

ThreatScan™

Real-time impact monitoring for pipelines

Government / Industry Pipeline R&D Forum
February 7th, 2007



ThreatScan™ Overview

ThreatScan Objectives

ThreatScan uses acoustics to monitor and alert operators of unwanted pipeline impacts....

- Prevents delayed failures
- Minimizes loss during immediate failures
- Reduces costs associated with damage repair
- Provides reporting for future risk mitigation

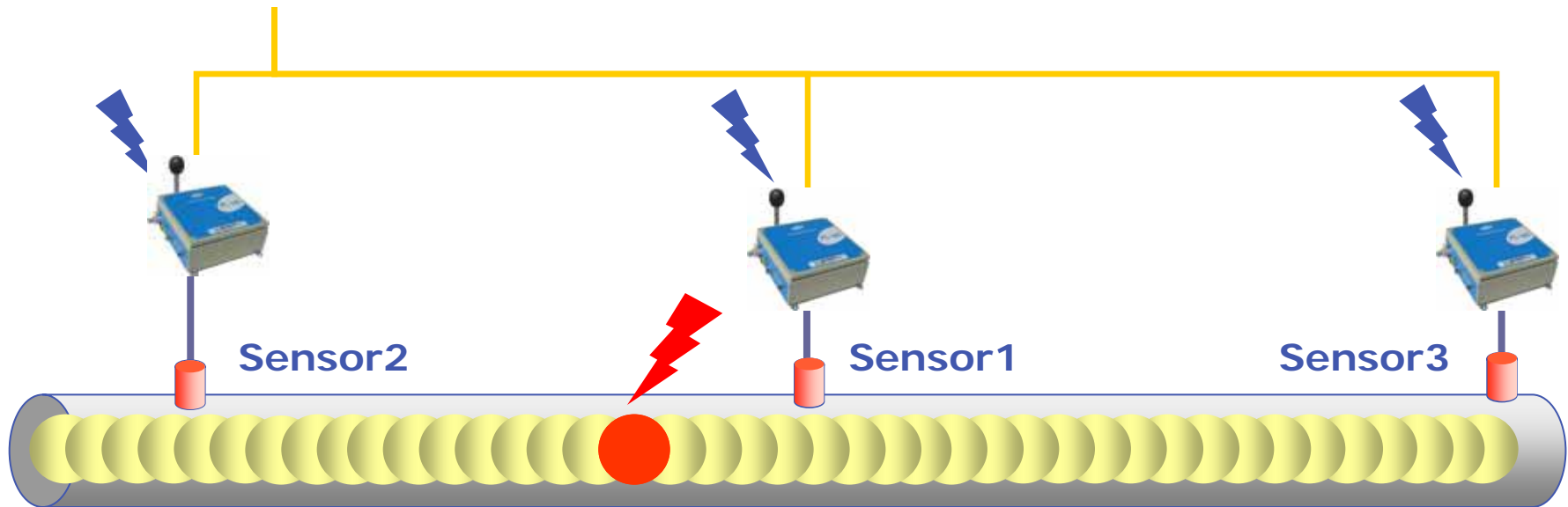


Shock Detection Process Overview



GE Monitoring Center

- Shock alarm on **Sensor1**
- Shock alarm on **Sensor2**
- Shock alarm on **Sensor3**



Product Applications

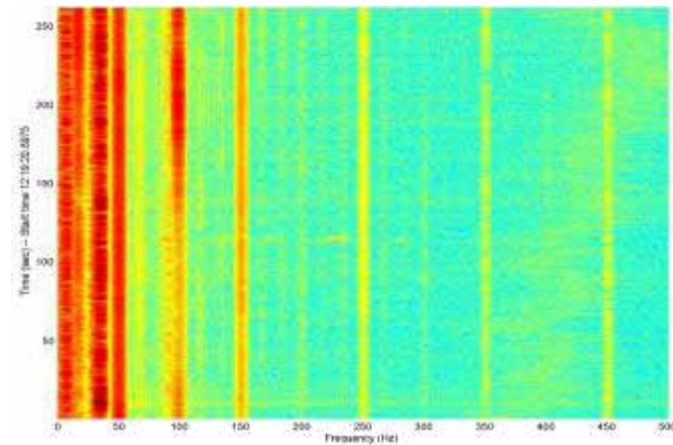
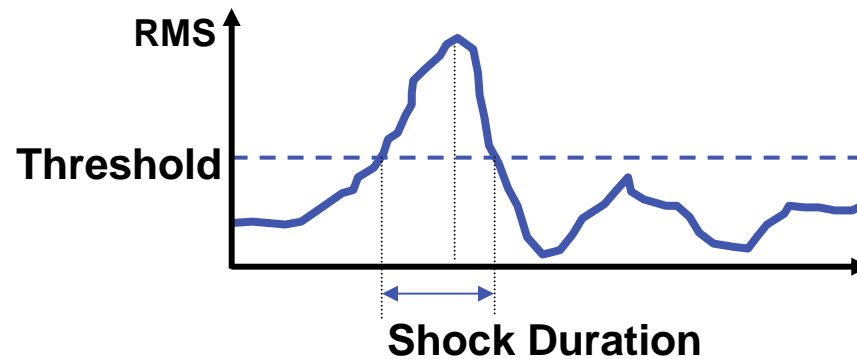
- ✓ 6" – 48" Diameter Pipe
- ✓ Buried Pipeline
- ✓ Above Ground Pipeline

