

Pipeline Research Council International, Inc.

Leak Detection R&D for the Pipeline Industry

Gaps & Challenges to be Addressed through Collaborative R&D

**US DOT PHMSA R&D Forum
Working Group #2
Arlington, VA
July 18, 2012**

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LEADING PIPELINE RESEARCH

Presentation Topics

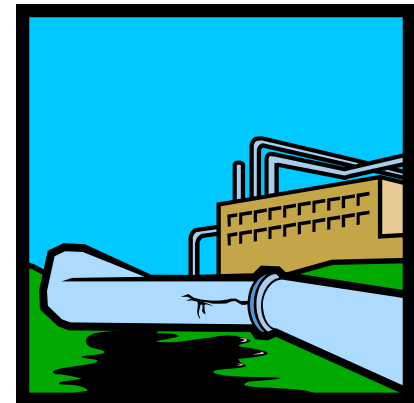
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- **Issues and Drivers for Leak Detection**
- **Current Understanding and Programs**
- **PRCI Leak Detection Roadmap**
- **Facilities and Offshore Leak Detection**
- **Game Changers & Changing the Game**
 - **“Moving the Needle Quickly”**

Research Drivers for Leak Detection

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- **Safety and Environmental Performance**
 - Potential for unknown/unexpected worker and public exposure
 - Incidental contact
 - Vapor/gas intrusion concerns (liquids)
 - Liability for natural resource impacts and damages
 - Remediation and restoration
 - Legal claims
 - LAUFE – emphasis on greenhouse gas releases
- **Financial and Economic Considerations**
 - Keeping product in the pipe and delivery to market
 - Paying for liabilities from above
 - Credits and trading
- **Public Perception and Corporate Citizenship**
 - Encroachment
 - Enhanced awareness
- **The Best Leak is One that Never Happens (API website)**



Challenges for Leak Detection Technology

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- **Needs vary based on unique operating conditions**
 - Gas vs. liquids
 - Gathering , Transmission, Distribution
- **Monitoring frequency and timing – challenge of continuous monitoring**
- **Sensitivity of measurement systems relative to size of leak**
- **Substantial mileage of systems - transmission and distribution**
 - 170,000 miles of hazardous liquid lines
 - 295,000 miles of gas transmission lines
 - 1,900,000 miles of natural gas distribution lines

PRCI Leak Detection Research

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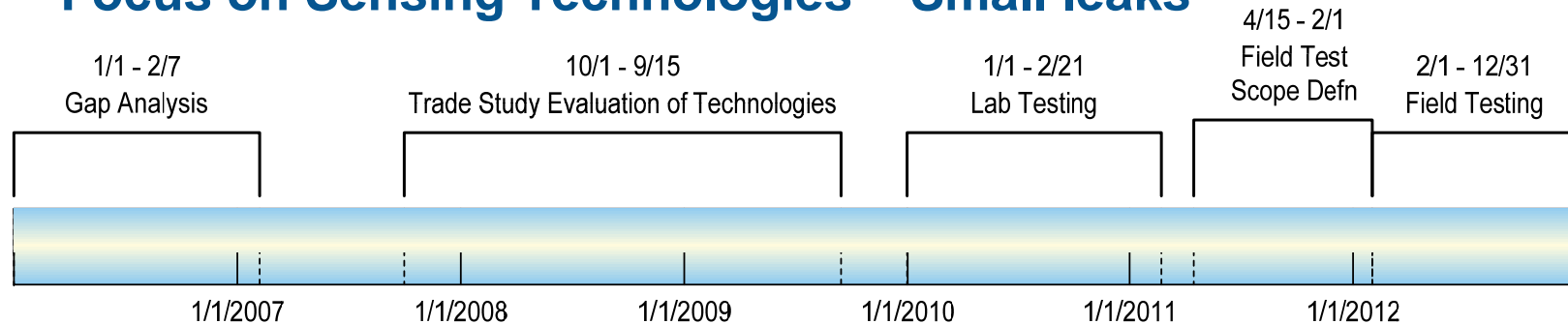
- **Multiple projects/programs on developing ILI technology for defect detection – IMP provides data**
- **Past efforts conducted to research a number of leak detection approaches and technologies**
 - Satellite and remote sensing – linked to Damage Prevention
 - Fiber Optic cables
 - Human Factors and Control Room Operations
 - Computational Pipeline Monitoring (CPM)
 - Acoustic methods
- **Current Program Focus**
 - Evaluation of external leak detection systems
 - Leak Detection Technologies for unmanned facilities
 - RAM Program



