

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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Cleveland, OH

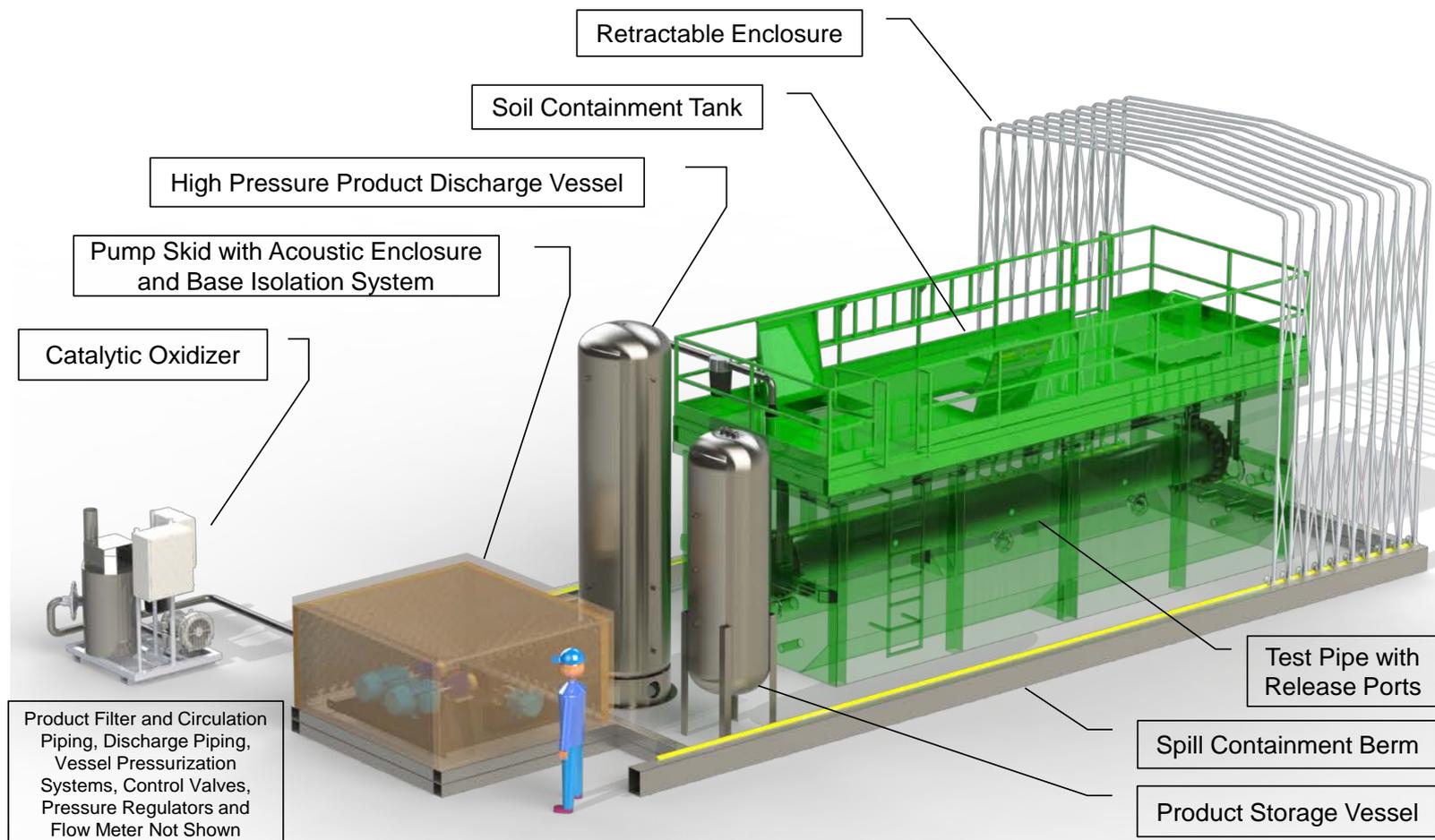
- C-FER research focus
 - External leak detection (ELD) systems
 - Detection of small releases
- Major projects
 - Experimental performance evaluation - liquids
 - In-ground leak detection project
 - Airborne leak detection project
 - On-water leak detection project
 - Framework for performance evaluation – gas & liquids
 - PHMSA Project DTPH5615T00004