- ✓ Crude Oil
- ✓ Refined Product
- ✓ Natural Gas
- ✓ Water



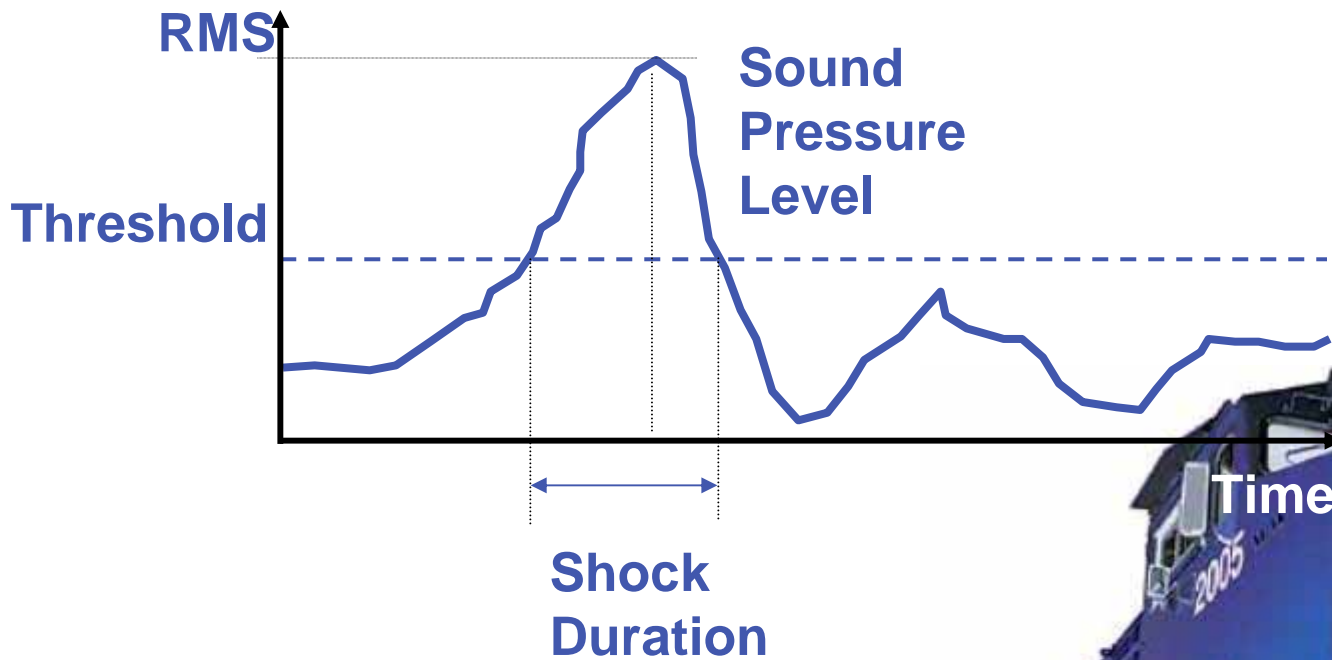
ThreatScan – Detection Criteria

- ✓ Shock duration
- ✓ Signal within defined frequency
- ✓ “Amplitude” threshold

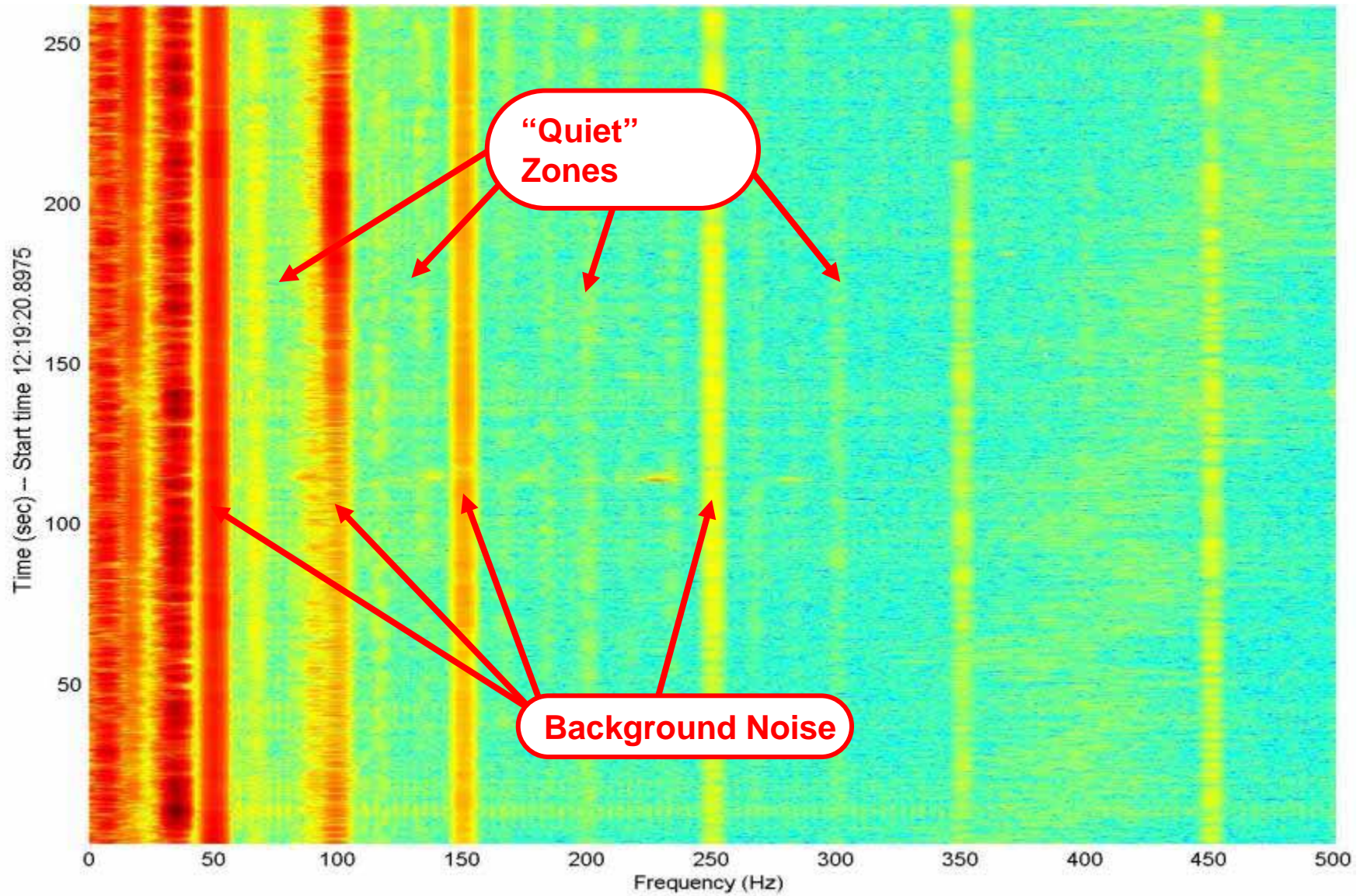


Time Duration Filtering

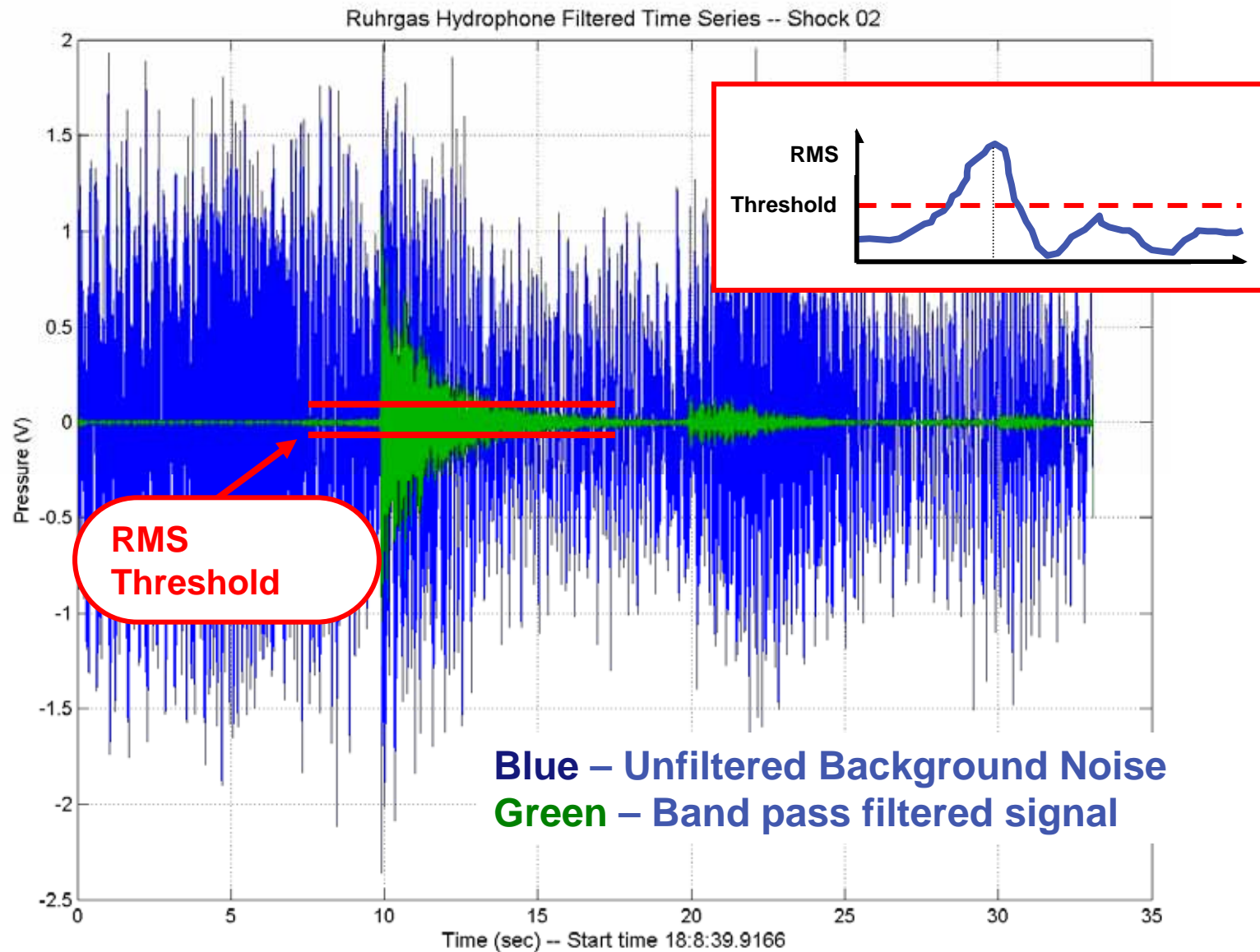
ThreatScan Imposes Min and Max Time limits on shock duration