External Leak Detection R&D - Ground

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Focus on Sensing Technologies – Small leaks



1/1/2006

12/31/2012

- Fiber optic cables and acoustic emissions ranked highest for performance (40 technologies reviewed); limitations in analysis
- Field testing of Acoustic/Negative Pressure Wave Leak Detection Technologies Underway
- The retrofit dilemma



External Leak Detection R&D - Air RAM Program Concept of Operations

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No single, cost-effective system, service or suite of technologies has been developed to apply over the entire pipeline system network to address the three primary threats:

- Machinery threats (3rd party damage)
- Leaks
- Geologic activity/natural forces

Automating ROW Monitoring:

Detect – sensing & imagery collection

Process - data analysis via algorithms

Distribute – communication

Archive – improved data management processes and predictive modeling

LEAK DETECTION
Gas + Liquids

Courtesy of NASA Ames Research Center



Standard aerial surveillance with regular manned aircraft

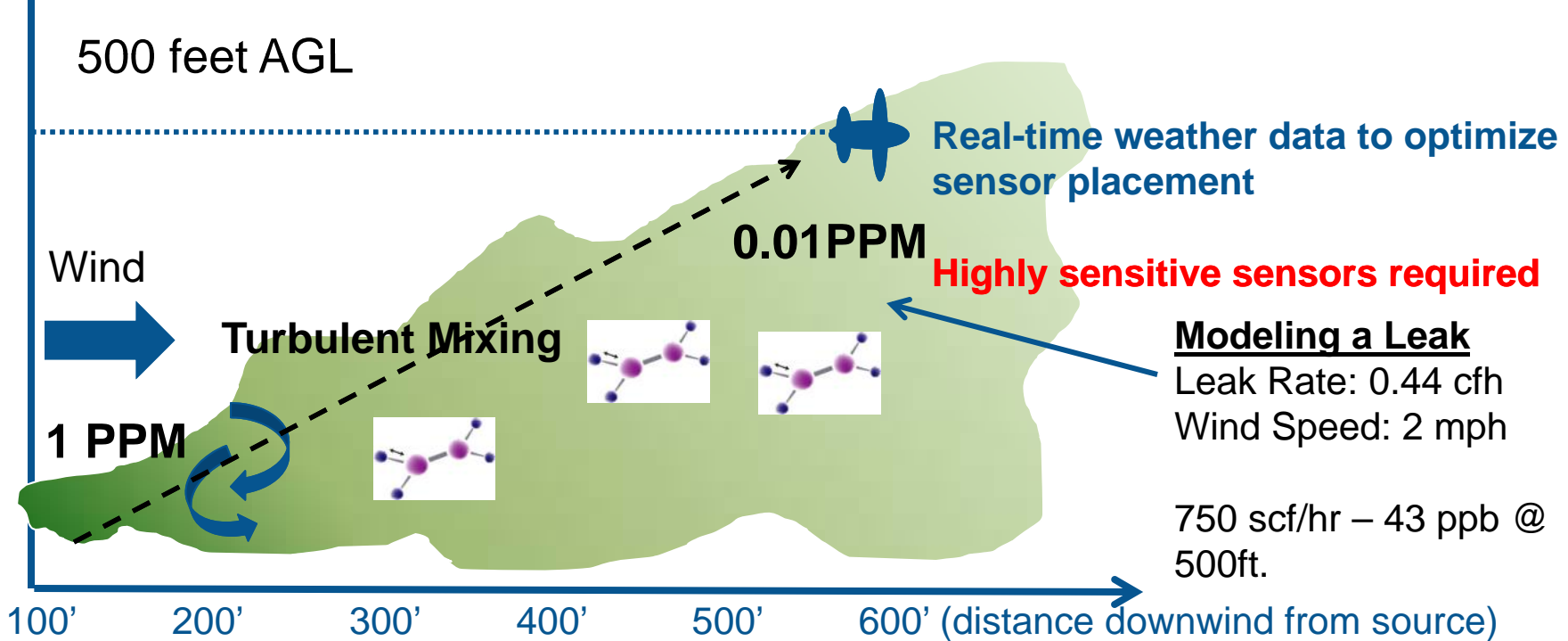


Automated processing and communication – benefits to Damage Prevention, Emergency Response & Crisis Management

Challenge for Aerial Sensing - Sensitivity

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- Proof of Concept demonstrated for Natural Gas
- Field Trials June 2012 – liquids included
- Vapor plume dynamics – subsurface and air



Turbulence acts to disperse the plume both laterally and vertically while the mean wind simply moves the plume downwind of the release.

