qualification programs
- Increased **exposure to different scenarios** including hazard situations
- Improved **reporting capabilities** and **training effectiveness** data



Benefits of Virtual Reality Training



Consistency



Scalability



Economical

Types of VR Training Technologies



- **3D HD VR Video:** This technology allows trainees to interact with real-life scenes. Interactions, such as, annotations, assessment questions, etc. can be added into the scene for the trainee.
- **3D AR/VR Interactive Models:** This technology allows for trainees to interact with photo-realistic models of tools, equipment, etc. that may have annotations and animations.
- **Photo-Realistic VR Experiences:** This technology allows trainees to complete different training scenarios that may have thousands of randomizations to test their skills on.

Example of Pipeline Heater Overview

- 3D HD VR Video -



3D AR/VR Interactive Models

Categories

GAS FITTINGS

GAS TOOLS

FUSION JOINTS

GAS PROCEDURES

DIGITAL TWIN

VEHICLES

DEMOS



Dresser Style 90 Coupling

Nut follower-type mechanical fitting used to connect steel to steel pipe or steel to polyethylene (PE) pipe.



Dresser Style 711 Coupling

Bolted-style mechanical fitting used to connect steel to steel pipe or steel to polyethylene (PE) pipe.



Dresser Style 711 Coupling

Bolted-style mechanical fitting used to connect steel to steel pipe or steel to polyethylene (PE) pipe.



Dresser Style 502 Service Head Adapter

Compression-type mechanical fitting used as a riser adapter, a male adapter for polyethylene (PE), or a service head adapter.



Permasert 2.0

Stab-type mechanical fitting used to join polyethylene (PE) pipe and tubing.

3D AR/VR Interactive Models - Benefits

3D VR (Virtual Reality) and AR (Augmented Reality) models for training involve the use of computer-generated, three-dimensional tools, equipment, or fittings to simulate real-world objects and scenarios for training purposes.

Below are some of the benefits of using 3DVR/AR models.

- Immersive Learning
- Interactivity
- Real-World Simulation
- Accessibility
- Safety
- Cost Savings
- Data Driven
- Scalability
- Customization
- Emotional Preparedness



Photo-Realistic Computer-Generated VR



RNG and Gas Quality

Sponsoring Program



WORKSHOP

RNG

Understanding Critical Success Factors



Many Constituents to be Monitored in RNG

- **Some also found in geologic natural gas...**

- Methane
- Nitrogen
- Oxygen
- Carbon Dioxide
- Heating Value
- Wobbe Index
- Hydrogen Sulfide and other sulfurs
- Water
- Mercury

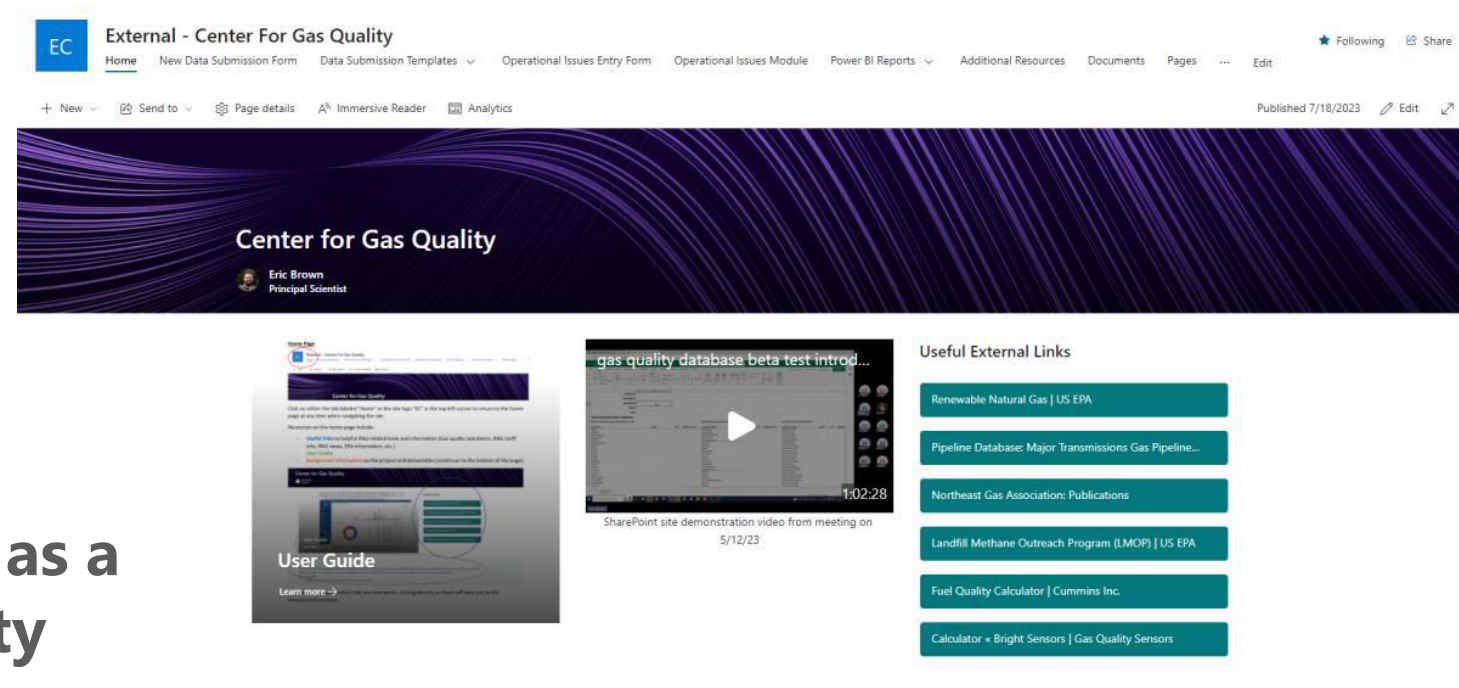
- **And some not...**

- Carbon Monoxide
- Siloxanes
- Halocarbons (Cl and F)
- Ammonia
- Biologicals (MIC)
- Other metals (Cu, As, Pb, etc.)

- **Except for state of CA (SoCal Rule 45, PG&E Rule 29) and EU (DIN EN 16723-1), limits are largely up to distributor to decide what they will accept**
 - Required methodology not always listed in tariff / regulation
 - Air Monitoring standards often cited when natgas / RNG standards not available
 - Similar in some respects (gas), but not identical (air vs hydrocarbon fuel)
 - Standards need verification in RNG for confidence in results
- **ASTM and ISO only international standard organizations with standards scoped for RNG**
 - Allows alignment of analytical procedures and data between labs

RNG Gas Quality Database

- Created the database in phase one (OTD project 7.18.h)
- Created the SharePoint site "Center for Gas Quality" in phase two
- Modules included in the SharePoint site:
 - Power BI database reports
 - Operational Issues Log
 - Field Sampling Protocols
 - Analytical information



End goal is to maintain the site as a central repository for gas quality resources and info

Hello!
 The Center for Gas Quality will take the database created in 7.18.h and continue to update it with new gas constituent data from new resources and the latest GTI data, a new guide to microbiologically induced corrosion (MIC), and other modules like the potential resources below:

Tier 1 Modules

- Identification of microbiologically influenced corrosion
- RNG tariff spreadsheet with quarterly updates



GTI ENERGY

solutions that transform

Questions / Comments

GTI Energy develops innovative solutions that transform lives, economies, and the environment



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