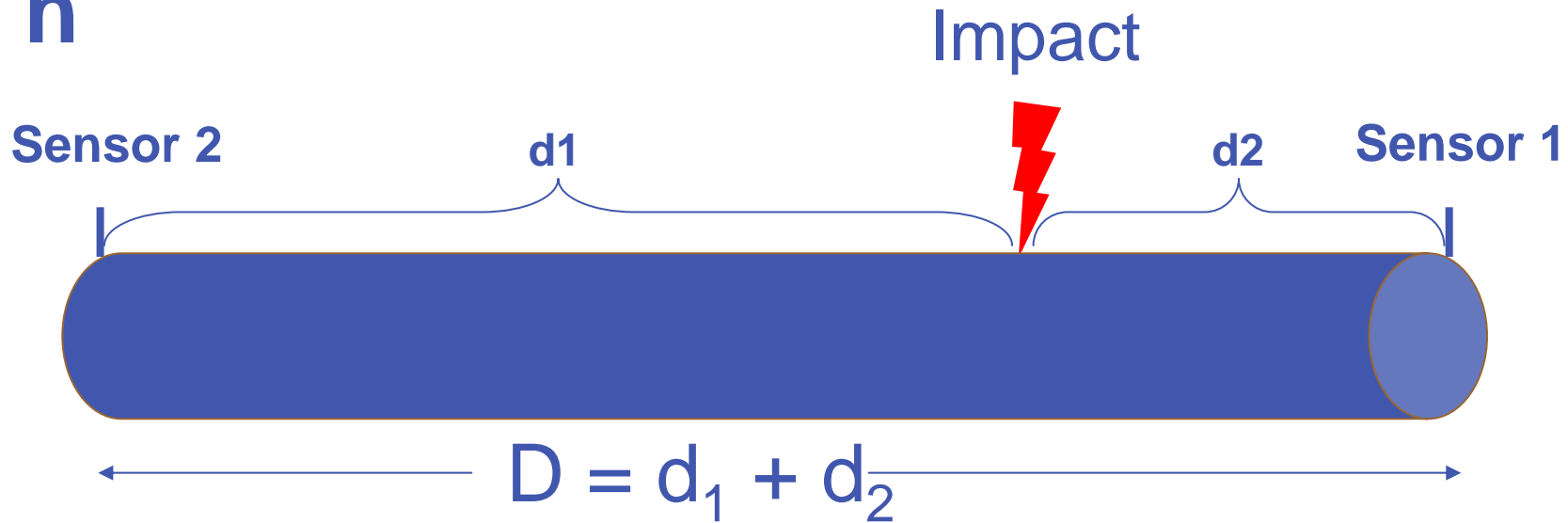
Frequency Filtering



Amplitude Threshold



Localization

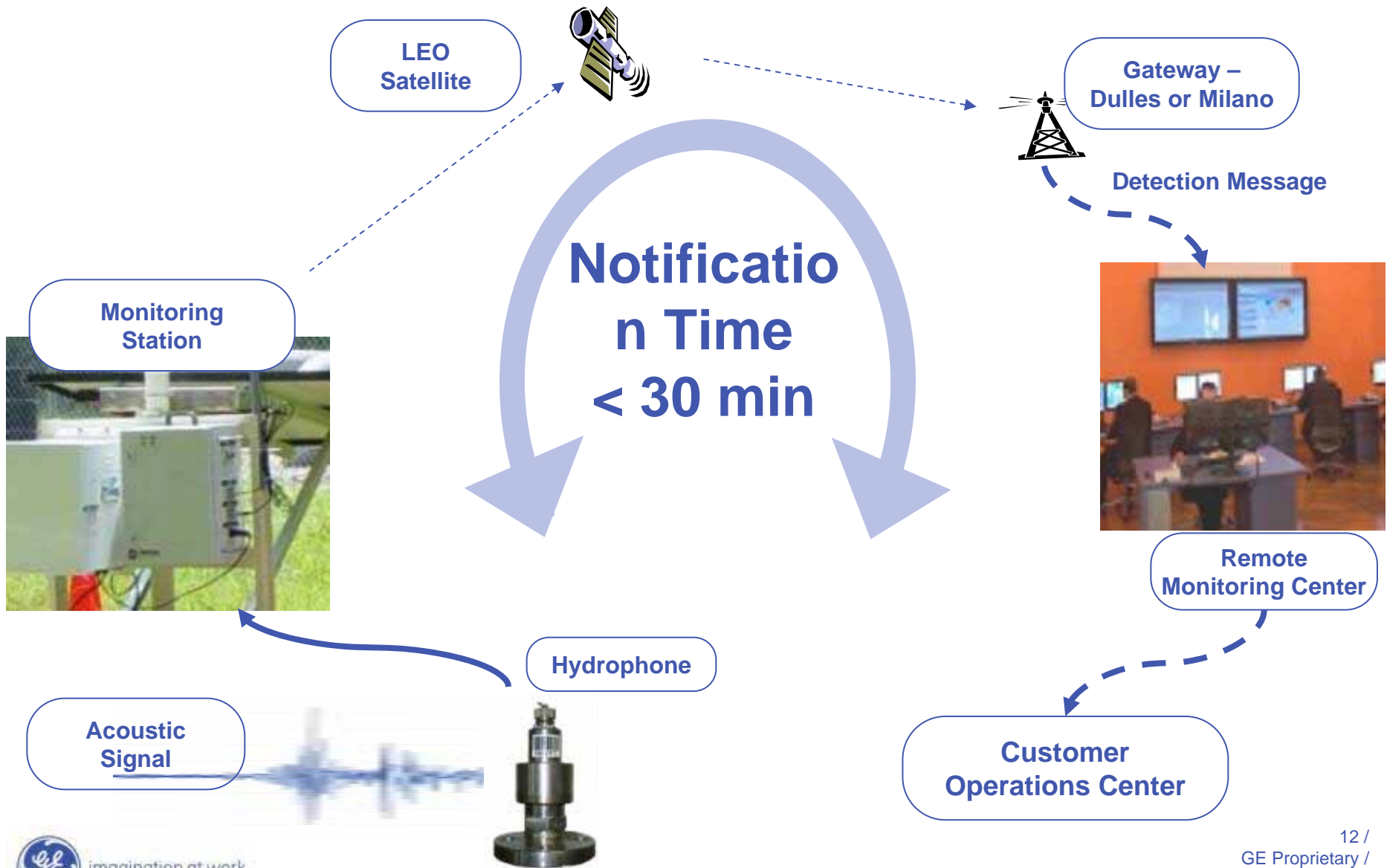


Arrival Time Sensor 1	Arrival Time Sensor 2	Δ Time	Δ Distance ($d_1 - d_2$)
13:00:30	13:00:45	15 sec	$c\Delta T$ $c \equiv$ sound velocity

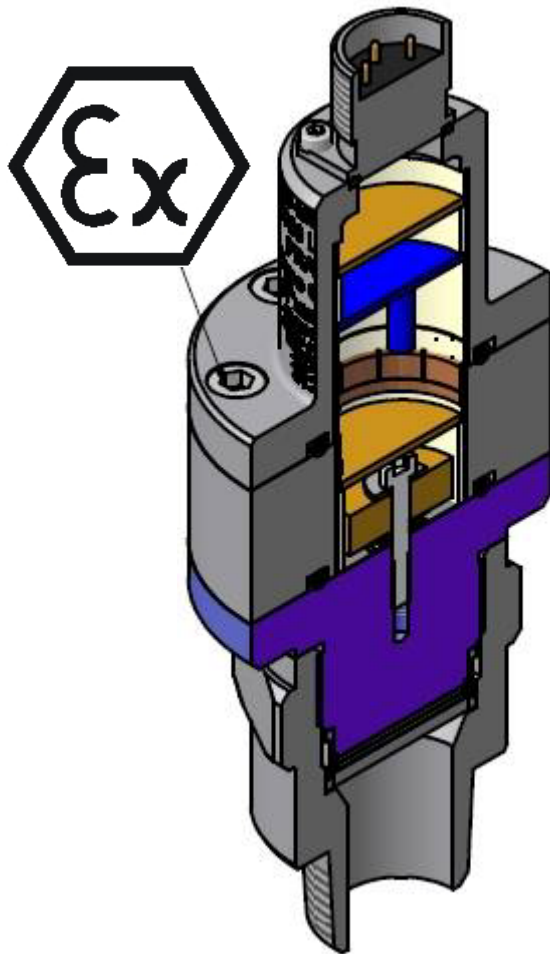
$$\Delta d = d_1 - d_2 = c \Delta t \rightarrow \underline{d_1 = \frac{1}{2}[D + c \Delta t]}$$

ThreatScan™ Components & Specification

Shock Detection Process



Hydrophone Specifications



- **ATEX certified**
- **High Pressure (Rated to 1600 psi)**
- **Long Range Detection (10mi avg)**
- **Resistant to external vibration**
- **Wide dynamic range (1Pa to 30kPa)**
- **Temperature -40°C to +85°C**
