

# GTI's Natural Gas Pipeline Safety Research

*the Energy to Lead*

**CEC Staff Workshop  
July 16, 2015**

## **CALIFORNIA NATURAL GAS PIPELINE ASSESSMENT - CEC #500-10-050 PIPELINE INTEGRITY and MONITORING TECHNOLOGY ASSESSMENT**

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GTI Project - Summary

<http://www.energy.ca.gov/2014publications/CEC-500-2014-024/CEC-500-2014-024.pdf>

# GTI at a Glance...

- > Not-for-profit research, with 65+ year history
- > Facilities
  - 18 acre campus near Chicago
  - 200,000 ft<sup>2</sup>, 28 specialized labs
- > Staff of 250
- > A growing business
- > Commercial partners take our technologies to market



Offices  
& Labs



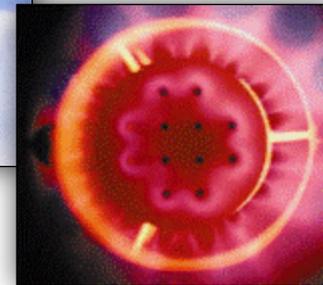
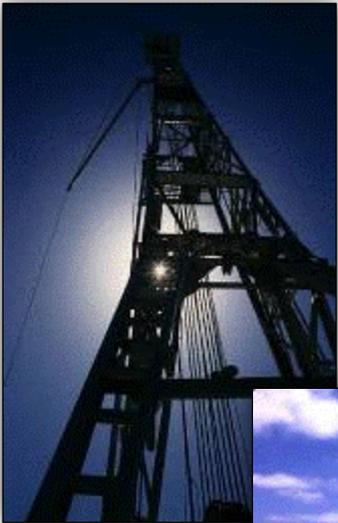
Energy & Environmental Technology Center

Flex-Fuel  
Test  
Facility

# Gas Technology Institute

## Solving Important Energy Challenges via:

- > Contract Research
- > Program Management
- > Technical Services
- > Education and Training



- > Over 1,000 patents
- > Nearly 500 products commercialized

# GTI Data and Integrity Management Program

## Pipeline Integrity Management

- Inspection technology development and evaluation
- Guidance materials and best practices

## Distribution Integrity Management

- Distribution risk models
- Standardized distribution data model

**Advance the collection, storage, and utilization of field data for improved integrity management, risk reduction, damage prevention, and operational efficiency**

## Data Collection

- GPS-Based Excavation Encroachment Notification
- GPS-Enabled Leak Surveying

## Data Utilization

- Remote monitoring of field operations
- 3-D multi-utility repository

## CEC #500-10-050 Project Goals - Summary

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- > Identify Quick “Wins”: Commercial Technologies Not in Use That Could/Should Be  
or
- > Emerging Technologies That Could Be Moved to Commercial Availability Quicker
- > Leverage and Optimize the Use of the Advanced Metering Infrastructure (AMI)
- > Develop an Implementation Plan

# TASKS and DELIVERABLES

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- > Task 2 - Baseline Technology Assessment in the State of California
  - Review of current state of technologies being used
  - April 30, 2012
- > Task 3 - Assessment of Currently Available Technology
  - Catalogue of available technologies
  - Gap analysis
  - July 31, 2012
- > Task 4 - Evaluate Emerging Technology
  - Identify technologies that could be developed or enhanced in the next 2-4 years
  - Emphasis on integration with the AMI communications backbone
  - October 31, 2012
- > Task 5 - Implementation Plan
  - Recommend specific technologies to implement in a timely and cost effective manner
    - > Testing and deployment currently available technologies
    - > Development of select emerging technologies
    - > Development of new technologies to meet outstanding gaps
  - February 28, 2013

# Organization of Technologies Into Strategic Elements

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- > Asset Life Cycle Management – “What’s Where”
  - Technologies providing an efficient set of capabilities to know what you have and where it is located
- > System Communications and Control
  - Technologies to create or enhance the capabilities to communicate and control the system
- > System Monitoring and Assessment
  - Technologies needed to assess and monitor the system
- > Overarching Issues
  - Needs and recommended activities that span the entire integrity management process

