the Energy to Lead

Improving Methane Emissions Estimates for the Natural Gas Industry

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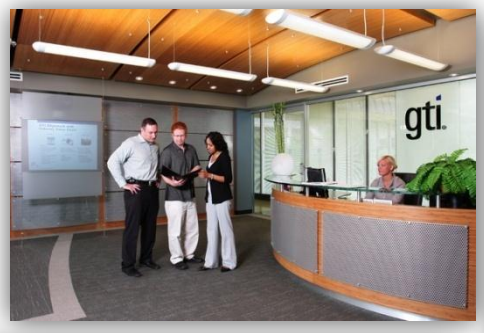
GTI at a Glance…

- Not-for-profit research, with 65+ year history
- Facilities
  - 18 acre campus
  - 200,000 ft^2, 28 labs
- $60+ million in revenue
- Staff of 250
- A growing business
- Commercial partners take our technologies to market.



Flex-Fuel Test Facility

Offices & Labs

Energy & Environmental Technology Center

Defining the Problem:
More Accurate Emissions Information

- GTI is:
  - Developing a methodology for calculating methane emissions that will provide an increased level of accuracy
  - Securing appropriate industry partners to provide the technical validation of these methodologies
  - Coordinating work with AGA, EPA, and other appropriate stakeholders
- Method is based on leak measurements made at the surface using current technology, Hi-Flow Sampler
- Emission estimates will be based on leak rates and company specific leak records

Estimating Methane Emissions

Calculated Potential= Emission factor x Activity Data

- Emission Factors = Leak rate in scf/leak-year
- Activity Data = Number of equivalent leaks leaking year round, from database of leak repairs.

Measuring Methane Emissions

Obtained from surface measurements of methane emissions (*in scf/leak-hour*).

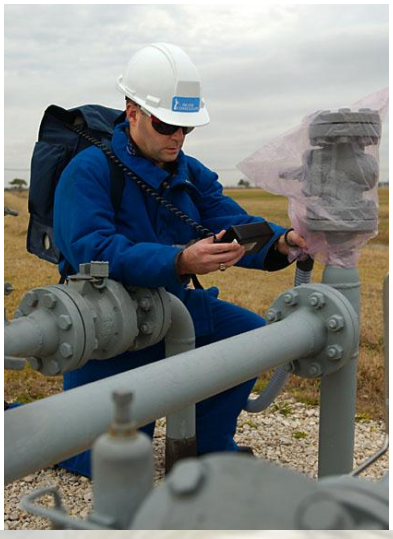
a) Use the Hi-Flow Sampler for surface measurement.

b) Correlate measurements with belowground leaks from isolated pipes (the old GRI/EPA method).