- **Attachment 1" NPT or 4 bolt flange**
- **Remotely configurable via satellite from monitoring center**

“The Specification “

- > Pipeline diameter: 6 – 48”
- > Notification timing: 30 minutes
- > Localization accuracy: 2% of sensor spacing
- > Minimum detection: 2,000J or greater impact
- > Sensor spacing: 1km – 20km (median 16km)
 - *Sensor spacing “sweet spot” is 16-28”*
 - *Sensor spacing challenge for large diameter crude*

PRCI

ROW-1 Committee

“Three Test Regime”

Project #: PR-331-05408

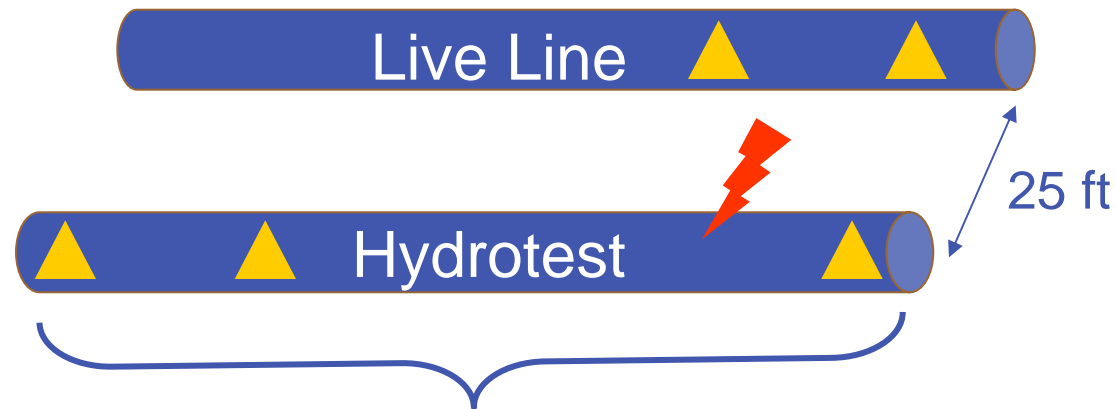


Duke
Ruhrgas
NNG



Duke Energy (Test 1 - Backhoe)

Location: Clinton Mississippi
Date: August 7-8, 2006
Product: Water
Pipe diameter: 30"
Pressure: 1- 20 psi
Sensor spacing (▲): 2, 7 and 9.3 miles from impact



