DM&S - PIPELINE EF'S: LARGE LEAK DT METHOD; RISK-BASED LEAK SURVEY & UNKNOWN LEAKS

2021 Winter Workshop (R. 15-001-08)—Jan 21, 2021
Decision Tree to Detect Large Leaks & Mitigation Strategy

1. COLLECT FIELD DATA
   Leverage data collected during routine leak survey
2. DATA ANALYTICS
   Algorithms identify leaks with highest probability to be “large” (10 CFH+)
3. MEASURE SUBSET OF LEAKS
   Measure ~20% of DM&S leaks detected
4. PRIORITIZE LARGE LEAKS FOR REPAIR
   ~2% of DM&S leaks are “large”

BENEFITS
1. Directly Measure only ~20% of leaks
2. Minimize cost of implementation
3. Maximize Accuracy of Buried Leak Emission Estimate
Decision Tree (DT) Variables

» Data is collected at the time leaks are detected and graded

» Ground-level methane concentration measurements are recorded for each type of surface with elevated methane concentrations

» Separate threshold values are used for each surface type

» Leak Flow Rate is later measured if leak meets DT thresholds for any of the 4 defined surface types
Leak Flow Rate Measurement

- System operation validated using controlled releases prior to daily use
- Standardized Measurement Procedure
- Identify leak area size/boundaries
- Plan grid layout (when needed)
- Perform Surface-Expression/Tarping Flow Measurement process
- Calculate leak flow rate
New 2020 Data Added to DT Study

- Data added for 92 leaks raising total from 291 to 383 samples

- 2019/2020 Data Shown side-by-side for:
  - System-Wide Random Sample - “AllDisPilot”
  - 3-District Pilot Study samples - “3DisPilot”

- New 2020 data sets are very similar to the 2019 data sets
Distribution Plots for All-District and 3-District Pilot (2019 & 2020 combined)

Cumulative Fraction of Leak Rates
2019/2020 AllDis vs. LogNormal Fit

2019/2020 AllDis: 137 Samples
LogNormal Fit ($\mu=2.570, \sigma=23.572$)

Cumulative Fraction of Leak Rates
2019/2020 3Dis vs. LogNormal Fit

2019/2020 3Dis: 89 Samples
LogNormal Fit ($\mu=7.784, \sigma=58.850$)
Bayesian Probabilistic Decision Tree Analysis

» Phase 1 (2019) and Phase 2 (2020) Probabilistic DT model output results for Negatives (True/False, i.e. Not a Large Leak)

- **False Negatives (FN): 1.1% (2019) 0.9% (2020)**
  - This is the probability that a leak > 10 SCFH will not meet the DT criteria
  - These are the leaks > 10 SCFH that are missed
  - This is an outstanding result, acceptable by the most-stringent standards

- **True Negatives (TN): 98.9% (2019) 99.1% (2020)**
  - This is the probability that a leak <10 SCFH will not meet the DT criteria
  - These are the leaks <10 SCFH that are not measured.
  - 99% confidence these leaks are not large leaks!

Note: These add to 100%. Represents ~80% of system leaks

» Probabilistic DT model output results for Positives (True/False) (i.e. May be a Large Leak)

- **False Positives (FP): 89.7% (2019) 86.6% (2020)**
  - This is the probability that a leak < 10 SCFH will meet the DT criteria
  - These are the Grade 2&3 leaks that are measured and found to be < 10 SCFH

- **True Positives (TP): 10.3% (2019) 13.4% (2020)**
  - This is the probability that a leak > 10 SCFH will meet the DT criteria
  - These are the Grade 2&3 leaks that are measured and found to be ≥10 SCFH
  - Estimate 2% of Grade 2 & 3 leaks are ≥10 SCFH

Note: These add to 100%. Represents ~20% of system leaks
**Company-Specific Distribution Leaker Emission Factors**

- Emission Factors (EFs) derived using a combination of the appropriate bootstrap population leak rate means and the Bayesian Decision Tree error table percentiles (95% confidence)
- Result of robust methodology, data analysis, and quality data
- EFs are refined over time as more data is collected and layered on
- Methodology provides for detection of changes in system leak rates

