

NYSEARCH Methane Emissions Technology Evaluation & Test Program

WHITE PAPER/UPDATE ON BEHALF OF FUNDERS
D. D'ZURKO AND J. MALLIA

NYSEARCH



NYSEARCH Organization

- Voluntary RD & D organization, that serves over (23) LDCs in North America
- Part of Northeast Gas Association – 501c (6) non-profit association
- Members are specific to NYSEARCH organization and are not limited geographically in N. America
- Focused on gas operations technology design, development and testing to improve safety, reliability, efficiency and customer service

Funders of the Methane Emissions Technology Evaluation & Test Program*

- Central Hudson Gas & Electric
- Con Edison of NY
- National Grid – KSP
- National Grid – NMPC
- National Fuel Gas
- New York State Electric & Gas
- Orange & Rockland Utilities
- Rochester Gas & Electric
- Pacific Gas & Electric
- PECO Energy
- Public Service Electric & Gas
- Southern California Gas Company
- SouthWest Gas
- Xcel Energy
- Union Gas

* PHMSA/DOT cofunding fourth and active phase addressing Emissions Quantification Validation Process

Drivers for Collaborative Program

- Increased attention to greenhouse gas emissions that may come from or near natural gas industry's infrastructure
- Safety-driven approach for prioritization of 'non-hazardous' leaks
- Interest in best methods for measuring flow rates of non-hazardous leaks
 - Particularly interested in capability of technologies to measure emissions flow rates
 - Ultimately understand impact of emissions & prioritization for repair of non-hazardous leaks
- Many technology providers using equipment from other applications

Program Objectives

- Overall : To identify and evaluate what safe and cost-effective technology or technologies are available, that can be applied from a mobile platform to quantify methane emissions rates of known non-hazardous leaks from the gas distribution infrastructure.
- Test and Validation Program Goals
 - Complete tests of the selected technologies in a controlled environment and in the field to gather extensive data
 - Work with operators and other collaborators to identify, test and implement ways to validate performance of 3rd party technologies in the distribution company leak survey process

Three Technology Provider Selected from Competitive RFP

- Technologies Used
 - CRDS, 2 inlet/sensors (2)
 - Differential Absorption Laser (DIAL) technology
- One week for each provider; separate weeks
- Weather monitored; overall very similar in three consecutive weeks for each series of tests



Flow Rates Tested

Category	Bins for Emissions Flow Rates (SCFH)
Very low	0.2 to 0.5
Low	0.6 to 2.0
Medium	2.1 to 10.0
High	> 10.0

- Following calibration tests, random controlled emissions from 0.2 - 50 scfh
- All Technology Providers given same durations and range of flows to test. After calibration opportunity, tests were conducted blind
- Test plan allowing for quantification and/or binning of relative size emissions
- The range of emission rate test values/bins provided does NOT reflect any one company's leak population distribution