11.31 miles



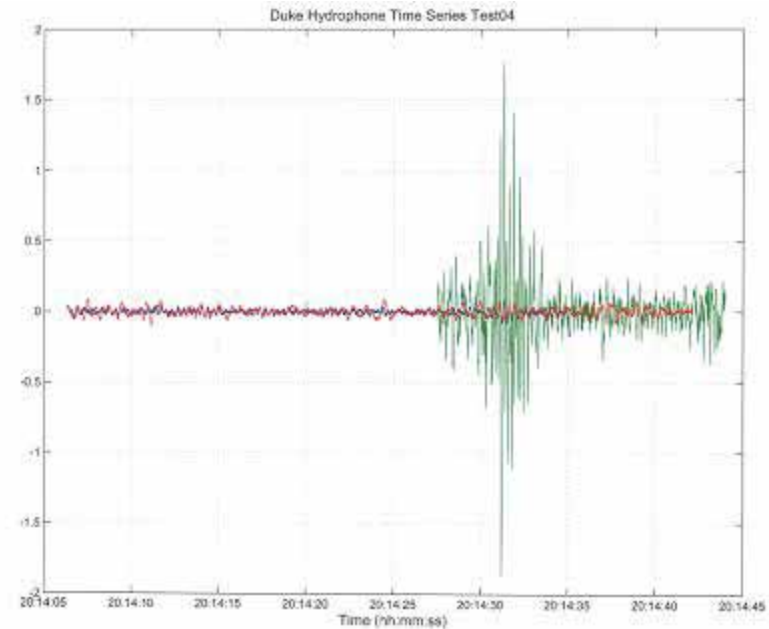
Challenges:

- End-capped pipeline
- Ongoing construction in right-of-way
- Detection of backhoe scratching

Duke - Results

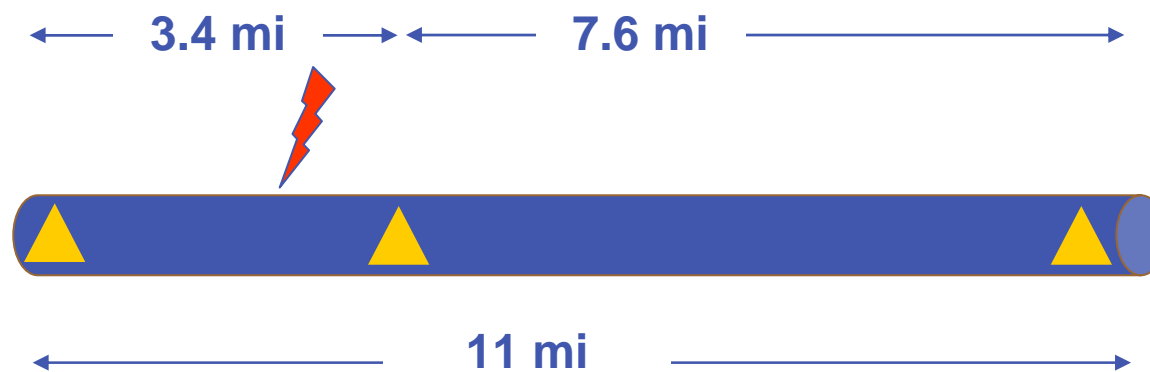


Vshflilfdwlrq	Shuirup dqfh	Suhg lfwhg
Orfdd}dwlrq Huuru	Q2D	Q2D
Q rwlilfdwlrq Wlp h	49 p lq dyj	? 53 p lq
Vp dchvwlp sdfwGhwhfwhg	406õvfudwfkhv	00000