# Implementation Plan Recommended Approach (1)

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- > Concurrent Three Phase Program
- > Phase 1 – PON 12-505 (Tasks 2/3)
  - Awarded 2/15/2013
  - Pipeline Integrity Technology Demonstration Grant
- > Phase 2 – Emerging Technologies (Task 4)
  - Technology Development Roadmap (Next slide)
    - > Technologies Recommended For Consideration by CEC = +/-50, Subset of Those Identified
    - > Organization Conducting the Project
    - > Development Status
    - > Recommended Level of Participation by CEC

# Emerging Pipeline Integrity Assessment and Monitoring Technology

Strategic Element	Program Area	Projects*																					
		2013				2014				2015				2016				2017					
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
What's Where	Data Standards and Guidelines	National Utility As-Built Standard/New/CEC																					
		ASTM F2897-11/New/CEC																					
		Asset Tracking Guidelines/Ongoing/OTD																					
	Tracking and Traceability	Lifecycle Tracking of Specs & Procedures/Ongoing/OTD																					
	Records Management	Long Term Traceability/Available/Not is Regular Use																					
	Database Integration	Geographic Information system (GIS)/Available/Requires Upgrading																					
	Field Data Capture	GIS Barcode Decoding Tool/Ongoing/OTD																					
		Hand-Held Data collection Device/Ongoing/OTD																					
										Mobile Device Area Network/New/CEC													
		High Accuracy GPS/Ongoing/OTD																					
Bar Coding for Asset Tracking/Ongoing/OTD																							
RFID Tags for Asset Tracking/New/TBD																							
Pipe Rover Platform for Above-Ground Surveys/Proposed/SMP																							
System Communications and Control	Interoperability	Interoperability Standards/Ongoing/OTD																					
	Control - AMI	AMI Capability Verification/New/CEC																					
	Control - System	Transmission EZ Valve/Proposed/SMP																					
System Monitoring and Assessment	MEMS - UC Berkeley	MEMS Sensor Development/Ongoing/UC Berkeley																					
	Monitoring Devices for ROW Encroachment and Excavation Damage Prevention	GPS Based EEN for ROW Monitoring/New/GTI																					
		ROW Damage Detection and Operational Improvement/New/UC Berkeley																					
		Learning Algorithms for PIGPEN Warning System/Ongoing/PHMSA																					
	Monitoring Devices for Leak Detection	Mobile Leak Detection - Picarro/Ongoing/PG&E and Others																					
		Smart Pipeline Network - Pipe & Repair Sensor System/Ongoing/PHMSA																					
	ILI for Unpiggable Pipelines	Acoustic Leak Detection for High Pressure Pipeline/Proposed/OTD																					
		Explorer Series of Robotic Inspection Platforms/Ongoing/NYSEARCH																					
		Pipecrawlers/Ongoing/Pipecrawlers																					
		EMAT for Unpiggable Pipe/Proposed/OTD and PRCI																					
	In-Line Inspection (ILI)	Dry Hydro - Phase 2/Proposed/SMP																					
		Internal Inspection Optimization (IIO)/New/OTD, PRCI, INGAA Foundation																					
		Laser Ultrasonic Testing (LUT)/Ongoing/UC Berkeley																					
		Real-Time Pipe Movement Detection/Proposed/SMP																					
		UT Tool and Sensor Improvements/Ongoing/PRCI																					
EMAT/Ongoing/OTD and PRCI																							
Above Ground Inspection	Coating Disbondment Detector/Ongoing/SMP																						
Direct Assessment	Validation of 3D Scanners for Anomaly Assessment/Proposed/OTD																						
Methods for Stress Assessment	Quan. Non-destructive Residual Stress Assessment Tool/Ongoing/PHMSA																						
Mechanical Damage	Programs focused on Impacts of Mechanical Damage to Pipelines/Ongoing/PRCI																						
Corrosion	Program focused on Internal, SCC, and External Corrosion/Ongoing/PRCI																						
Methods for Risk Assessment	Interactive Threats in Kiefner/NYGAS & other Models/Ongoing/NYSEARCH																						
Overarching Issues	Program Coordination	Focus on Safety/Ongoing/CEC																					
		Lessons Learned and Technology Demonstration Workshop/New/CEC																					
	Education	Larger Resource Pool/New/CEC																					
		Improvements in Situational Awareness/New/CEC																					
		Primer on Integrity Management/New/CEC																					
		Situational Information/New/CEC																					
	Advocacy	Real Time Knowledge to Situation - Video Link to Advisor/New/CEC																					
Innovative Rate Recovery for New Tech Development/New/CEC with CPUC																							
		Regulatory Acceptance of New Technologies/New/CEC with CPUC																					