1st Round of Controlled Tests PSE&G's Training Facility in Edison, NJ



A - Cert Methane Gas



B - Mass Flow Control



C - 3D Anemometer



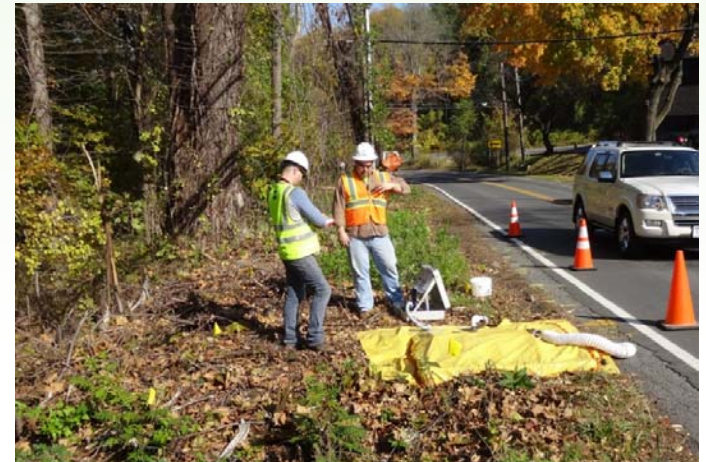
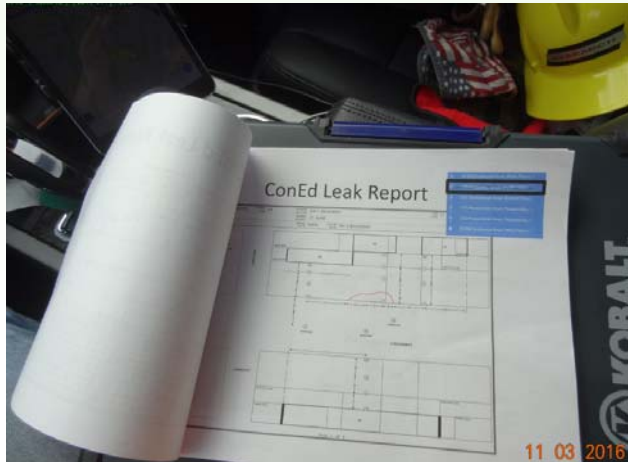
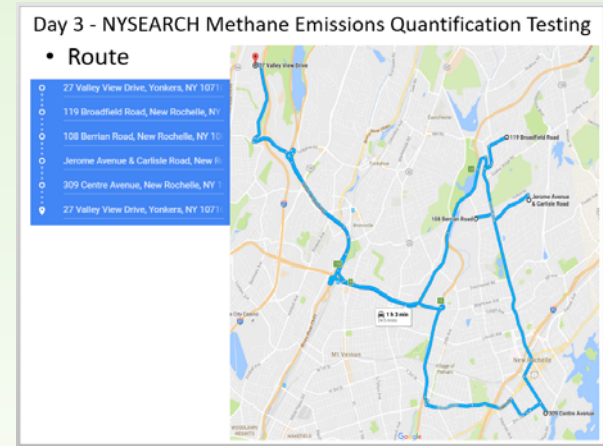
D - Windsock

2nd Round of Controlled Tests SoCal Gas' Facility, E. Los Angeles, Ca.



Field Test Planning and Setup

- Type 3 Non-Hazardous Leak Log – Con Edison of NY (CECONY)'s Westchester service territory
- Like controlled tests, test plan distributed and reviewed by TPs & program funders



Methods of Validation During Field Tests



Summary of Data Collected thru 2016

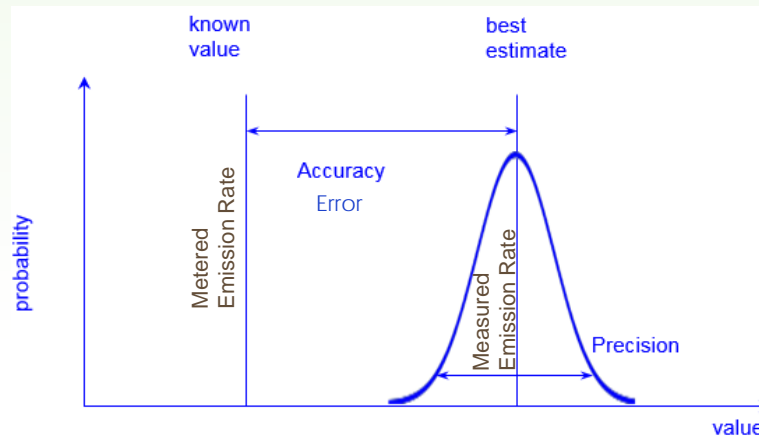
- Number of Emissions Measurements* Collected by Technology Provider & Test Series

Technology Provider (TP)	2015 Controlled Tests	2016 Controlled Tests	2016 Field Tests
Company A	36	62	19
Company B	36	50	18
Company C	36	50	18
All TPs	108	162	55