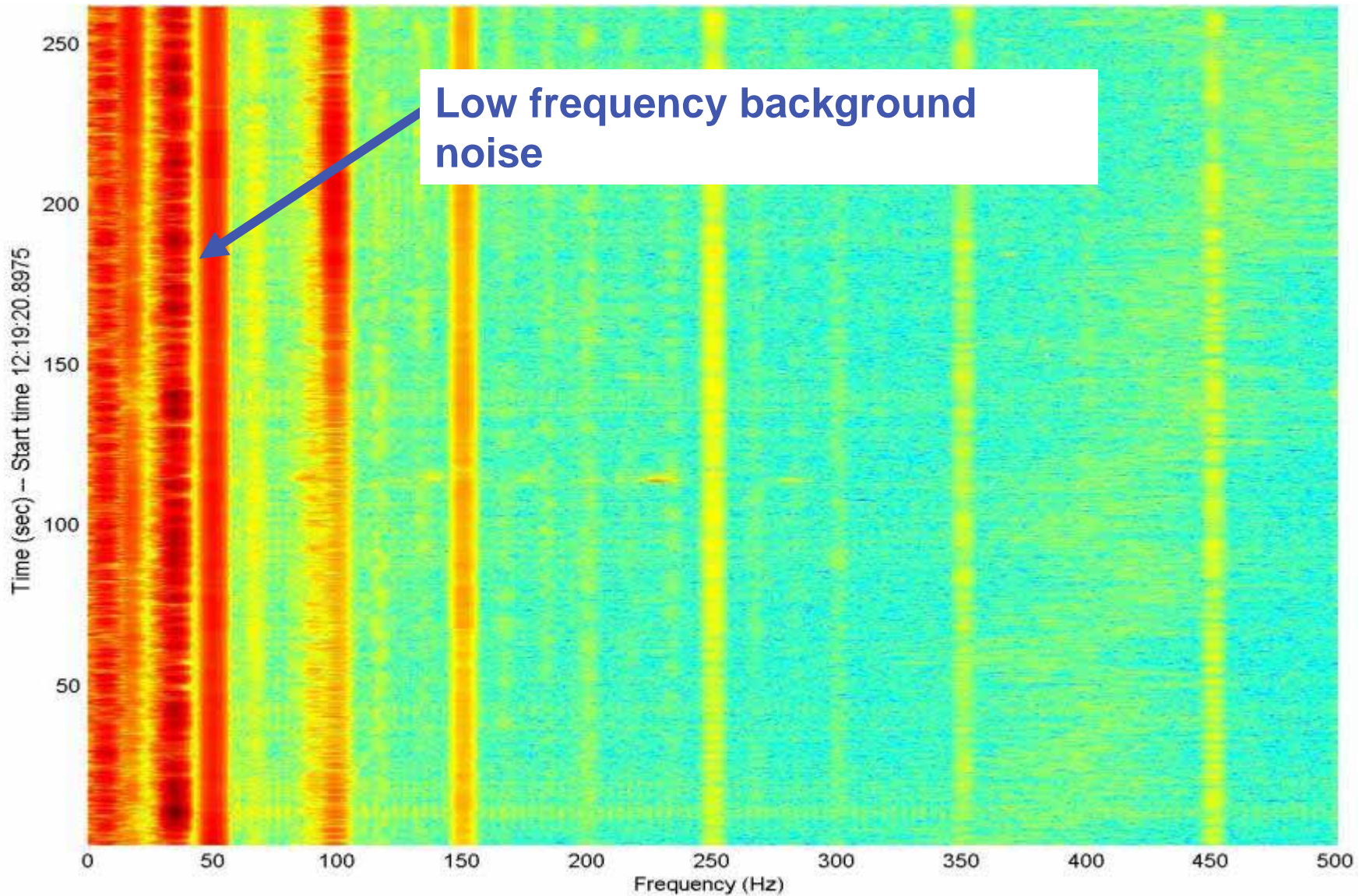


Ruhrgas (Test 2 – Controlled Weight | Ruhrgas

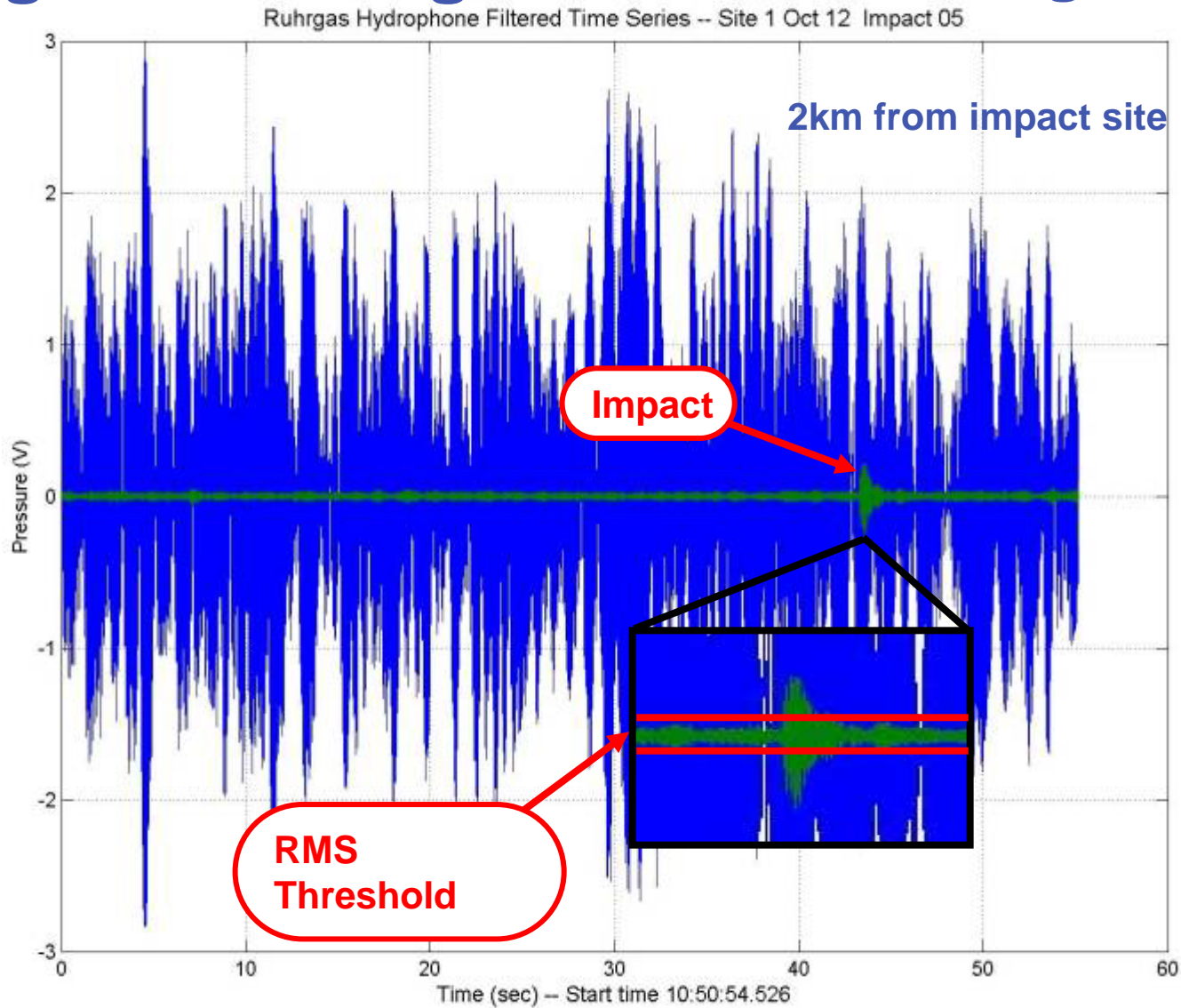
Location: Ruhrgas, Essen Germany
Date: October 11-12, 2006
Product: Natural Gas
Pipe diameter: 40"
Pressure: 870 psi
Sensor spacing (▲): 1.2, 2.2 and 8.8 miles from impact



Ruhrgas Challenge: Saturated Background Noise



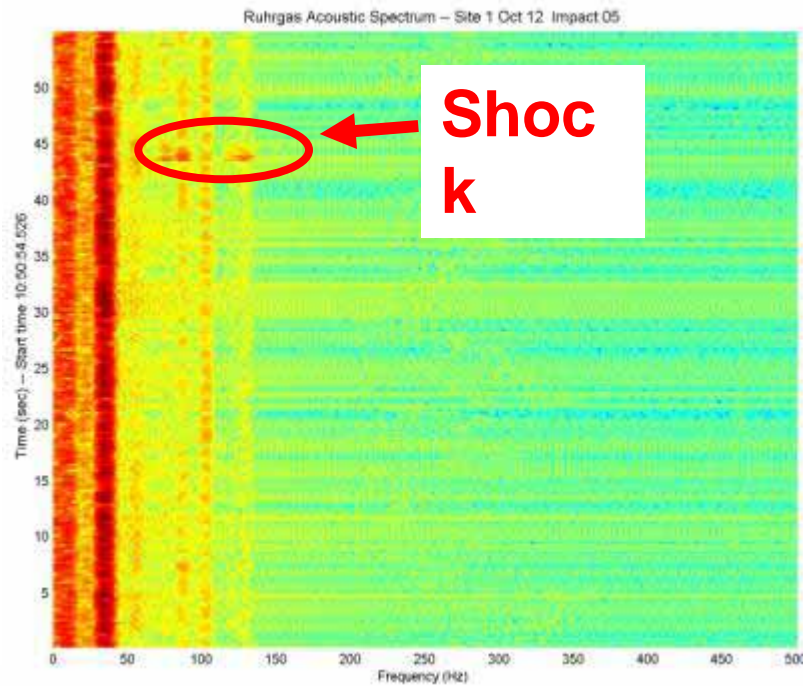
Ruhrgas Challenge: Saturated Background Noise



Blue – Unfiltered Measurement
Green – Processed Signal

Ruhrgas Results

Vshflilfdwlrq	Shuirup dqfh	Suhg lfwng
Orfdd}dwlrq Huuru	:5 iwdyj	477 iw
Q rwlilfdwlrq Wlp h	8k p lq dyj	? 53 p lq
Vp dchvwlp sdfwGhwhfwng	733 Mrxdhv	000000

