Leak Detection Research
Overview of Current Projects

Government & Industry Pipeline R&D Forum
Working Group No. 2 – Leak Detection/Mitigation

Mark Stephens
m.stephens@cfertech.com
C-FER Technologies
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Overview

• C-FER research focus
  – External leak detection (ELD) systems
  – Detection of small releases

• Major projects
  – Experimental performance evaluation - liquids
    • In-ground leak detection project
    • Airborne leak detection project
    • On-water leak detection project
  – Framework for performance evaluation – gas & liquids
    • PHMSA Project DTPH5615T00004
In-ground Leak Detection

• **Objective**
  – Experimentally evaluate performance of a range of commercial ELD technologies for continuous in-ground monitoring of buried hydrocarbon liquid pipelines

• **Focus**
  – Distributed sensing systems intended for burial on/near pipe
    • Acoustic, temperature or displacement sensing (fiber optic cables)
    • Hydrocarbon liquid sensing (electrical cables)
    • Hydrocarbon vapour sensing (permeable tubes)

• **Participation**
  – JIP on-going (Enbridge Pipelines, TransCanada Pipelines, Kinder Morgan Canada)
Experimental Design Considerations

• Simulate leaks under real world operating conditions
  – Realistic soil conditions and sensor placement configurations
  – Realistic temperature differentials between oil and soil
  – Realistic release events (pressures, hole sizes and orientations)

• Facilitate unbiased evaluation of ELD technologies
  – Matching conditions for competing technologies
  – Provisions to ensure ‘blind testing’ from vendor perspective

• Ensure safe handling and disposal of hydrocarbons
  – Apparatus to accommodate full range of LVP hydrocarbon liquids
  – Near-term focus on diluted bitumen (dilbit)
External Leak Detection Experimental Research (ELDER) Apparatus

- Retractable Enclosure
- Soil Containment Tank
- High Pressure Product Discharge Vessel
- Pump Skid with Acoustic Enclosure and Base Isolation System
- Catalytic Oxidizer
- Product Filter and Circulation Piping, Discharge Piping, Vessel Pressurization Systems, Control Valves, Pressure Regulators and Flow Meter Not Shown
- Test Pipe with Release Ports
- Spill Containment Berm
- Product Storage Vessel
In-ground Leak Detection

• JIP Status
  – Phase 1 (completed): evaluate and compare system performance (i.e. probability of detection and time to detect) as a function of release parameters and sensor cable position in a single representative soil environment
  – Phase 2 (ongoing): further explore system performance (including systematic evaluation of detection floor) for selected technologies in two distinct soil environments
  – Phase 3: TBD based on level of interest and support

• Other opportunities
  – ELDER apparatus available for work outside JIP
Airborne Leak Detection

• Objective
  – Evaluate performance capabilities of selected commercial ELD technologies for periodic above-ground monitoring of buried hydrocarbon liquid pipelines

• Focus
  – Development of analytical models for key phenomena
    • Hydrocarbon liquid migration through soil
    • Hydrocarbon vapour (VOC) migration through soil
    • Hydrocarbon vapour (VOC) dispersion in atmosphere
  – Evaluation of point sensing systems intended for airborne deployment
    • Atmospheric VOC sensing (light absorption sensing or flame ionization detection)
    • Ground temperature sensing (thermal imaging)

• Participation
  – JIP on-going (Enbridge Pipelines, TransCanada Pipelines, Kinder Morgan Canada)
Release Modeling

- Magnitudes of temperature change and vapour flux at surface
- Dominant species of gases generated by subsurface leaks
- Vapour concentrations above ground surface
Field Trials –
Example VOC Detection Systems

Open Path Lasers
Plume visualization
Point sensors

Variable weather conditions...
Airborne Leak Detection

- JIP Status
  - Phase 1 (completed): develop and exercise models for subsurface liquid & vapour migration, atmospheric vapour dispersion and ground temperature changes resulting from subsurface releases
  - Phase 2 (ongoing): evaluate detection capability of selected atmospheric vapour sensing and ground temperature monitoring systems through field trials involving controlled gas releases from surface and selective ground heating
  - Phase 3: TBD based on level of interest and support
    - Expanded field trials – more technologies deployed on more realistic platforms
    - Generate vapour flux & thermal gradients from actual subsurface liquid releases
On-water Leak Detection

• **Objective**
  – Experimentally evaluate performance of selected commercial ELD technologies for continuous monitoring of hydrocarbon liquid releases into fresh water environments

• **Focus**
  – Point sensing systems intended for deployment on/above water surface
    • Electromagnetic field (EMF) sensing
    • Hydrocarbon florescence sensing
    • Hydrocarbon liquid contact sensing
  – Range of hydrocarbons
    • Light and heavy oils, dilbit, condensate and surrogate fluid

• **Participation**
  – Program under development
Test Apparatus

Configuration for Phase 1 - idealized lab-scale testing
On-water Leak Detection

• Program Status
  – Phase 1 (solicitation pending): evaluate detection capability of selected systems through idealized lab-scale tests involving incremental and continuous releases of a range of hydrocarbon liquids
  – Phase 2: TBD based on level of interest and support
    • More realistic lab-scale testing (e.g. moving water, surface waves, wind and precipitation)
ELD Evaluation Framework

PHMSA Project DTPH5615T00004 - Framework for Verifying and Validating the Performance and Viability of Leak Detection Systems for Liquid and Natural Gas Pipelines

• Objective
  – To provide guidance for identifying and evaluating candidate ELD systems for possible deployment on onshore gas or hazardous liquid transmission pipelines

• Scope
  – Develop technology evaluation framework
    • Technology requirements
    • Technology screening
    • Technology characterization
    • Technology evaluation and selection
  – Demonstrate framework application → ELDER Test
  – Finalize framework

• Status
  – Project ongoing
    • Draft framework complete
    • Framework demonstration test under development