*numerous measurements were taken for each emission tested

Statistical Analysis Metrics

- **Accuracy/Error** - The difference between the best estimate and the known value is **bias**, or a lack of **accuracy** equating to **error**
- **Precision** - The variation (**standard deviation**) for all the measurements of one part is measurement of **precision (+/- 3 standard deviations)**



Results – Error & Standard Deviation

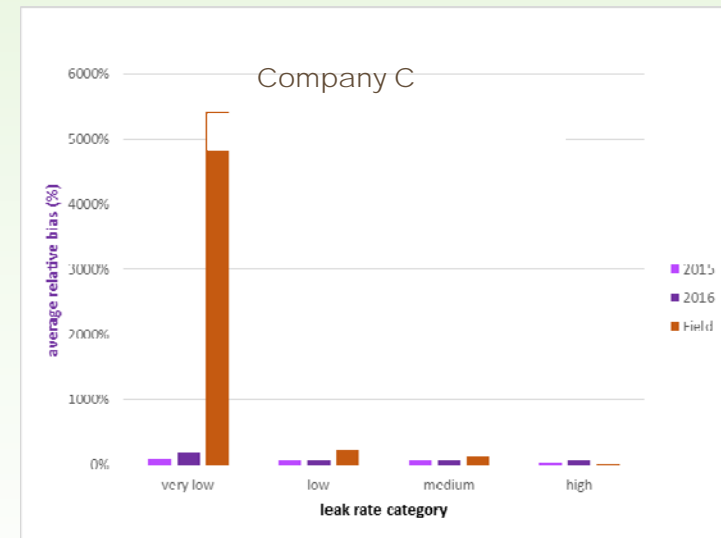
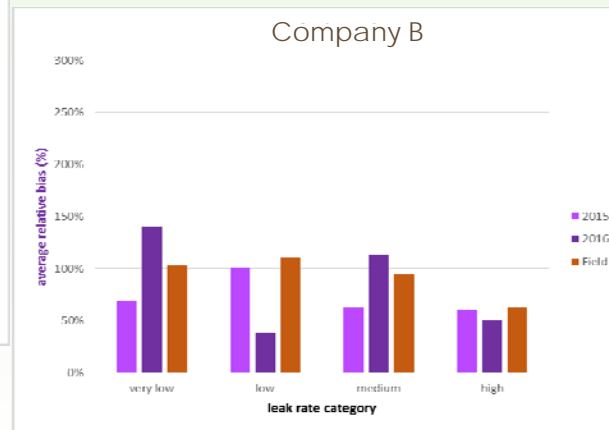
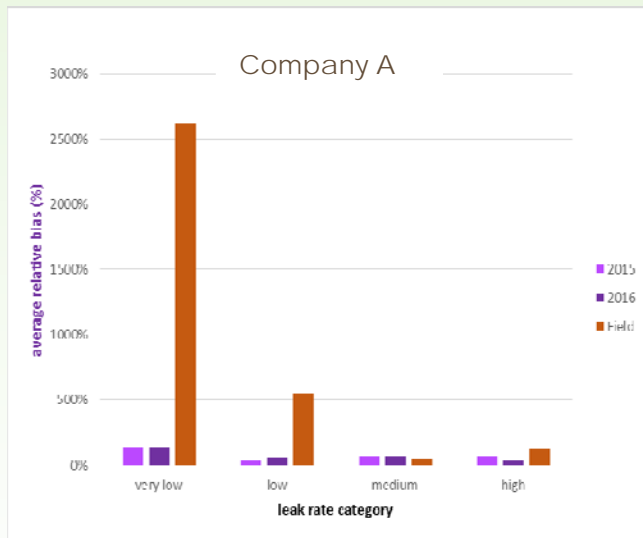
- Error – All Categories