<table>
<thead>
<tr>
<th>Situation Number</th>
<th>Field Situation Description</th>
<th>Phase 1 EFs (2019)</th>
<th>Phase 1+2 EFs (2020)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Measured methane concentration(s) triggers DT &lt; 10 SCFH category &amp; leak rate not measured (typical situation) - Use when DT is Not Triggered</td>
<td>2.27 SCFH</td>
<td>1.96 SCFH</td>
</tr>
<tr>
<td>2</td>
<td>Measured methane concentration(s) trigger DT ≥ 10 category &amp; leak flow rate not measured (used for all Hazardous leaks and when flow rate is not measured) - Use when DT is Triggered</td>
<td>7.37 SCFH</td>
<td>7.74 SCFH</td>
</tr>
<tr>
<td>3</td>
<td>No methane concentration(s) or leak rate measurement (used during implementation period and when data issues arise) - Use when DT data is not available</td>
<td>4.30 SCFH</td>
<td>4.21 SCFH</td>
</tr>
<tr>
<td>4</td>
<td>Measured methane concentration(s) trigger DT &gt;10 category &amp; measured leak flow rate is &lt;10 SCFH - Use the actual leak flow rate for each leak measured</td>
<td>Use actual leak flow rate measurement</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Measured methane concentration(s) trigger DT &gt;10 category &amp; measured leak flow rate is ≥ 10 SCFH - Use the actual leak flow rate for each leak measured</td>
<td>Use actual leak flow rate measurement</td>
<td></td>
</tr>
</tbody>
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Company-Specific Emission Factor Research

» **Objective:** Develop Company-Specific emission factors for buried Mains and Services

» **Milestones Reached:**
  - Develop Company-Specific DM&S EFs
    - Statistical Random Sample Across Service Territory – Completed
    - Develop Large Leak Decision Tree Model – Completed
    - 2nd Statistical Random Sample Across Service Territory - Complete
  - OTD (7.17.d) - framework for Company-Specific EFs is in progress, scheduled for completion Q1 2021
  - Completed statistical and probabilistic analysis of project data
    - Validation of random direct measurement of system leaks

» **Next Steps:**
  - Complete Large Leak DT Implementation (SoCalGas)
  - Continue to refine EFs with new data
  - OTD - finalize and publish Company-Specific EF development framework and methodology
Accelerated Leak Survey based on Emissions Risk

**OBJECTIVE**
- Reduce duration of leaks and number of unknown leaks at lowest cost

**SOLUTION**
- Change leak survey interval of vintage pipe materials to annual due to higher leak rates
- Detect, Prioritize and Repair Large Leaks

**RESULTS**
- Reduced inventory of Unknown leaks
- Reduced leak duration & emissions from Known and Unknown Leaks
- Provides for More Accurate Emissions Estimates

### INCREASED ANNUAL LEAK SURVEY

<table>
<thead>
<tr>
<th></th>
<th>Annual</th>
<th>Multi-Year</th>
<th>Unsurveyed</th>
</tr>
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<tbody>
<tr>
<td><strong>BEFORE CHANGE</strong></td>
<td>52%</td>
<td>14%</td>
<td>34%</td>
</tr>
<tr>
<td><strong>AFTER CHANGE</strong></td>
<td>32%</td>
<td>8%</td>
<td>60%</td>
</tr>
</tbody>
</table>

### INCREASED % OF LEAKS DETECTED

<table>
<thead>
<tr>
<th></th>
<th>Detected Leaks</th>
<th>Estimated Unknown*</th>
</tr>
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<tbody>
<tr>
<td><strong>BEFORE CHANGE</strong></td>
<td>46%</td>
<td>54%</td>
</tr>
<tr>
<td><strong>AFTER CHANGE</strong></td>
<td>8%</td>
<td>92%</td>
</tr>
</tbody>
</table>

* Number of leaks are estimated in areas not surveyed in the report year
Leak Survey Maps

» Provides breakdown of survey volume for given areas by material category

» Used to group survey activities into geographic areas for work scheduling

» Provides geographic area units for tracking regulatory compliance
Risk-Based Factors Drive Leak Survey Cycle Assignments

» Pipeline Material factor
  ▪ Driven by PHMSA and CPUC Safety Regulations
    • General minimum survey intervals
  ▪ Pipeline Integrity Risk Management factor
    • Driver for Vintage Plastic Annual Survey
  ▪ SB-1371 Environmental Risk Management factor
    • Driver for Unprotected Steel Annual Survey
    • Vintage Protected Steel Annual Survey

» Population Density factor
  ▪ Driven by PHMSA and CPUC Safety regulations
    • Aka “Business Districts”
  ▪ Pipeline Integrity Risk Management factor
Comparison of Leaks to Pipe Materials Ratios

» Unprotected Steel pipelines represent 17% of the inventory, but accounts for 57% of all pipeline leaks

» Vintage Plastic pipelines represent 20% of the inventory, but accounts for 32% of all pipeline leaks

» Modern pipeline materials represent 63% of the pipeline inventory, but contribute only 10% of all pipeline leaks
Questions?

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