Measurement Tools

The Hi-Flow Sampler

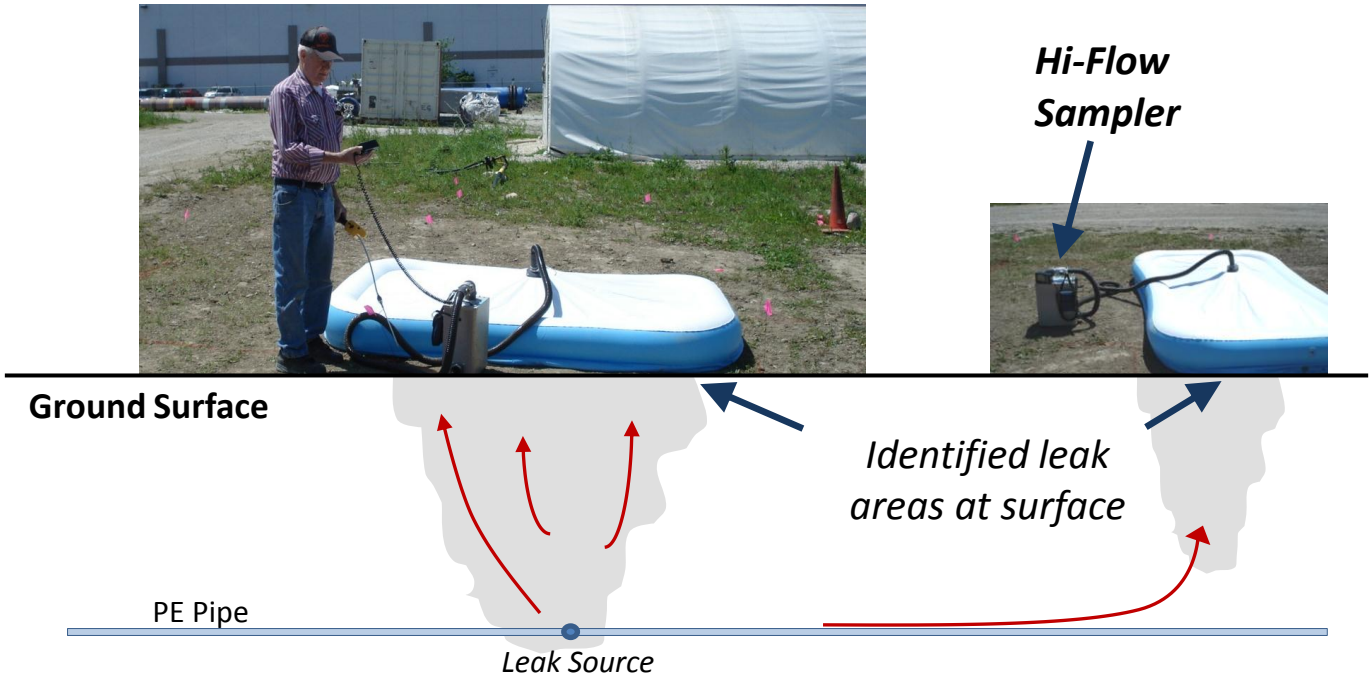
- The Hi-Flow Sampler is a portable, intrinsically safe, battery-powered instrument designed to determine the rate of gas leakage.
- Commonly used around pipe fittings, valves, and compressor in natural gas facilities.



Surface Measurement Technique

- **Surface measurements of emissions**

  (in scf/leak-hour)



Field Tests Sites

Field Tests – Utility Sites

- Field tests were performed at 4 utilities.
- About three leak sites were tested at each utility.

