R&D and Innovation for Gas Operations

Redacted

CPUC-SED August 27th, 2013

PG&E ®

■ Mission Statement

R&D and Innovation detects, adapts, qualifies and implements innovative solutions in the Gas Operations business to improve its performance measured in public and work safety, customer satisfaction, cost effectiveness, environmental impact, regulatory compliance, and communication.
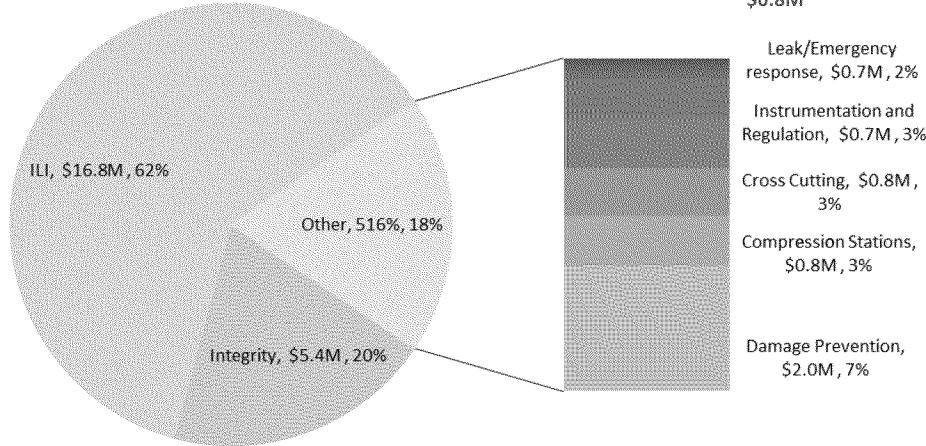
External Resources

Design › Develop › Test › Deploy
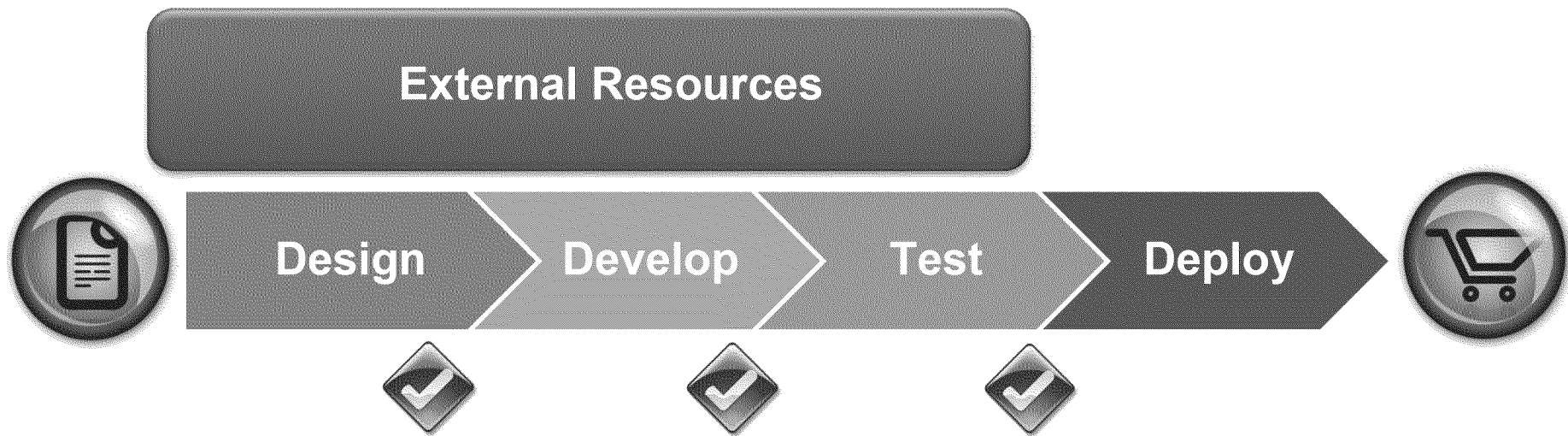
59 active projects, 128 in evaluation (as of August 23, 2013)

**Current R&D and Innovation Portfolio leveraging collaborative R&D**

ILI, $16.8M, 62%
Other, 516%, 18%
Integrity, $5.4M, 20%

System Operation and Control $0.04M
Knowledge Management $0.07M
Emergency Preparedness $0.8M