\*Projects are shown by Title/Status (New, Proposed or Ongoing)/Lead Organization or CEC if To Be Determined and Color Shows Timeline and Priority of Involvement by CEC (High = Red, Medium = Green, Low = Blue)

# Implementation Plan Recommended Approach (2)

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- > Phase 3 – Addressing 5 Root Causes (Plan)
  - PON Program Areas
    - > 3 Damage Reduction Groups
    - > 15 Broad Based PON Descriptions
    - > Group 1 - Prevention of Pipeline Failures
      - Improving the Capability to Detect Existing Pipeline Defects (7)
      - Improving the Records Used for Pipeline Asset Lifecycle Management (1)
      - Improving the Data Analysis Used for Pipeline Integrity Management (3)

# Implementation Plan Recommended Approach (3)

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- > Phase 3 – Addressing 5 Root Causes (Plan)
  - PON Program Areas
    - > 3 Damage Reduction Groups
    - > Group 2 - Mitigation of Consequences
      - Improving the Capability to Detect, Locate, and React to Pipeline Leaks/Ruptures (2)
    - > Group 3 - Improvements in Response
      - Improving Pipeline Incident Coordination and Response (2)

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## **CEC PIR-14-014**

### **Natural Gas Pipeline Safety and Damage Prevention Grant**

#### **Technologies to Monitor and Report Encroachments on the Pipeline Right of Way**

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GTI Project Plan

July 16, 2015

## PIR-14-014 Project Goals - Summary

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- > **To Deploy and Demonstrate a pipeline monitoring system that can detect encroachments and alert operators of activity in the ROW in real time**
- > **There are two technologies that will be applied during this project.**
  - **The use of GPS enabled sensors mounted on excavating equipment to alert operators when a geo-fence has been crossed.**
  - **The use of stationary sensors to provide continuous monitoring pipelines**
- > **Risk reduction is achieved by instrumenting the most active excavation equipment and the highest consequence lines.**
  - **It is not practical to cover 100% of either category.**

# Project Collaborators

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- > Sponsorship and Oversight
  - California Energy Commission
- > Utility Test Sites
  - Southern California Gas
  - Pacific Gas & Electric
- > Technical Direction and Oversight
  - Gas Technology Institute
- > Technology and Deployment Partners
  - Leidos Engineering
    - > On Ramp Wireless
  - Acellent Technologies

# TASKS

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- > Task 2 – Right of Way Monitor Hardware Design
- > Task 3 – Data Communication Design
- > Task 4 – Data Analytics
- > Task 5 – Stationary Monitor Prototype Construction
- > Task 6 – Mobile Monitor Prototype Construction
- > Task 7 – Pre-Deployment Testing
- > Task 8 – Deployment of Monitor Hardware
- > Task 9 – Field Testing of Hardware and Analytics
- > Task 10 – Evaluation of Project Benefits
- > Task 11 – Technology/Knowledge Transfer Activities