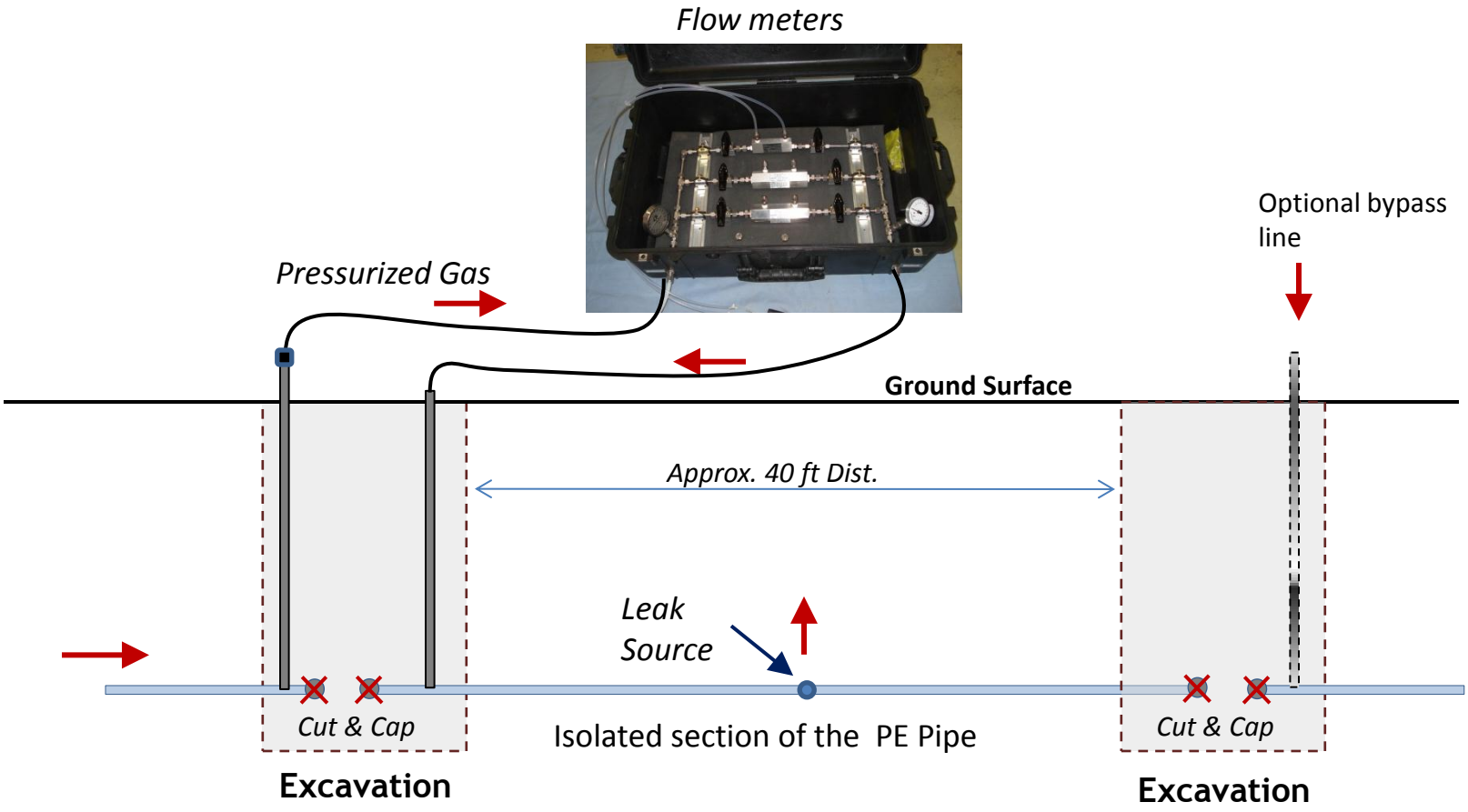
- The measurements provided a comparison between the aboveground Hi-Flow Sampler with the earlier GRI/EPA method of isolating and measuring the leak belowground.