+ CES21 projects

Leak/Emergency response, $0.7M, 2%

Instrumentation and Regulation, $0.7M, 3%

Cross Cutting, $0.8M, 3%

Compression Stations, $0.8M, 3%

Damage Prevention, $2.0M, 7%

TOTAL: $27M for $4.9M PG&E funding

Deploy
2, $0.5, 1

Design
4, $7k, 109

Test
2, $3.5M, 4

Develop
31, $0.9M, 15
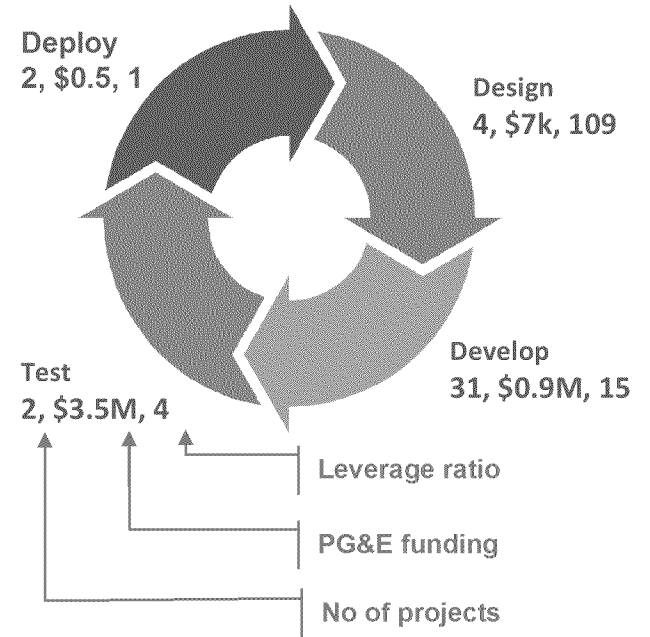
Leverage ratio
PG&E funding
No of projects

Asset Families			
Storage	●	Distribution Mains	●
Compression & Processing	●	Distribution Services	●
Measurement & Control	●	Customer Connected Equipment	●
Transmission Pipe	●	CNG/LNG	○

3

Mapping on Major Threats

17 Hazards That Impact Public Safety (CPUC - March 2012)	
1. Susceptibility of older plastic pipe to premature brittle-like cracking.	1%
2. Grandfathering provisions in 49 CFR Part 192.	
3. Excavation damage by third-parties (dig-ins).	3%
4. Operators unaware of the location and specification of the pipe in the ground.	2%
5. Unmonitored class location change.	
6. Aging infrastructure and interacting threats.	7%
7. Infrastructure, maintenance, and parts.	4%
8. Utility resource management and workforce development	
9. Ineffective or inadequate gas leak identification and response.	11%
10. Pipe with mechanical/strength characteristics susceptible to failure.	7%
11. Lack of protection redundancy.	
12. Lines unable to accommodate in-line inspection tools, such as smart pigs.	65%
13. Utility management deficiencies.	
14. Remote-controlled and automatic shutoff valves.	1%
15. Customer-owned or operated lines.	
16. Master-metered systems not in mobilehome parks.	
17. Inadequate regulation.	
TOTAL	**100%**

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Some Examples

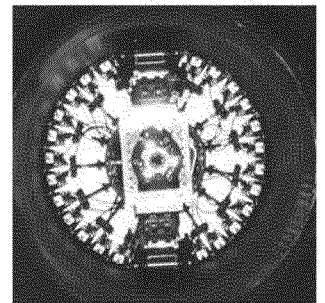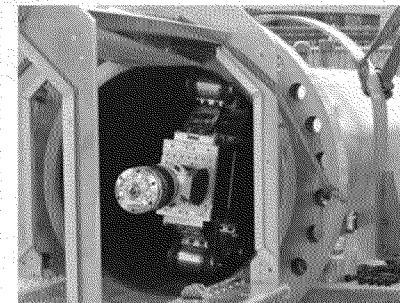**Threat #12: Lines unable to accommodate in-line inspection tools, such as smart pigs**

Line-153 at Irvington Station in Fremont
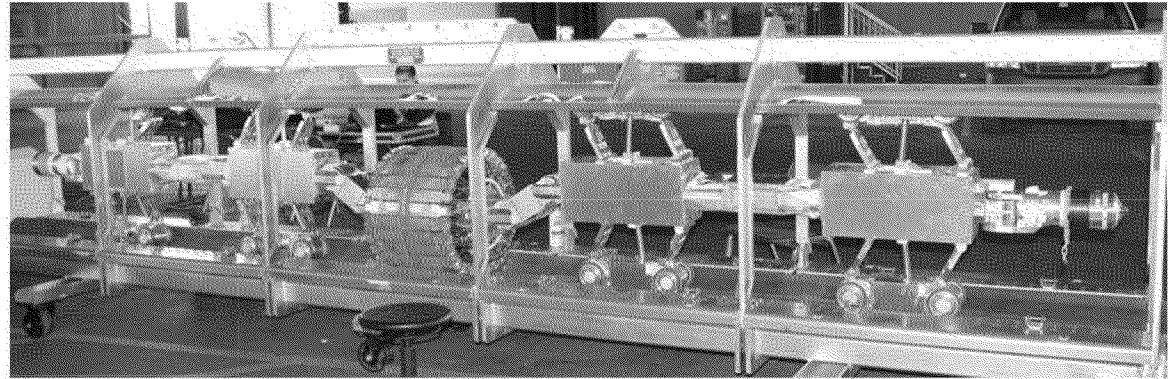
- Partnership with NYSEARCH and Invodane Engineering on developing untethered inspection robot for unpiggable transmission pipelines 30-36" diameter

- Successful demonstration performed on July 22-23, 2013 consisting of a test run through a 30" test spool and actual inspection of live pipeline (L-153) in Fremont

- Next steps: 2nd demonstration at National Grid through a hot tap before commercialization in 2014.