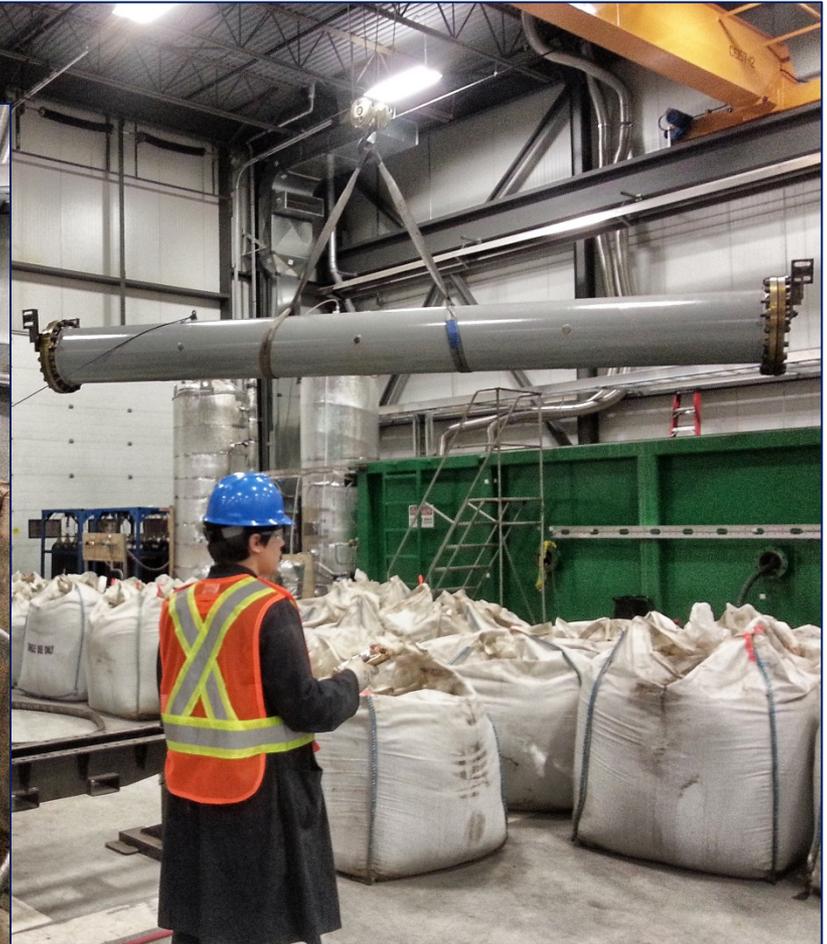
In-ground Leak Detection

- 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)

- 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



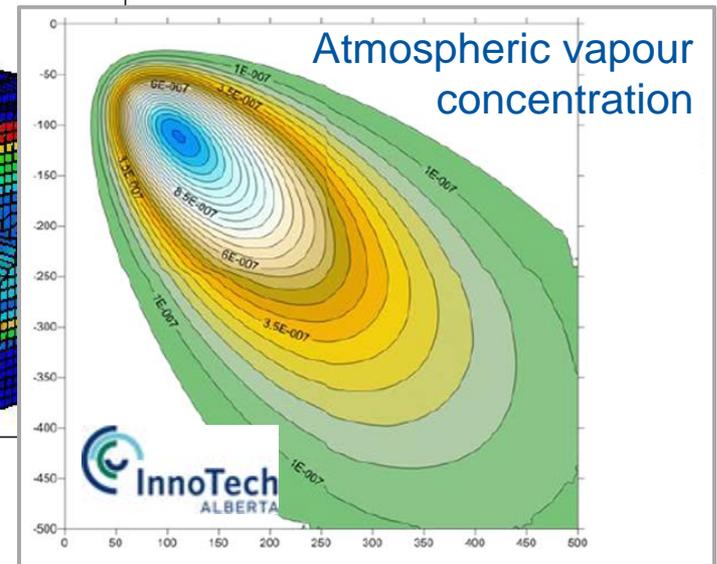
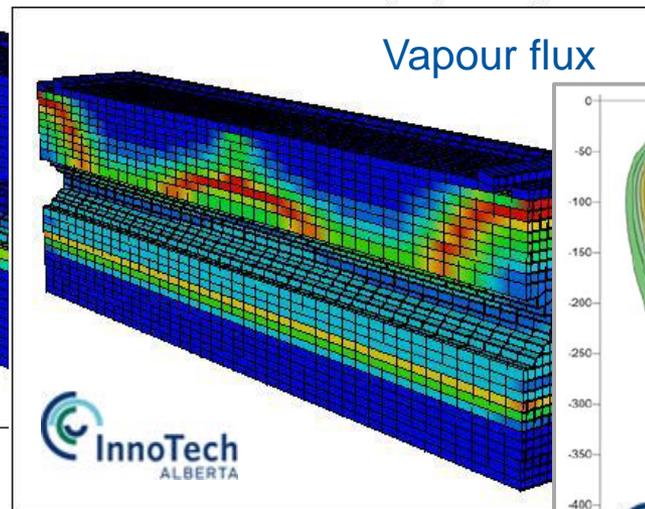
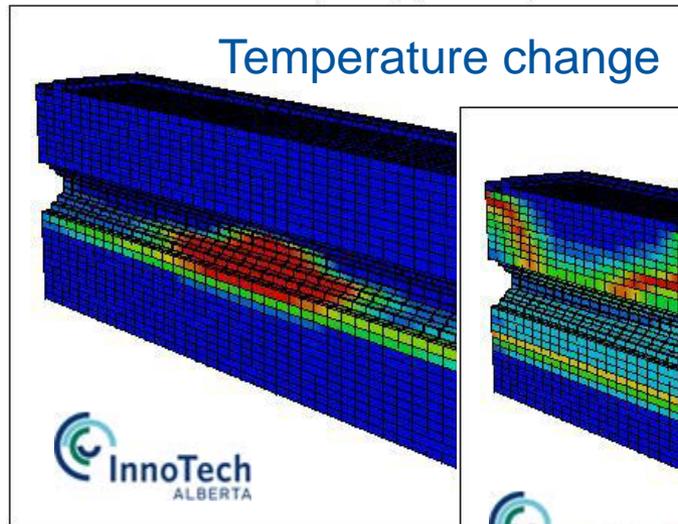