Field Tests

Measure surface leaks

Excavate bellholes

Field Measurement Methodology



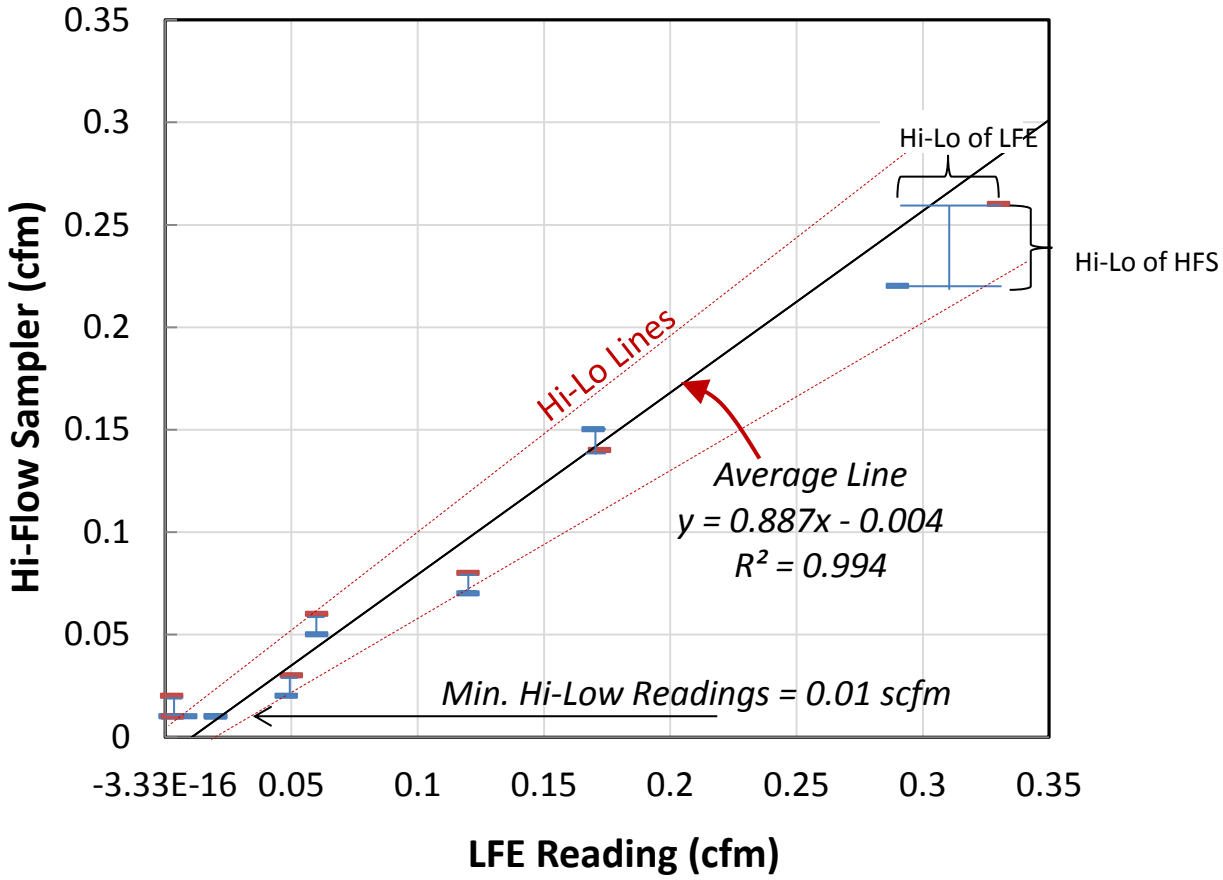
Isolating Leaks in the Field

Isolate leaking section

Leak Types

- The leaks at most of the sites were grades 2 and 3, characterized by small flow rates.
- The surface measurements using the Hi-Flow Sampler compared well for the leak rates at and above 0.01 scfm.