2011
Design > Develop > Test > Deploy
2014

6

Robot for Visual Inspection of Pipe Casing through Vents

Threat #12
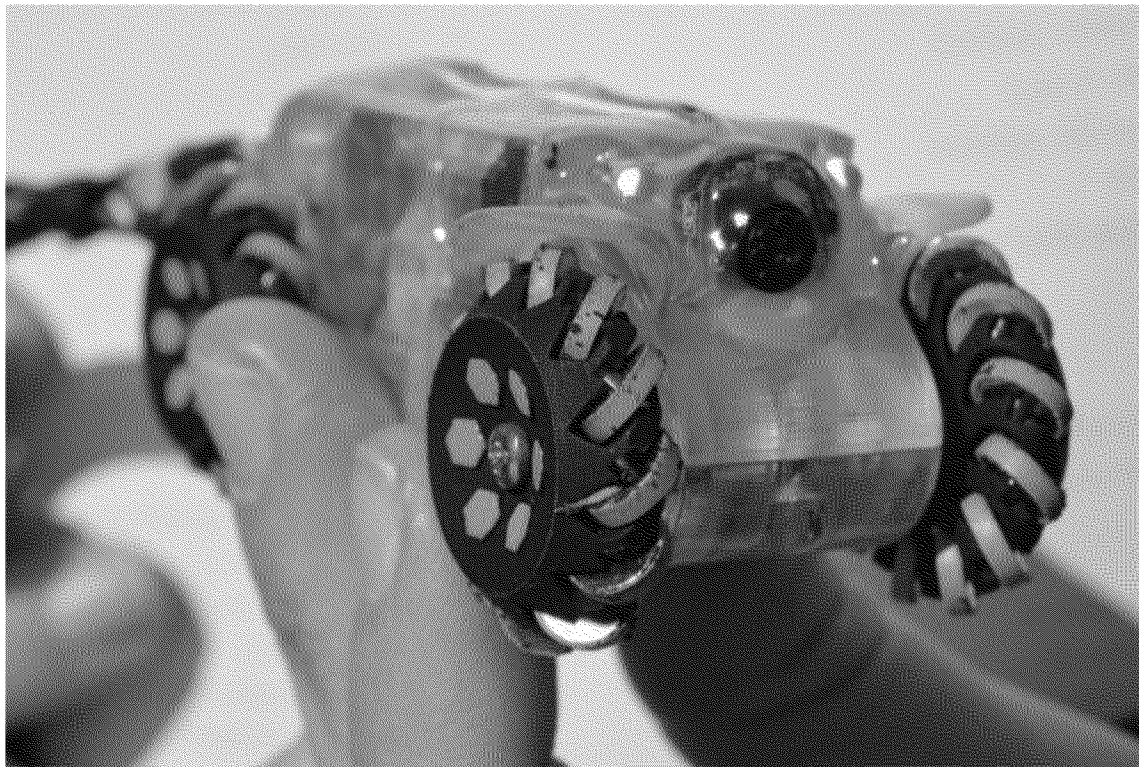
Prototype of Robot for Visual Inspection of Pipe Casing through Vents

- NYSEARCH project with Honeybee Robotics initiated in 2012

- Quick visual inspection of pipe casing without digging

- Prioritization of ILI inspection and digs

- First functional prototype tested by National Grid in February 2013

- Development of a refined prototype to be tested in August 2013

We are looking for a demonstration site!

2012　Design ⟩ Develop ⟩ Test ⟩ 2014　Deploy ⟩

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Some Examples

Threat #9: Ineffective or inadequate gas leak identification and response

Installed Remote Methane Leak Detector at PG&E
Livermore Training Center (February 2013)

- Continuously monitor pipelines and provide rapid warning of potentially explosive leaks.

- System is set up in area where leaks can be created and controlled for testing purposes.

- Testing of this system consists of
  - Demonstration of sensor efficacy
  - Evaluate sensor response to leaks in typical operating scenarios and weather conditions
  - Verify sensor freedom from sensitivity to other ambient gases

- Currently collecting data from the facility's scheduled of leak training classes and from planned leaks from the team.

- System consists of sensor, weather station, camera and computer ops station.

2013 ▼ 2014

Design > Develop > Test > Deploy

9

Light Weight Methane Detector to rapidly Locate Leaks

Threat #9

Prototype of Methane Detector by JPL (March 2013)

- Jet Propulsion Laboratory of Nasa in Pasadena has developed a miniaturized methane detector to be mounted on a UAV to locate methane sources on Mars

- Precision of 10 ppb with an open path of 20 cm by using 3.3 μm absorption band.

- Allows to go from Picarro methane indication to leak by tracking the plume.

- Can be mounted on a UAV for rough terrain pipeline survey. Senior project at UC MERCED.

- Proposed partnership with JPL to complete development and adaptation to our needs.