	Units in SCFH	2015 Controlled Tests	2016 Controlled Tests	2016 Field Tests
Actual Test Parameters	Avg Actual	17.0	10.2	8.6
	Emission Range	0.2 – 50.0	0.21 – 49.2	0.01 - 100
Average Error	Company A	58%	39%	90%
	Company B	55%	51%	46%
	Company C	47%	68%	65%
All Avg Error as a % of Average Actual	All	53%	53%	67%

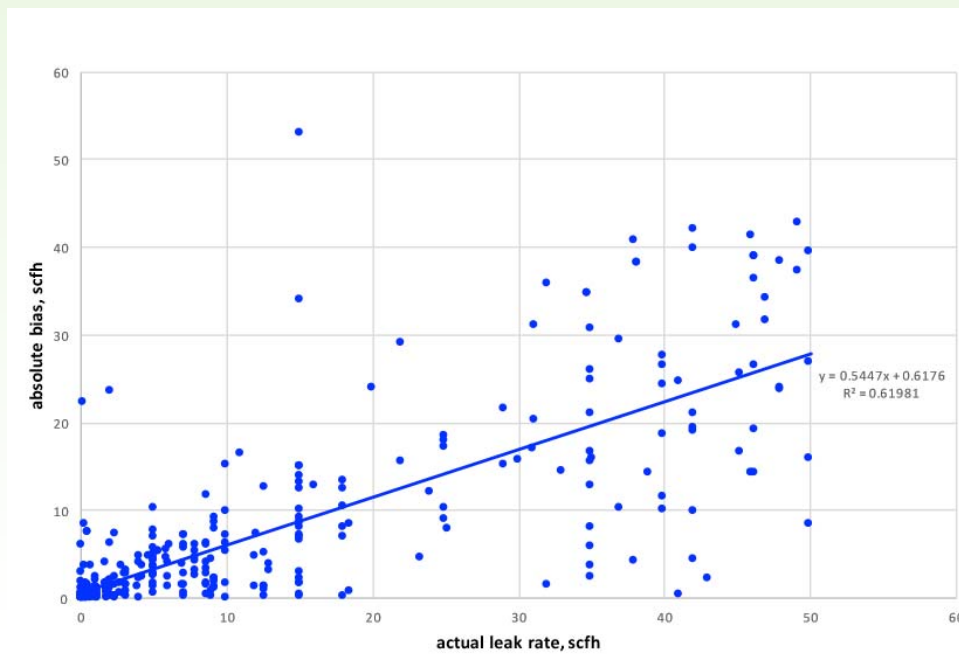
- Standard Deviation of Group of Measurements – All Categories

Technology Provider (TP)	2015 Controlled Tests (SCFH)	2016 Controlled Tests (SCFH)	2016 Field Tests (SCFH)
Company A	9.4	7.6	13.5
Company B	12.8	9.3	4.6
Company C	9.3	11.3	6.1
All TPs	10.5	9.4	8.1

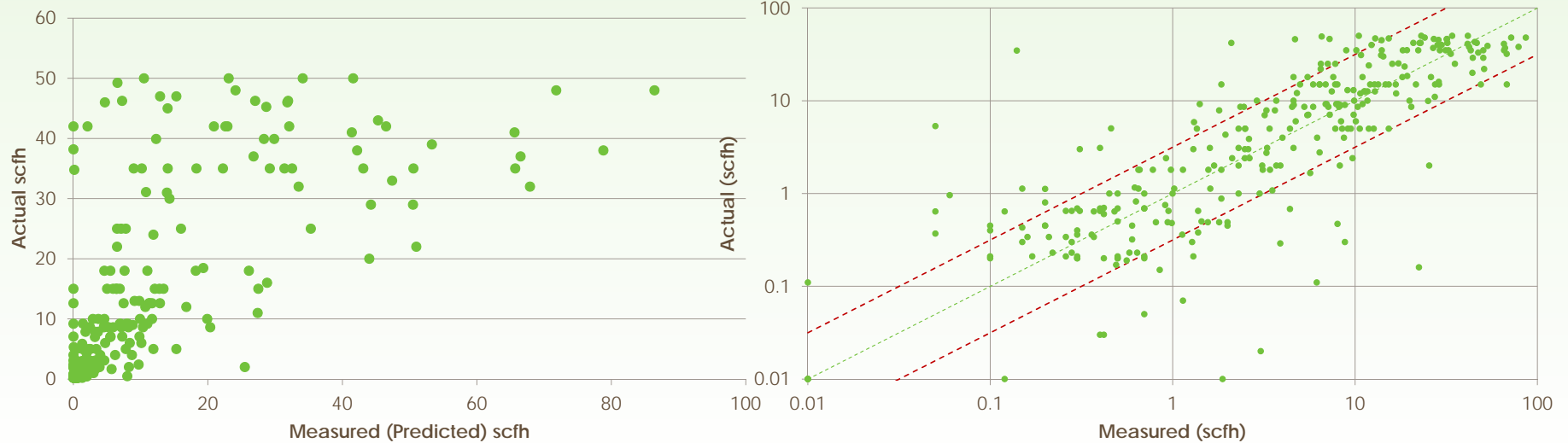
Average Relative Error – normalized by magnitude of actual flow rate