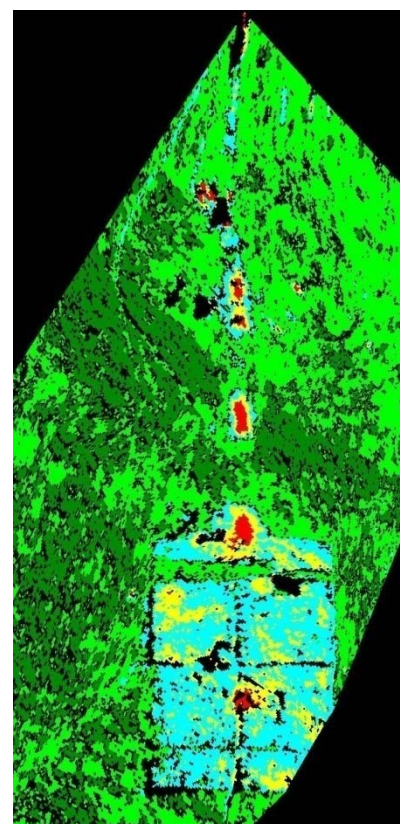
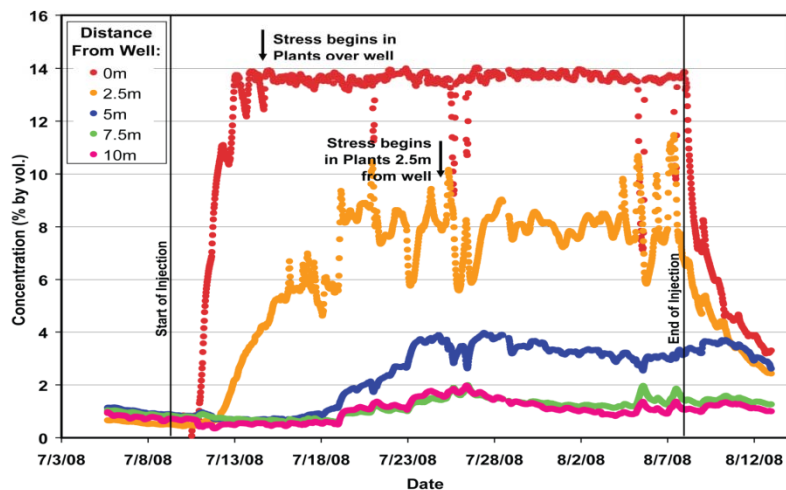
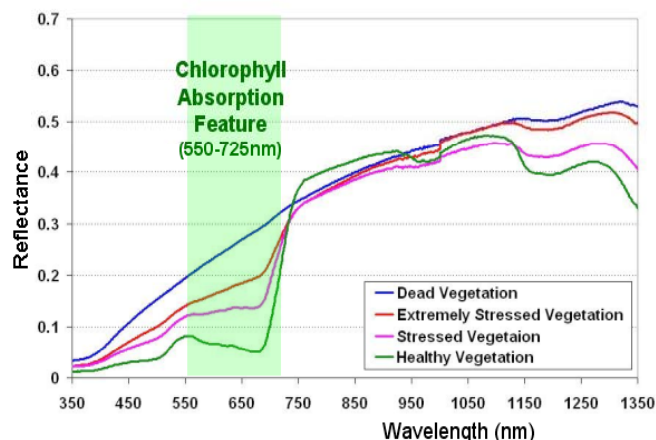
Proven Capabilities – Hyperspectral Sensing

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Resolution requirements:

0.5 meter pixel is sufficient

> 5 nm wavelength from 300nm and 800nm



27 days after CO₂ injection

- High Stress
- Moderate Stress
- Low or Seasonal Stress
- Healthy Vegetation (Grasses)
- Healthy Vegetation (Herbaceous Legumes)
- Unclassified