2010 | Design > Develop > Test > 2015 | Deploy

10

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Some Examples

Threat #7: Infrastructure, maintenance, and parts.
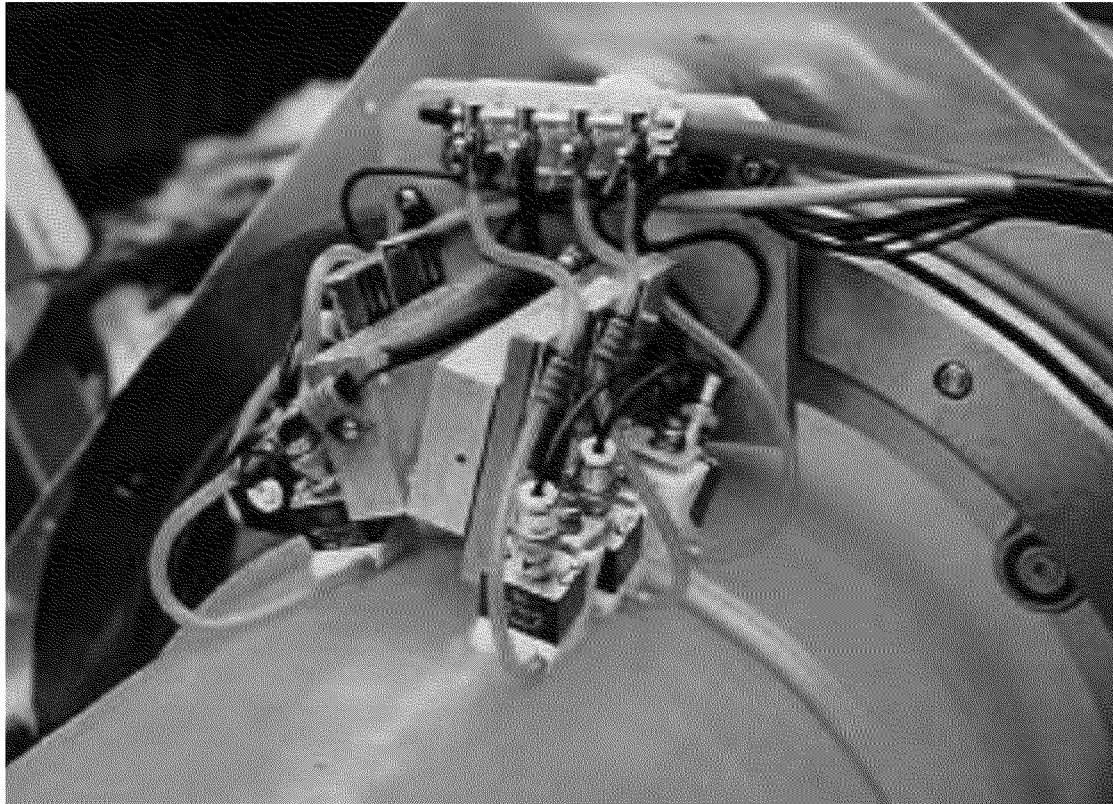
Prototype NDE system for Butt Fusion welds in PE pipes
(Ref.: TWI WINDEPP Program)

- NYSEARCH project on developing automated NDE (Phased Array UT) system for inspection of butt fusion joints of polyethylene distribution pipelines

- Current validation method is visual inspection

- Automated NDE tool increases reliability

- Will be used for Integrity Management, Training, and Quality Control

- Currently developing PAUT recognition signatures in preparation for field-ready configuration

2010			2014	
Design	Develop	Test	Deploy	

12

Gas Ops iQ

	Activities	Organization	Recorded Information	Tools	QA/QC
Definition					
Procurement					
Reception and Storage					
Retrieving from storage					
Installation					
Maintenance					

2013 ▼

Design > Develop > Test > Deploy

2015

- Web-based enterprise mobile solution (Field Operations and Reporting Management Systems – FORMS)

- Balance of data collection and data management considerations over:
  - Inventory management
  - Operations (field installations and failure)
  - Compliance management
  - Reporting

- Collect & process through various data systems

- NYSEARCH project at National Fuel
  - Selected high volume gas materials to document
  - Focusing on:
    - Plastic failures
    - Failed and replaced fittings
    - Actual feature locations
    - Leaks

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Some Examples

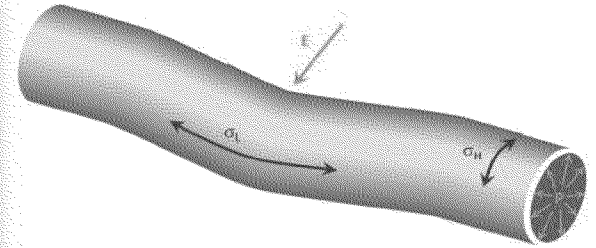**Threat #6: Aging infrastructure and interacting threats**

JIP on Ground Movements

- **Industry project started in April 2012 focused on development of Fitness for Service (FFS) assessments and best practice document for management of ground movement hazards**

- **Consortium of several oil and gas pipeline operators**

Pipe Movement
$\rightarrow$ Strain (ε) & Stress (σ_L)

Bending Strain & Stress
+
Girth Weld Features
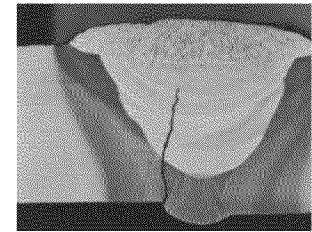
- **Study led by Center for Reliable Energy Systems (CRES)**
  - Girth weld failures on vintage pipelines
  - Additional stresses exerted on pipelines (ground movement, residual stresses, construction activities, soil creep, heavy rainfall, etc.)
  - Characterization of pre-existing flaws on girth welds from welding (lack of penetration, hydrogen embrittlement, high-low misalignment, cracking, etc.)