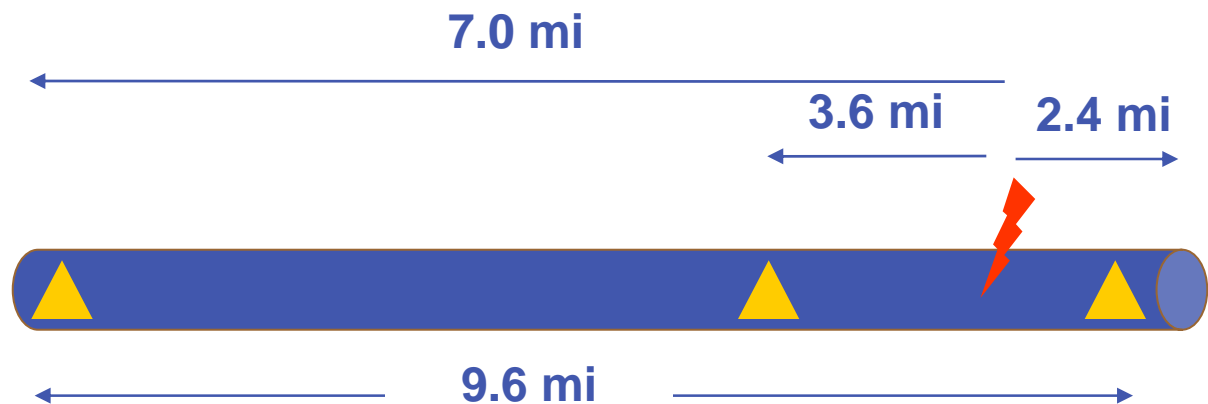


NNG (Test 3 – Controlled Weights)



Location: Omaha, Nebraska
Date: January 19, 2007
Product: Natural Gas
Pipe diameter: 10" (lateral)
Pressure: 870 psi
Sensor spacing (▲): 2.4, 3.4 and 7.2 miles from impact

- Four river crossings
- Two rail crossings



NNG – Sensor Location



Challenges:

- Pipeline buried 15 ft below railroad crossing
- Eight bends between Site 2 and impact site
- Line pressure decreases significantly from Site 1 to Site 3

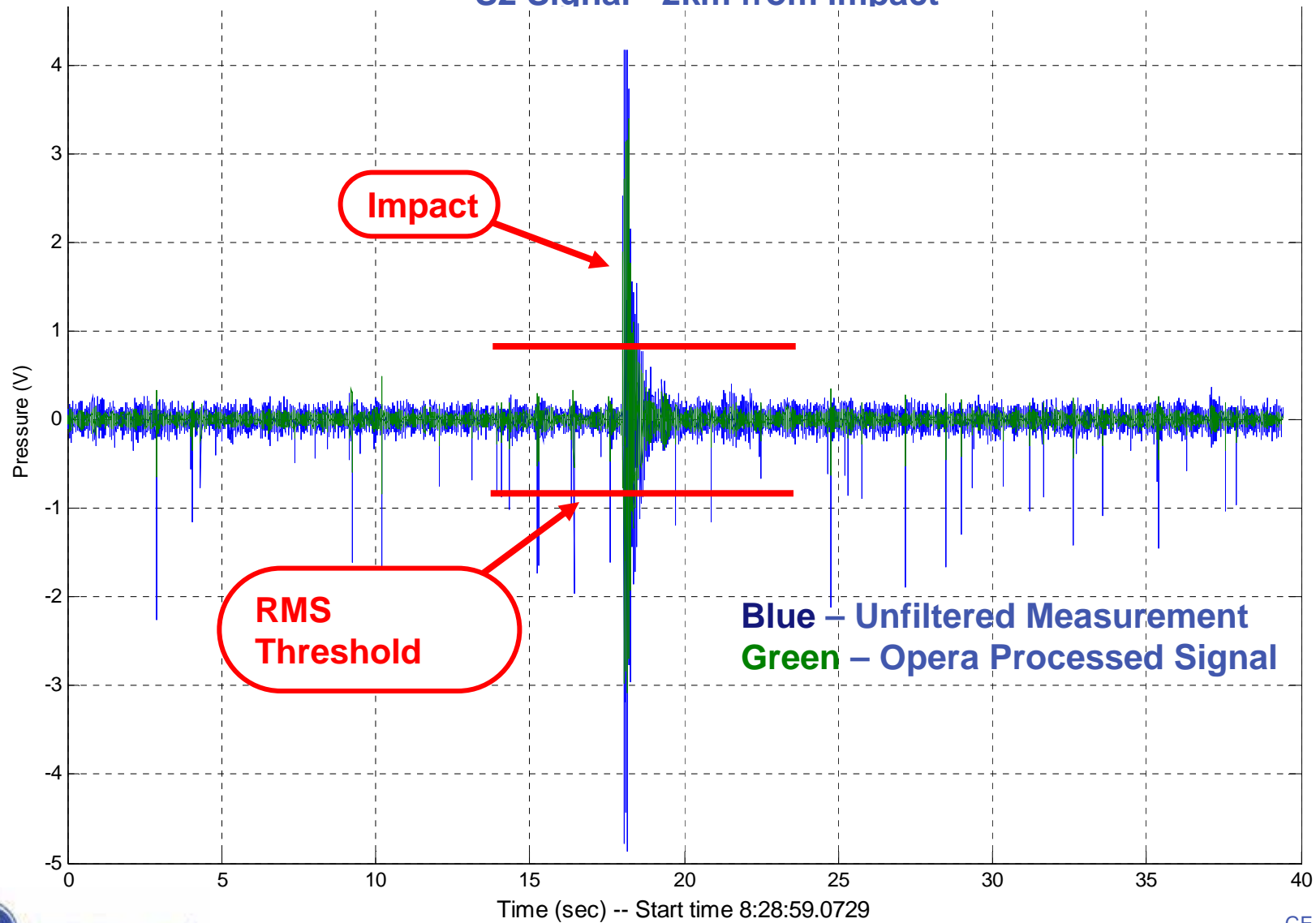
ThreatScan Performance

Vshflilfdwlrq	Shuirup dqfh	Suhglfwhg	Udqj h
Orfdd}dwlrq Huuru	496 æ 56 iw	4<9 iw	9<; 709389 iw
Q rwlilfdwlrq Wlp h	47 æ 43 p lq	? 53 p lq	6063 p lq
Vp dõhvwlp sdfwGhwhfwhg	83 Mrxðiv	00000	00000