Results from Field Tests

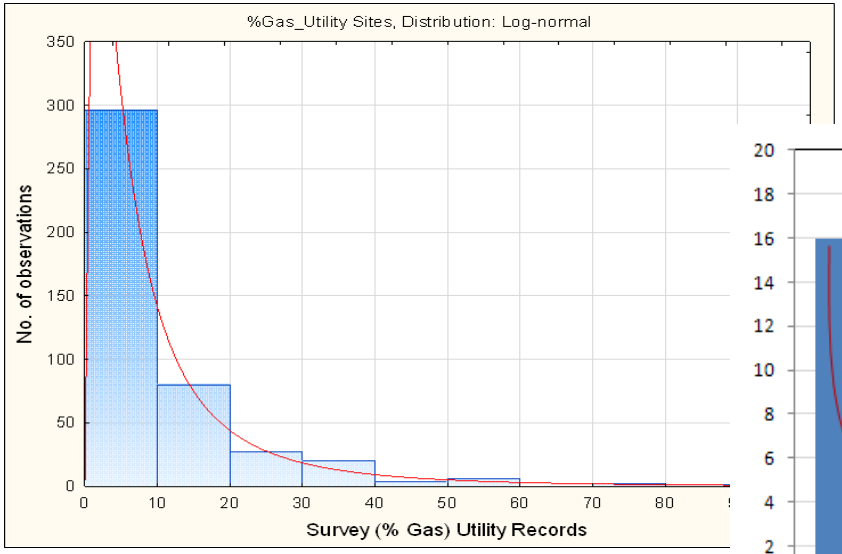


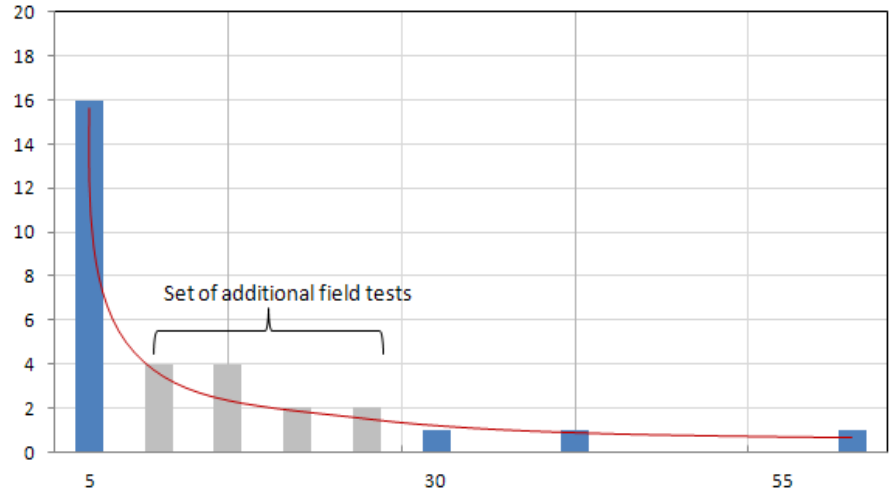
Hi-Flow and LFE measurements at Utilities and GTI sites

Results Con't

- Emission Factors (from surface reading at utilities and test sites) **= 2.36 scf/leak-hour**.
- Additional surface measurements using the Hi-Flow Device at utility sites will be performed to have a representative distribution to the utility leak records.
- The total Emission Factor can be updated with additional surface measurement test sets.

Additional Data is Needed





Mann-Whitney Non-parametrical Analysis - *(*) With additional 12 field tests*

n1	n2	U	numerator	denominator	fraction	phi (or T)	1-phi
31	438	5879	-909.5	729.2496	-1.2472	0.1062	0.8938

Activity Data: Leaks vs Miles

Advantage of using Activity Data as the '**Number of Equivalent Leaks**' rather than miles:

- Uses data from utility repair & scheduled repair records.
- Takes quality of pipes into consideration.
- Identifies the utilities with aggressive leak repair policy & the ones with high leak records.
- Reflects improvements due to rehabilitation (as in using liners in cast iron pipes).
- Allows for incorporating recent advances in leak detection methods, thus resulting in more accurate numbers of leaks.

Revised Activity Data

Two Activity Factors are proposed:

a) **National Emission Factors**

- Utilities use national updated estimates [in leak-year],

- EF can be transferred to a [per mile] basis in the emission inventory estimations.

b) **Utility-Specific Emission**

- Utilities use their specific ‘leak records’ and ‘repair records’ to reach their emission estimates.