2012

| Design | Develop | Test | Deploy |

2014

15

Diakont Multiple Channel EMAT
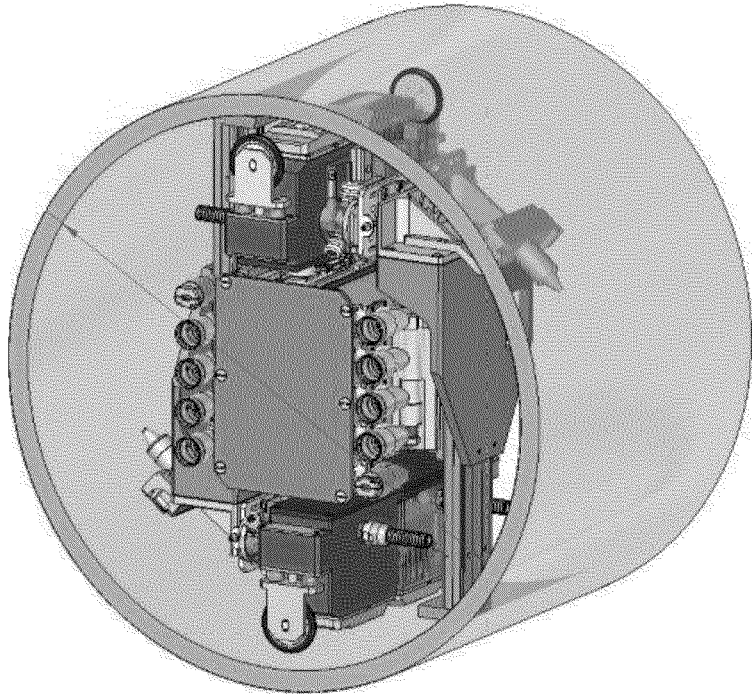
Rendering of Multi-Channel EMAT on Diakont's RODIS Crawler
(Ref: Diakont MS-EMAT Proposal)

- Demonstration of technology by developed by Diakont, funded through CEC-PIER.

- Multi-channel EMAT sensor to allow inspection, characterization, and measurement of girth welds.

- Sensor integrated onto Diakont's tethered crawler to inspect pipelines 30"-56" diameter.

  - Allows for inspection of girth welds as part of ILI inspection, compared to traditional in-the-ditch inspections using hand-held piezoelectric transducers

- Coordinating demonstration of test unit on PG&E territory in 1Q 2014

- Commercial availability in ~ 2Q 2014.

2010

Design > Develop > Test > Deploy

2014

16

Threat #6

Demonstration of the Seikowave system at ATS on April 18th, 2013
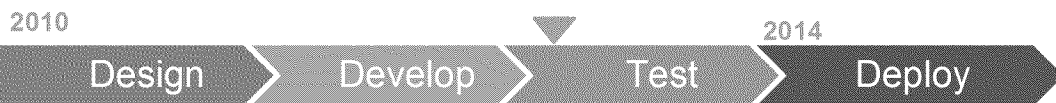
- PRCI detected the technology through the NASA Techfusion program

- Spin-off of University of Kentucky

- Projector and receiver integrated in the camera

- Projects about 600 frames on the object to measure the volume in one picture

- Automatically creates data for calculations in ASME B31G and RSTRENG

- Analysis is provided in real time with minimal skills required from the operator.

- Cost: $15k

2012   Design   Develop   2014   Test   Deploy

17

Some Examples

Threat #14: Remote-controlled and automatic shutoff valves

Using Smart Meter Infrastructure to transport Monitoring Data

Threat #14

ERX Unit and Data Collector Unit
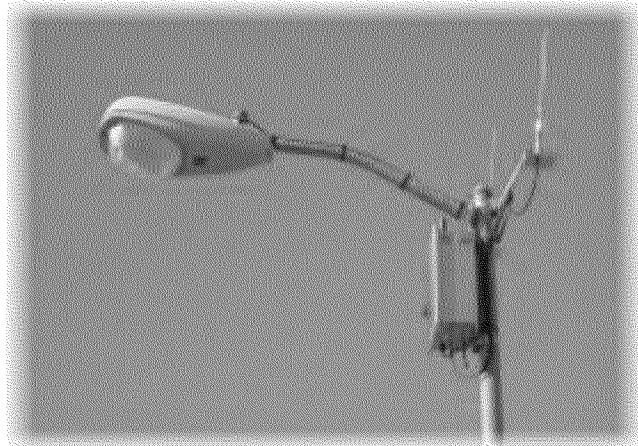
- Demonstrated that in adequate locations latency is less than few seconds

- Install Silverspring Networks modem on ERX to collect and transport local pressure and flow information towards the Control Room

- Cost effective alternative to cellular service or dedicated wireless network.

Design > Develop > Test > Deploy

2012

2013

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Separating our Control Room from Public Networks

Distributed sensors netwok

Control Room

Other information

DZ-BOX

ERX Unit and Data Collector Unit
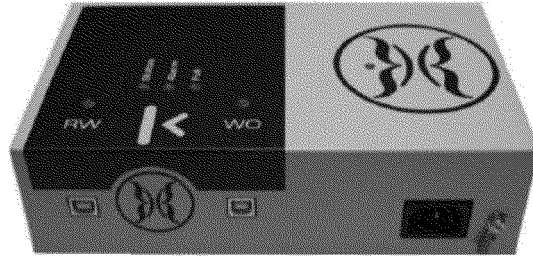
- Assure physical separation of the control room from the external network

- Controls and authorizes transfer of information from the public network to the Control Room

- Hardware-based ("security in silicon"), not subject to software flaws and configuration errors.