Error/Bias correlated with Actual Emission Flow Rate



Actual Flow Rates vs. Predicted Flow Rates, all tests



Log Scale

77% of Measured values within one Order of Magnitude

Process for Independent Validation of Methane Emissions Technologies

- Objective of Validation Phase of program
 - Identify, apply and test methodologies to allow an LDC gas operator to validate the accuracy of measuring and quantifying methane emissions that come from gas infrastructure from a mobile platform. Focus of application remains non-hazardous natural gas infrastructure leaks
- Decision made in late 2016 to develop validation framework modeled after API 1163 (Standard used for In Line Inspection tools used in gas industry)
- Independent expert worked with funders on similar framework
 - Formal Guideline
 - Flexible for a broad range of objectives, conditions, policies, weather patterns

Validation Process Field Tests

- Verification methods during testing
 - 1) Calibration of Technology Provider by NYSEARCH precise mass flow control gear – including new TP – Los Gatos Research
 - 2) Surface Expression measurement comparisons
 - 3) “Additive Marker Gas” by NYSEARCH precise mass flow control gear (measurements by TP and Surface Expression)



Surface Expression Measurements during Validation Field Tests

- Verification methods during testing
 - Surface Expression measurement comparisons
 - Surface Expression measurement, immediately following Tech Provider measurement



Sample Technique Used During Validation Field Tests

- Verification methods during testing
 - “Additive Marker Gas” by NYSEARCH precise mass flow control gear
 - Other references: tracer gas, atmospheric science - dynamic spiking



Status of Acceptance for Validation Process tested in 2017/ early 2018

- Validation process is a way to provide ground truth and whether the mobile methane emissions platform is measuring the same or near the same emissions coming from LDC piping
- Results from the fall '17/winter '18 tests are being reviewed
- Our NYSEARCH gas company funding group needs to come to consensus on next steps; whether Validation guideline and protocol is ready for discussion with regulators and/or standards organizations

Next Steps/Summary

- This project has produced an extensive validation dataset that can be used by scientific community
 - Model and comparison to other data
 - Investigate how flow rate is impacted by different conditions
- Our Validation Process project is ongoing and test protocols that were tested for the first time in fall 2017 need further discussion and assessment
- We believe that more work is required to implement quantification practices and new measurement techniques that reduce methane emissions from the gas infrastructure

ddzurko@northeastgas.org , jmallia@northeastgas.org

Sample Effect of Different Bucketing

	range (scfh)	trials	correct	percent correct	average absolute bias (scfh)
cat 1	0 - 1	58	48	82.8%	0.53
cat 2	1 - 10	63	41	65.1%	2.81
cat 3	> 10	41	28	68.3%	15.88
all categories		162	117	72.2%	5.30

- Results are for evenly distributed emission flow rate data that were collected in test scenarios; not reflective of any one company's leak size distribution