Plant stress spots correspond to measured CO₂ flux maxima

Other subsurface gases exhibit same patterns

False positives - not on pipeline path or migration pathways

Limitations:

- Proper vegetation
- Sensor size

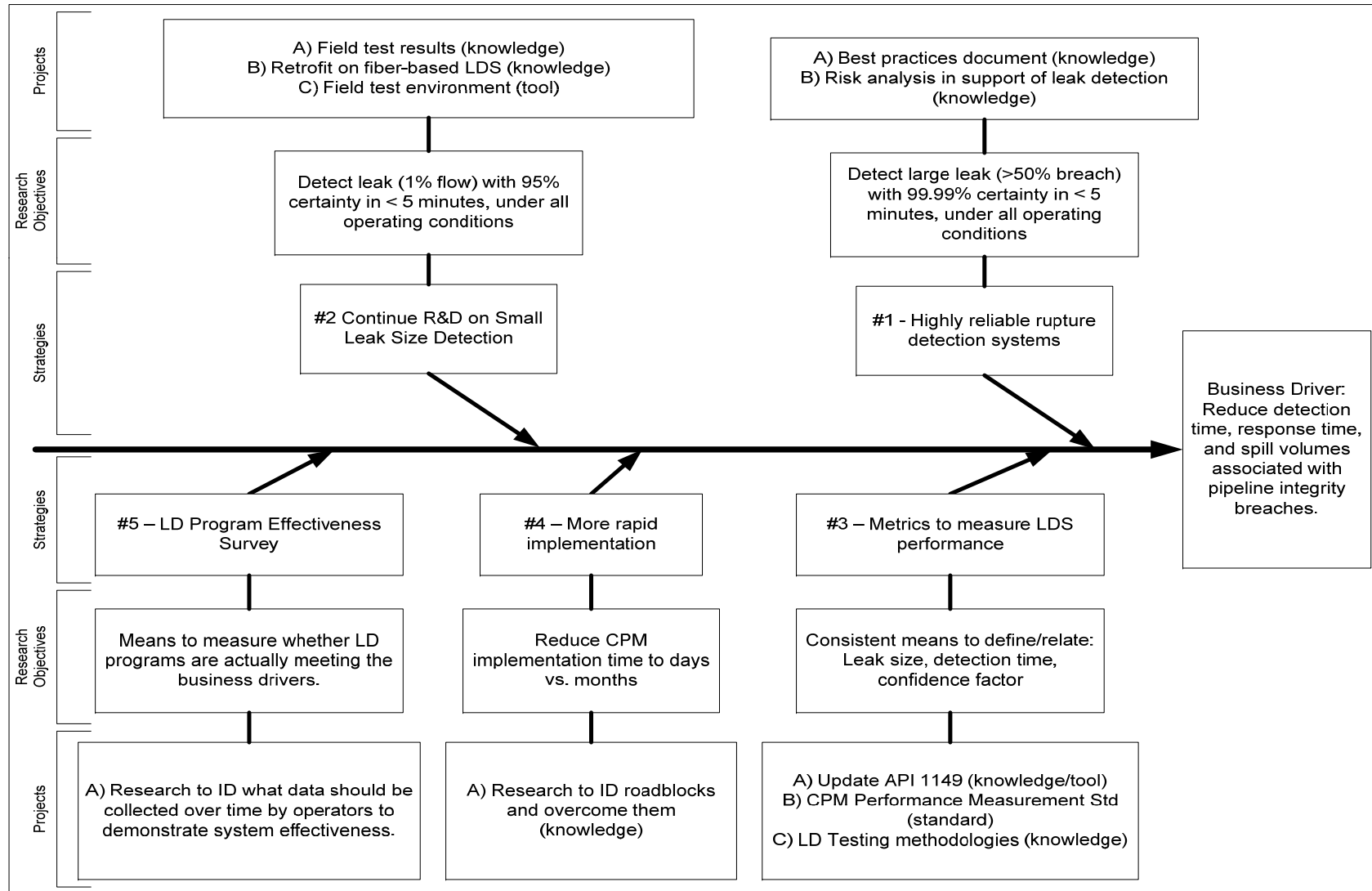
PRCI Leak Detection R&D Roadmap

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- **Part of Pipeline Industry R&D Roadmap**
- **High Priority - AOPL/API Pipeline Safety Improvement Areas**
- **Best in Class Mentality**
- **Three Primary Elements: People (Human Factors), Process, and Technology**
- **Five Primary Areas Defined**
 - **Continuing R&D on small leak size detection on liquids pipelines – external sensing & CPM**
 - **Highly reliable pipeline rupture detection**
 - **Metrics to Measure Leak Detection Performance**
 - **Facilitate More Rapid Implementation of CPM Systems**
 - **Leak Detection Program Effectiveness Surveys**