- Does not require any administration.

Design	Develop	2013 Test	2013 Deploy

20
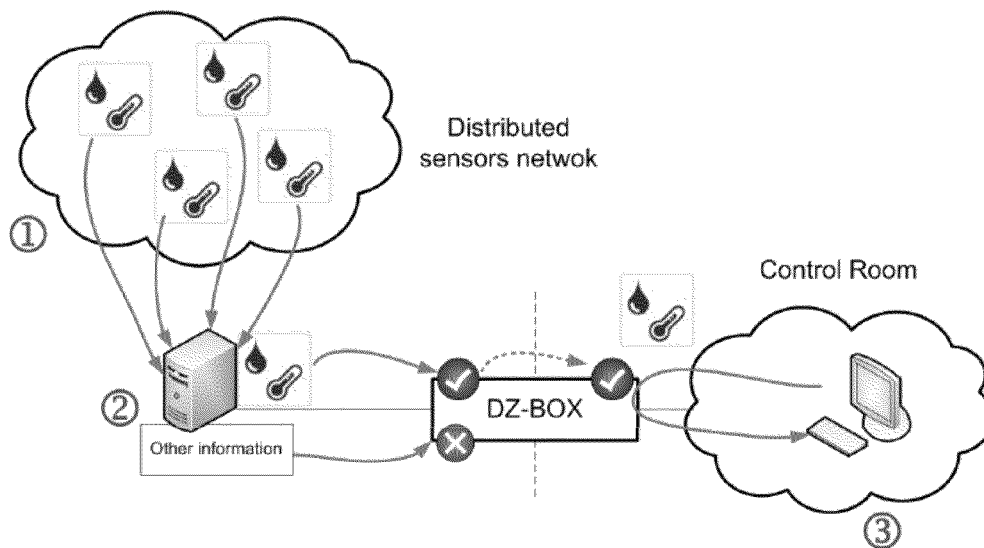
Some Examples

Threat #3: Excavation damage by third-parties (dig-ins)

Operations Technology Development

- Supplement 811 calls to provide additional protection

- Using GPS location of construction equipment and movement pattern

- Send alert to Control Room if equipment digs close to our assets

- Built upon development made by GTI with Virginia Utility protection Services

- Solution expected to be cheaper and more effective than ultra-sonic and optic fiber systems detection systems

2013 | 2014
Design > Develop > Test > Deploy

22

Some Examples

Threat #4: Operators unaware of the location and specification of the pipe in the ground

Redacted

2013

Design

Develop

2016

Test

Deploy

24

Our Tool Box

Project Assessment and Support Sheet
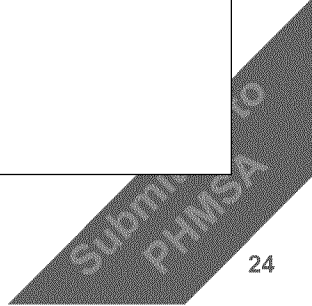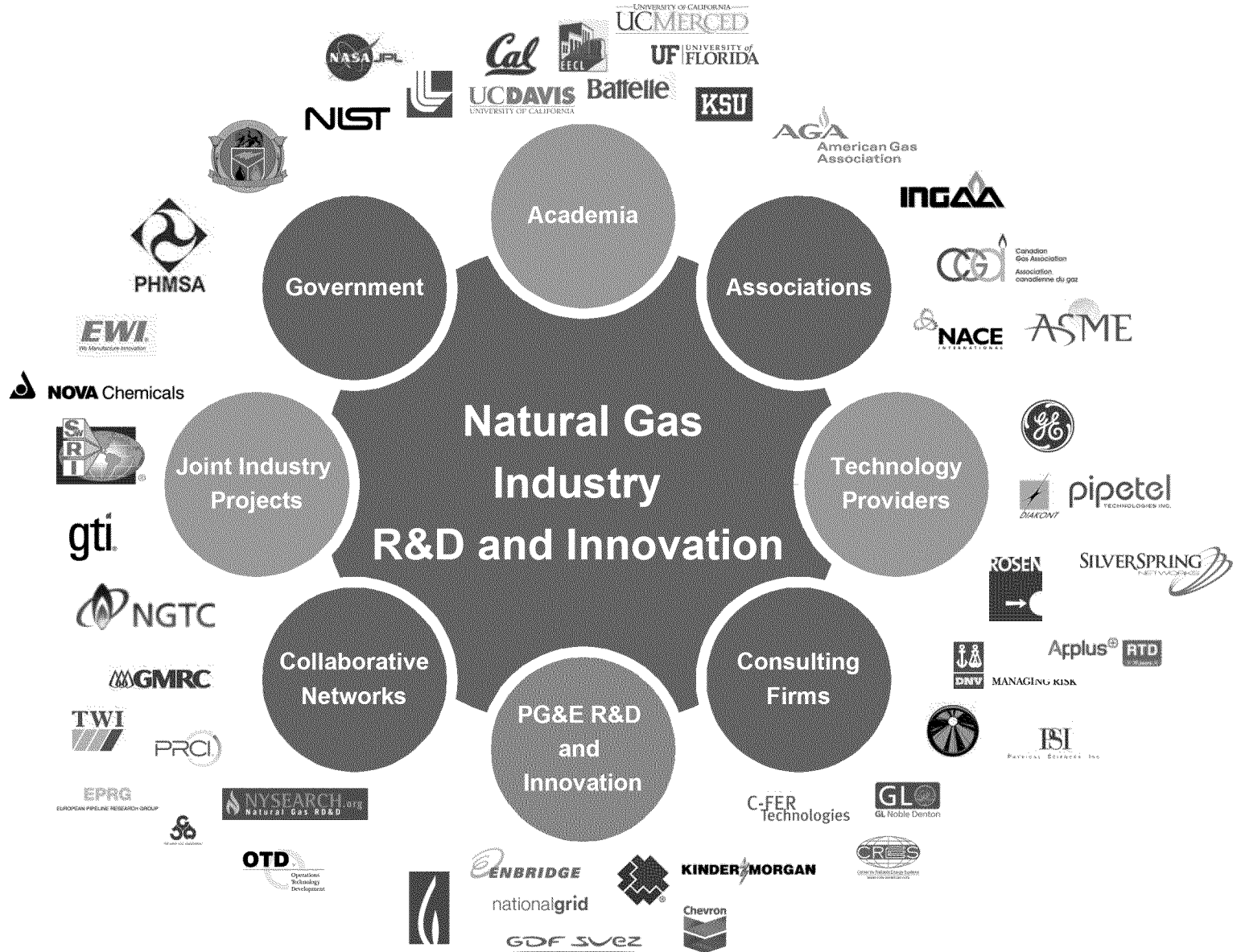
Strategy	What issue(s) does it solve?
	How does it fit in our overall strategy and rank among our priorities?
Innovation	What is the state of the art?
	What is the existing solution at PG&E?
	How does the team compare to competition?
Leverage	How does the project leverage previous work?
	What are the opportunities of co-financing?