In-ground Leak Detection

- 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

- 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)

- Magnitudes of temperature change and vapour flux at surface
- Dominant species of gases generated by subsurface leaks
- Vapour concentrations above ground surface



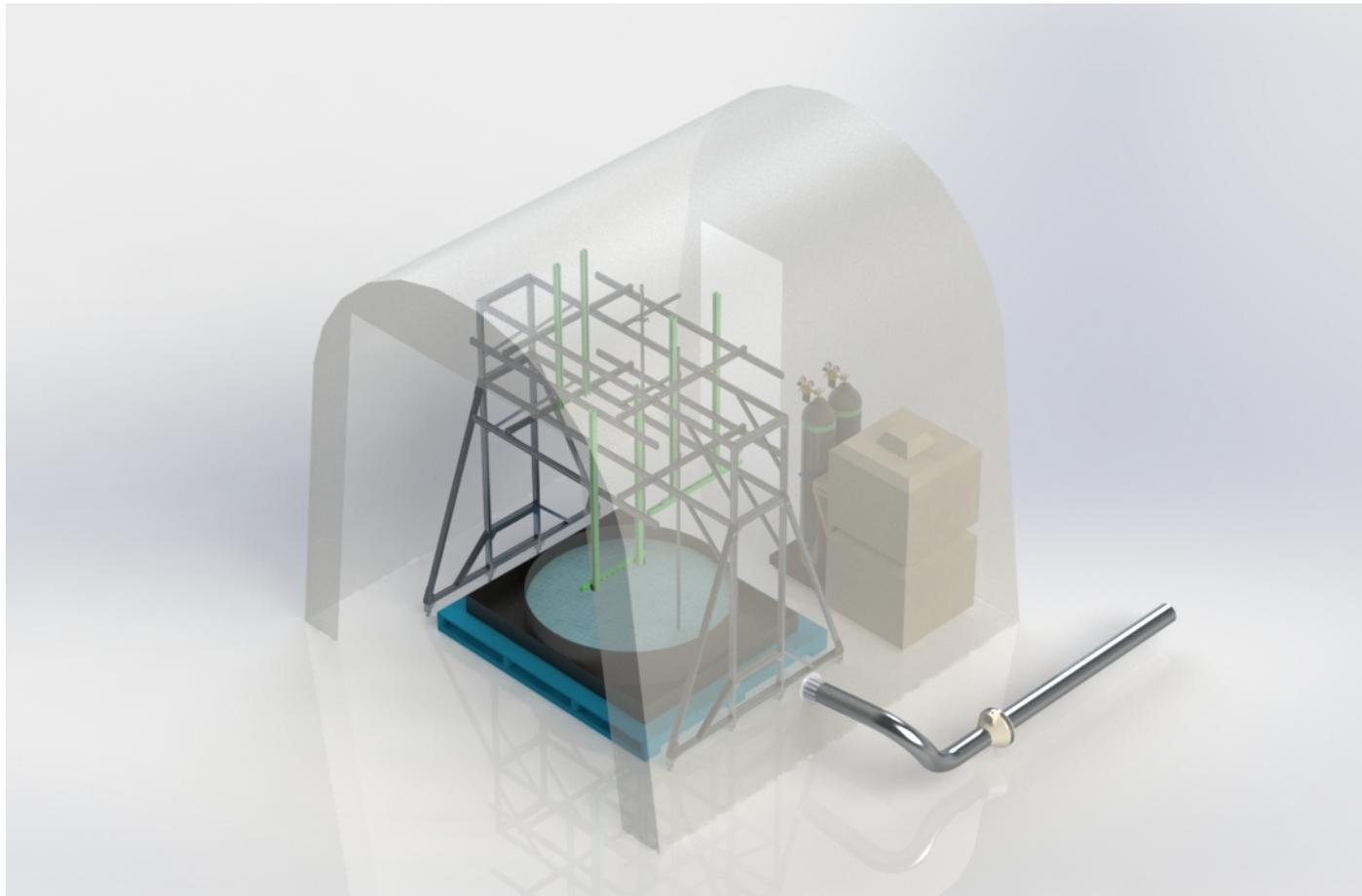
Field Trials – Example VOC Detection Systems



- 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 trails – more technologies deployed on more realistic platforms
 - Generate vapour flux & thermal gradients from actual subsurface liquid releases

- 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 fluorescence sensing
 - Hydrocarbon liquid contact sensing
 - Range of hydrocarbons
 - Light and heavy oils, dilbit, condensate and surrogate fluid
- Participation
 - Program under development

Configuration for Phase 1 - idealized lab-scale testing



- 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)

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
 - Frame work demonstration test under development