# Technology Background

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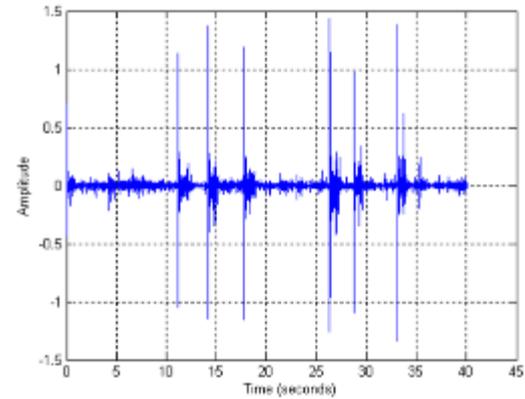
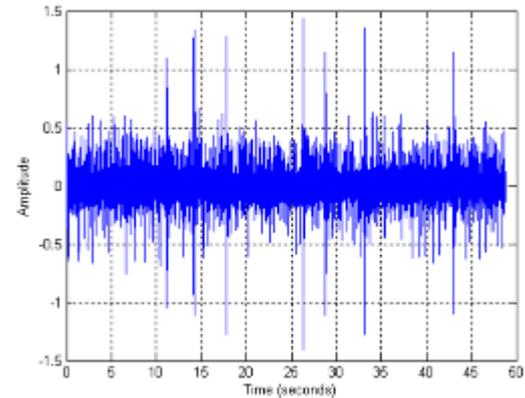
- > GPS Excavation Encroachment Notification
  - GTI has pioneered the use of wireless device to monitor the position and status of excavation equipment.
- > Stationary Sensors for Continuous Monitoring
  - GTI has an existing body of work that demonstrates the use of vibration sensors on the pipeline to monitor activity on the ROW.
- > Wireless Transport of the Monitor Data
  - Leidos provides long range wireless sensor data transport and has experience working with California based utilities.
- > Data Analytics and Notification
  - The combined data from these technologies will be processed using Bayesian Causal Network technology to eliminate false positives and provide alerts on events of interest.

# GPS Encroachment Notification Technology

- > Mounted smartphones on excavators/other construction equipment
- > Collected data at multiple locations during the pilot



# Stationary Vibration Sensor Technology



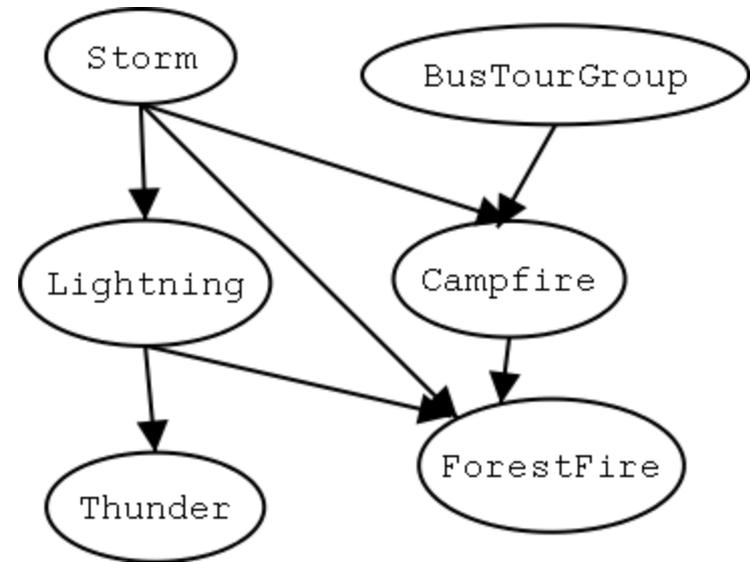
# Wireless Technology Backbone

- > GPS EEN Sensors make use of standard 3G/4G backhaul to a network operations center (NOC).
- > Stationary Sensors make use of advanced wireless technology that enables miles of range with very low power.
- > Leidos Engineering will install the stationary sensors and maintain the NOC.



# Analytics for Identifying Events of Interest

- > GTI will develop a set of analytics to discriminate events from background noise.
- > Causal Bayesian Networks (CBN) is proposed for the discriminator.
- > CBN technology enables the system to “learn” noise characteristics.
- > Event alerts will be generated and forwarded to the appropriate personnel.



# Project Timeline

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- > Project Initiation: June 30, 2015
- > Utility Site Survey and Planning: Q3-Q4 2015
- > Commence Hardware Construction: Q4 2015
- > Initial Deployments and Testing: Q2 2016
- > Main Deployment and set up: Q3 2016
- > Field Test Commences: Q4 2016
- > First Draft of Field Test Report: Q3 2017

# Questions?

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>Thank You