Chance of Success	What are the risks for failure?
	What are the requirements for deployment at PG&E?
Deployability	How will the solution be use?
	What additional delays have to be accounted for the full deployment?
	How does it synchronize with existing actions?
Cost vs Benefits	Can we assess cost benefits of the solution?
	What will the on-going cost of the solution after deployment be?
	What is an acceptable cost target for PG&E?

Objectives	Needs and Gaps	R&D Projects and Technologies

Time line

<2012	2012	2013	2014	2015	>2015

Damage Prevention

Prevent 3rd Party Damage

Detect Construction Equipment/Activity
- Satellite Observation — PRCI
- Aerial Surveys - Drones — PRCI
- Image Analysis — PRCI
- Optic Fiber (Cost Reduction) — NYSEARCH.org Natural Gas RD&D
- Ground Acoustic Sensors — NYSEARCH.org Natural Gas RD&D
- Signal Analysis
- Video Surveillance — NYSEARCH.org Natural Gas RD&D PRCI
- Electronic Fence

Eliminate False Alarms
- Multiple Signal Analysis

Locate Construction Equipment
- GPS Localization — OTD Operations Technology Development
- Best Practices — PRCI

Control HDD
- Ground Penetrating Radar — OTD Operations Technology Development / NYSEARCH.org Natural Gas RD&D
- XYZ localization sensor

Locate Pipelines
- GIS location validation — OTD Operations Technology Development
- Pipeline ROW markers

Improve Communication
- Smart Phone Solutions
- Standardization

● PG&E participating

Deploy

Design

Test

Develop

28

R&D and Innovation Fellowship

5+ year
5% Part time assignment

RDI Fellow

- Assignment Options:
  - Analyze R&D strategy and project portfolio
  - Voting position in R&D Collaborative Networks and attend conferences
  - Define lab test, field test, and pilot and prepare solution for deployment
- Become a champion for a new technology
- Research and propose new ideas for projects
- Mentor RDI Seniors

2-4 year
5% Part time assignment

RDI Senior

- Assignment Options:
  - Lead for an R&D Project
  - Expert lead for collaboration network
  - Project manager for lab tests, fields tests, or pilot
- Perform need/requirement analysis and build a business case
- Develop ideas into possible new solutions
- Mentor RDI Associates

0-1 year
2 – 6 month part time assignment

Orientation
Presentation

RDI Associate

- Type of projects:
  - Innovation assessment
  - Technology reviews
  - Test or pilot design, organization and management
  - Development of new procedures and/or training related to new technologies
- Work on assignment 40% of the time (2 days per week)
- Guidance provided by a mentor who has worked on a similar project