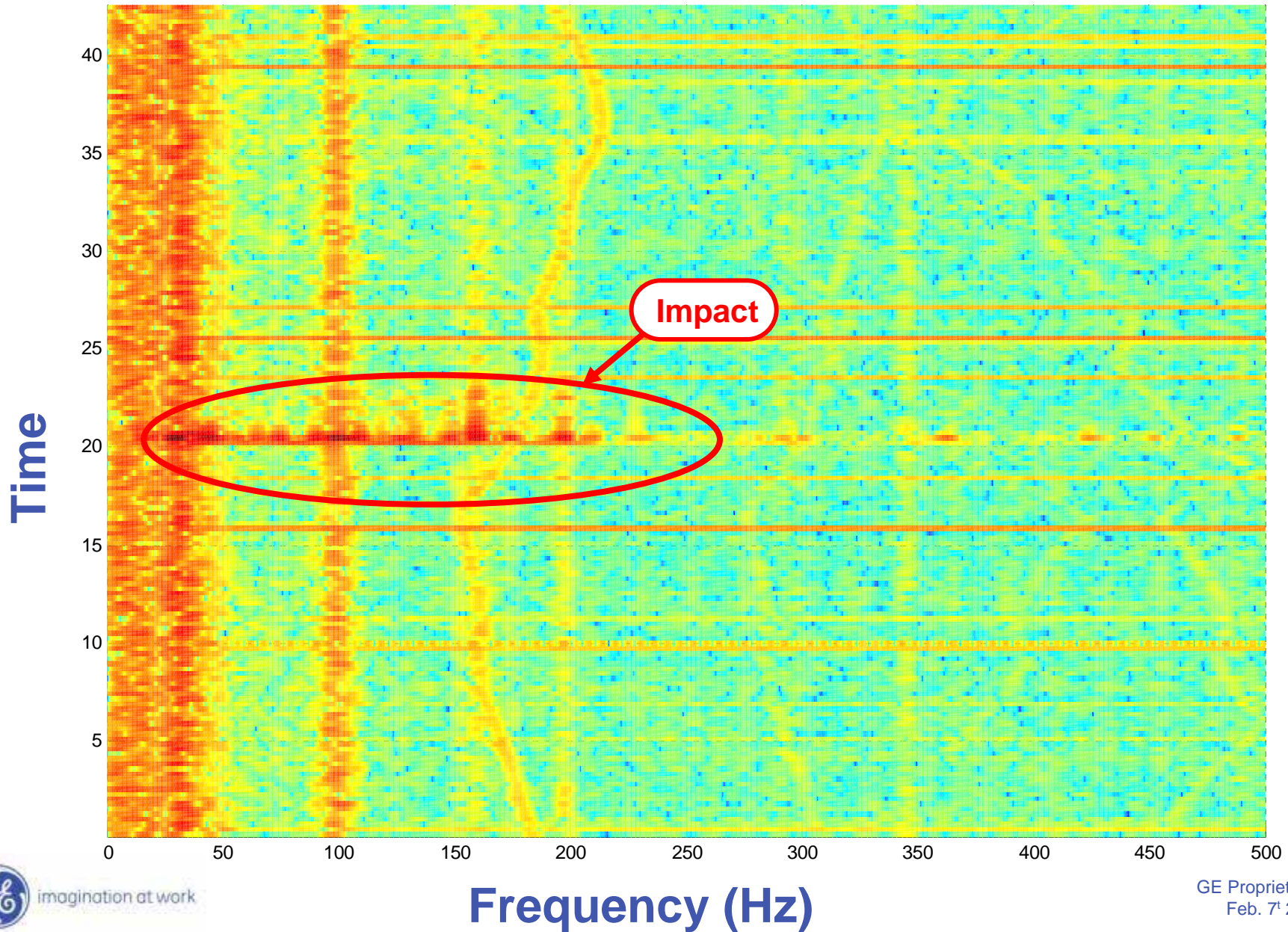


NNG – Shock Signal

S2 Signal - 2km from impact



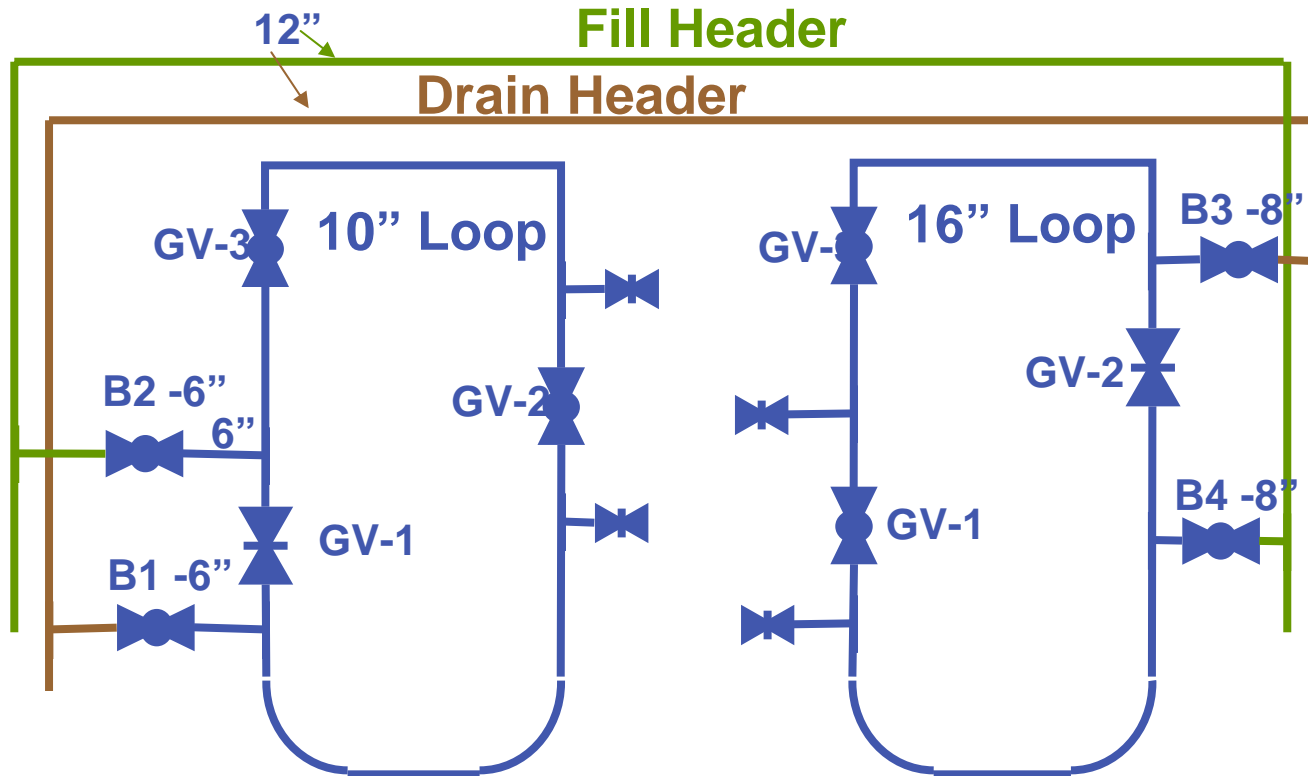
NNG – Shock Spectrum





Testing the Worst Case Scenario

8 – T connections and 8 – Diameter changes



200J Shocks detected at > 4km

Thank You

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