Utility Leak Records

08/19/2011

Region	Area	Sequence	Address	Town	Report Date	Comments	Item	Material
N	8	1141782	258 [redacted] E	[redacted]	05/01/2007	2% gas leak found in pkwy 12 f	Short Serv	P.E.
S	1	1262221	603 [redacted] T	[redacted]	08/18/2010	5% leak SS SVC, 3' N DRIVEW/	Short Serv	P.E.
N	8	1114300	1[redacted]	[redacted]	11/16/2006	got 2% over t on main on long si	Long Serv	P.E.
C	2	1114350	170 [redacted] T	[redacted]	11/21/2006	4% GAS 1' EAST OF DRIVEWA	Short Serv	P.E.
N	4	1120999	5[redacted]	[redacted]	01/12/2007	15FT N OF TOPAZ 65 FT E OF	Short Serv	P.E.
N	6	1294192	60 [redacted]	[redacted]	07/16/2011	3% GAS @ TAP 1' N OF SW 17	Short Serv	P.E.
M	1	1260733	602 [redacted] E	LA[redacted] DS	08/04/2010	5% GAS 12' N OF DW 24' W OF	Short Serv	P.E.
C	2	1288729	6[redacted]	[redacted]	05/20/2011	9% 27'E OF DRIVEWAY 1'S OF	Short Serv	P.E.
C	3	1134364	64 [redacted]	[redacted]	03/26/2007	' N OF SIDEWALK 33' W OF D/\	Short Serv	P.E.
N	9	1141180	1251 [redacted] VE	E [redacted] E	06/01/2007	leak on s/s under driveway aprot	Short Serv	P.E.
C	3	1152511	92 [redacted]	[redacted]	08/08/2007	10' N OF DRIVEWAY 7' W OF C	Short Serv	P.E.
M	4	1169850	2[redacted]	[redacted]	11/21/2007	7'S OF PARK 43'W OF LINCOLI	Short Serv	P.E.
M	4	1169851	[redacted]	[redacted]	11/21/2007	2'N OF DRVWY AND 1'W OF CI	Short Serv	P.E.
M	1	1180175	6[redacted]	[redacted]	04/01/2008	found 6% gas leaking 4ft N of N	Long Serv	P.E.
C	3	1182764	131 [redacted] R	[redacted]	04/18/2008	75' S OF WINDOR 9' W OF LAN	Short Serv	P.E.
C	3	1182768	11[redacted]	[redacted]	04/18/2008	27' W OF DW 1'S IF SDW 13% :	Short Serv	P.E.
M	4	1230336	809 [redacted] D	[redacted]	09/17/2009	34' N OF DW 7' EO F ST 1% G	Short Serv	P.E.
M	2	1231234	1460[redacted] VE	[redacted]	09/23/2009	2% GAS 4' EAST OF CURB 60'	Short Serv	P.E.
N	9	1231386	601 D[redacted] NY	[redacted]	09/30/2009	LEAK @ UNION ON PRESSUR	Press Set	P.E.
N	6	1234658	4111 [redacted])R	[redacted]	09/25/2009	LEAK ON SHORT SIDE IN PAR	Short Serv	P.E.
M	3	1235303	18[redacted] :	[redacted]	11/04/2009	GETTING 0% IN THE PKWY ,	Long Serv	P.E.
C	3	1236426	3[redacted]	[redacted]	11/05/2009	NIPPLE LEAKING PRESS SET	Press Set	P.E.
N	4	1240922	7810 [redacted] LN	[redacted]	10/20/2009	28'S OF DRIVEWAY 1'E OF SIL	Short Serv	P.E.

Example of Utilities PE Leak Record

OL = **Σ** [Outstanding leak records carried out for the full year]

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Quantifying Activity Data

Utility-Specific Equivalent Leak = OL + LI + UDL - RL

(in Leak-year)

OL = Σ [Outstanding leak records carried out for the full year]

LI = Σ [New leak indications x (End of Year - Report Date)/365]

UDL = Σ [Undetected leaks which cannot be found using industry standard survey procedures]
(estimated 15% of LI, in full year)

RL = Σ [No. of Repaired leaks x (Repair date - Report Date)/365]

Activity Data: National vs Utility Specific

National Activity Factor

- General & simple
- Provides a conservative estimate
- Similar approach to the GRI study
- Used as emission inventory.

Utility-Specific Activity Factors

- Specific to the utility inventory
- Utilizes actual leak & repair records,
- Uses actual leak durations
- Flexible (easy to adjust when utilities change their inventory or pipe type)
- AF's are the responsibility of the utility to provide
- Identifies utilities aggressive repairs,
- Easy to update with changes in utility leak detection practices.

Next Steps

- Complete additional leak rate measurements to complete data set
- Project should be completed in the next few months
- Phase 3 is underway
  - Will focus on updating emission factors for cast iron and unprotected steel

Questions

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