availability and the quality
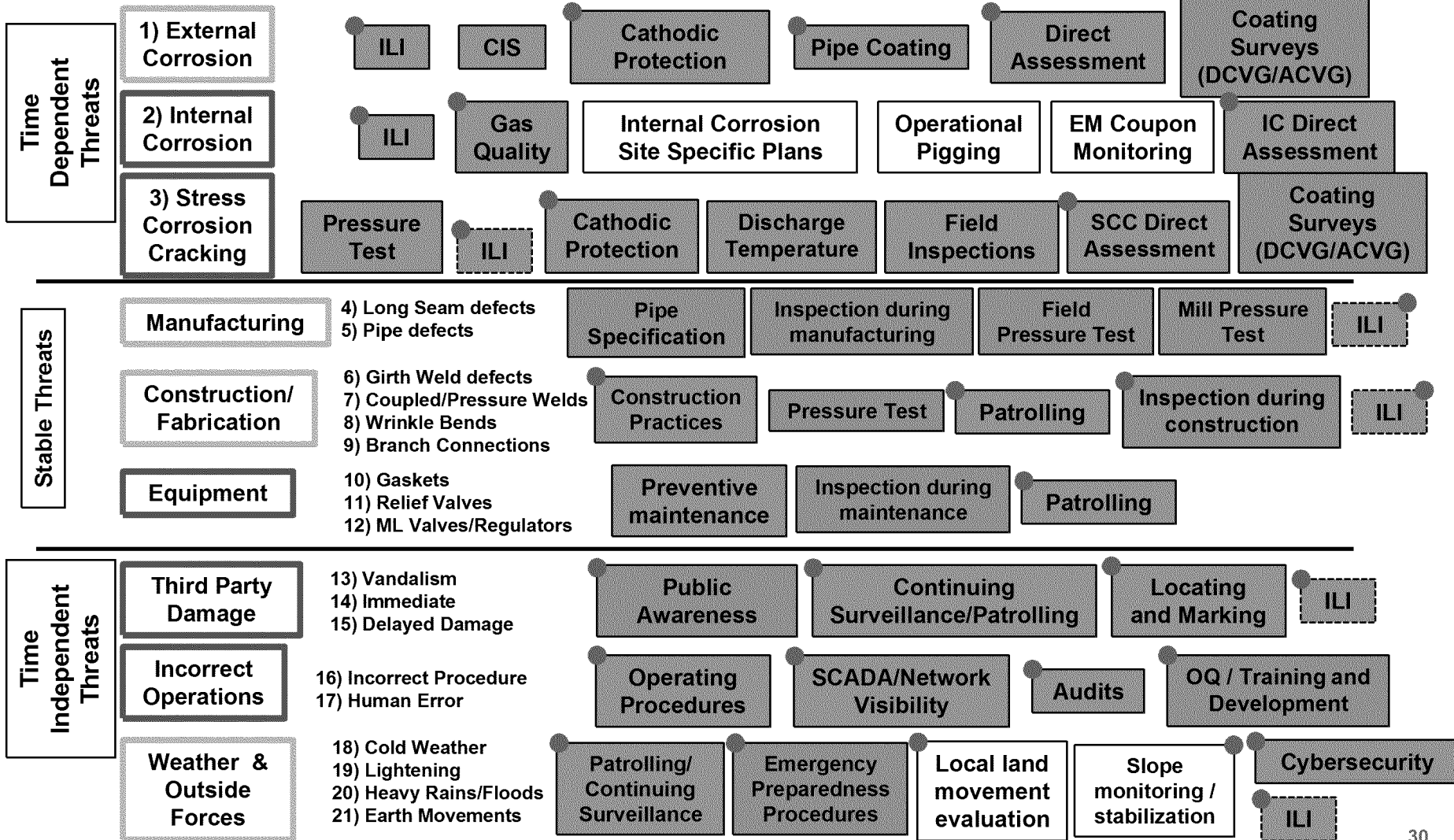of the asset data

| complete | partial | weak |

GREEN = Meet or exceed industry best practices
AMBER = Partially meet industry best practices
WHITE = Are not doing now, or do not meet best practices

Primary Causes of Failures

Primary Mitigation Measures

Time Dependent Threats

1) External Corrosion

ILI | CIS | Cathodic Protection | Pipe Coating | Direct Assessment | Coating Surveys (DCVG/ACVG)

2) Internal Corrosion

ILI | Gas Quality | Internal Corrosion Site Specific Plans | Operational Pigging | EM Coupon Monitoring | IC Direct Assessment

3) Stress Corrosion Cracking

Pressure Test | ILI | Cathodic Protection | Discharge Temperature | Field Inspections | SCC Direct Assessment | Coating Surveys (DCVG/ACVG)

Stable Threats

Manufacturing

4) Long Seam defects
5) Pipe defects

Pipe Specification | Inspection during manufacturing | Field Pressure Test | Mill Pressure Test | ILI

Construction/ Fabrication

6) Girth Weld defects
7) Coupled/Pressure Welds
8) Wrinkle Bends
9) Branch Connections

Construction Practices | Pressure Test | Patrolling | Inspection during construction | ILI

Equipment

10) Gaskets
11) Relief Valves
12) ML Valves/Regulators

Preventive maintenance | Inspection during maintenance | Patrolling

Time Independent Threats

Third Party Damage

13) Vandalism
14) Immediate
15) Delayed Damage

Public Awareness | Continuing Surveillance/Patrolling | Locating and Marking | ILI

Incorrect Operations

16) Incorrect Procedure
17) Human Error

Operating Procedures | SCADA/Network Visibility | Audits | OQ / Training and Development

Weather & Outside Forces

18) Cold Weather
19) Lightening
20) Heavy Rains/Floods
21) Earth Movements

Patrolling/ Continuing Surveillance | Emergency Preparedness Procedures | Local land movement evaluation | Slope monitoring / stabilization | Cybersecurity | ILI

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Thank you!

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PG&E Gas Operations
R&D and Innovation

Redacted