Leak Detection Roadmap Overview

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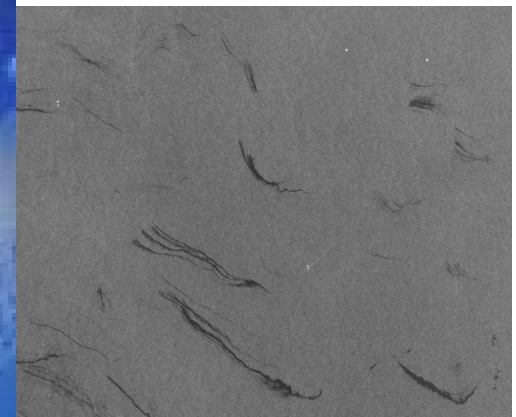
Facilities and Off shore Leak Detection

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- Facility Integrity Management Program
- Unmanned aerial Systems (UASs) and unmanned facilities
- Off shore pipelines and systems



Offshore seeps



Game Changers and Changing the Game

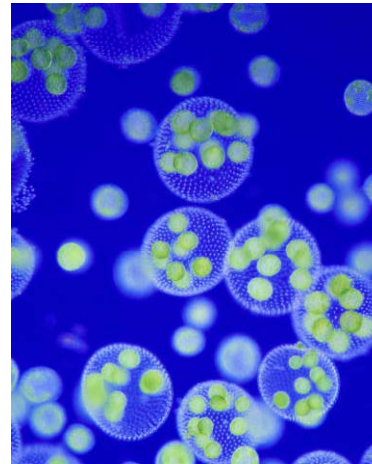
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Engineer the Environment

- Proactive vs reactive
- Plants
- Bugs – CO₂, Thermal, other
- Other?

DRA

Pattern Recognition

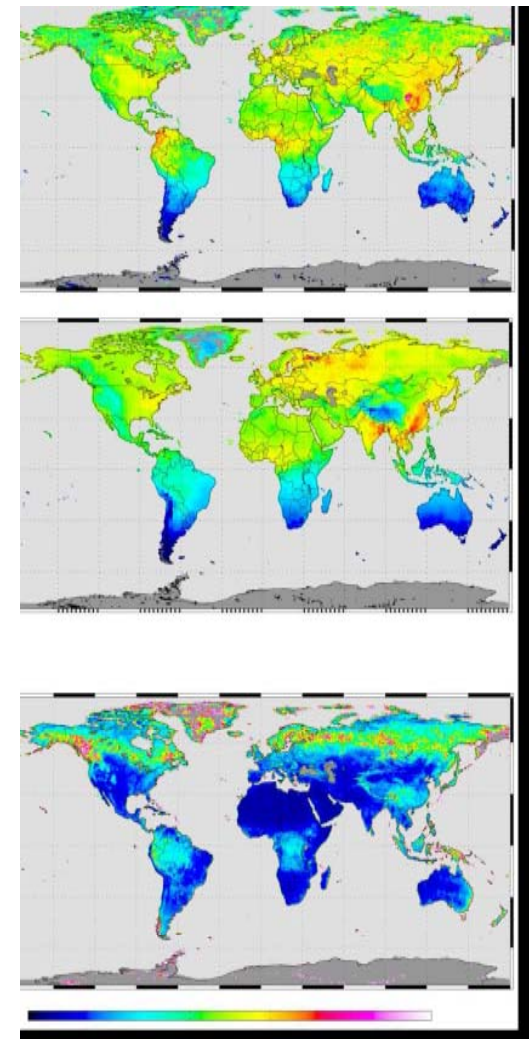


Satellites

- Move to automation - iPad Generation
- Current capabilities vs future
- How does pipeline industry help define next generation?
- Of, by, and for the people? Government role



Get rid of the Box - Expand our view of the world



From Frankenberg et. al., Journal of Geophysical Research, Vol. 111, 2006

Closing Slide
Thank you for your attention
Questions?

Follow-up questions or information needed:

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