

Acoustic Leak Detection for Water Distribution Systems

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Overview

- **Requirement, Background**
- **Technical Overview of Acoustic Leak Detection**
- **Army Facility Testing**
- **Permanently Mounted Sensor Demonstration**



Requirement / Problem

- Originally developed to detect fuel leaks
- EQ STRAT REQT: Compliance 2.111.2.00
Improved Leak Detection and Prevention Technologies for Underground Storage Tanks (UST) and Underground Pipeline
- EPA Requirement:
 - Annual tightness test
 - Detecting a leak as small as 0.1 gal/hr
 - Probability to detect 95%
 - Probability of false alarm 5%
 - Monthly monitoring test
 - Detecting a leak as small as 0.2 gal/hr

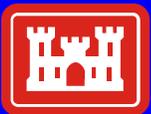


Early DEM/VAL of Acoustic Emission Technology

- EPA - SERDP Testing
- **Army Testing Systems:**
 - Hydrant Lines,
 - Heat distribution high temperature conduit pipe system
 - Deluge fire protection pipelines
 - Dual temperature heating and cooling
 - PVC fire hydrant supply
 - Domestic potable water



Technical Overview



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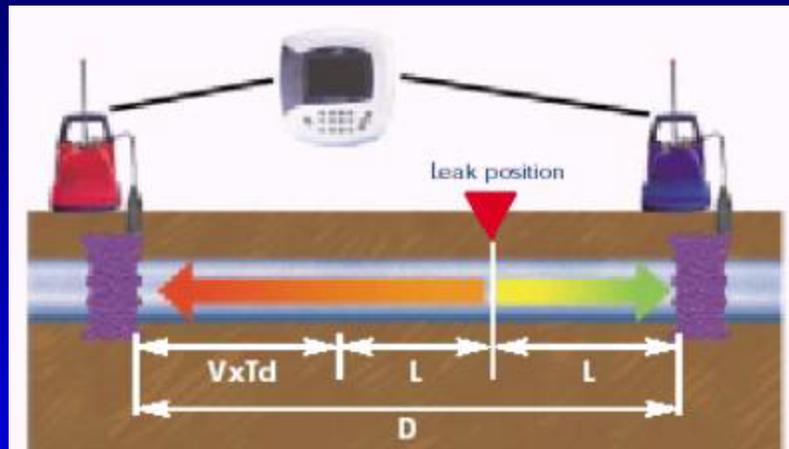
Acoustic Listening Equipment



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Leak-Location Through Acoustic Correlation



The correlation formula

$$L = \frac{D - (V \times Td)}{2}$$

A correlator works by detecting the sound from the leak when it arrives at two sensor points on the pipe, either side of the suspected leak position. The sound arrives at the closer of the two sensors first; then there is a "time delay" (Td) before the sound arrives at the farther sensor. This time delay, combined with knowledge of the distance (D) between the sensors and the velocity (V) of the sound in the pipe, enables the correlator to calculate the leak position (L)



Types of Sensor Mounting

- Acoustic Leak detection on operating HTW double walled pipelines
- Developed simple, generic field method of mounting sensors to carrier pipe
- Waveguide needed due to high surface temperatures of carrier pipe



Types of Sensor Mounting

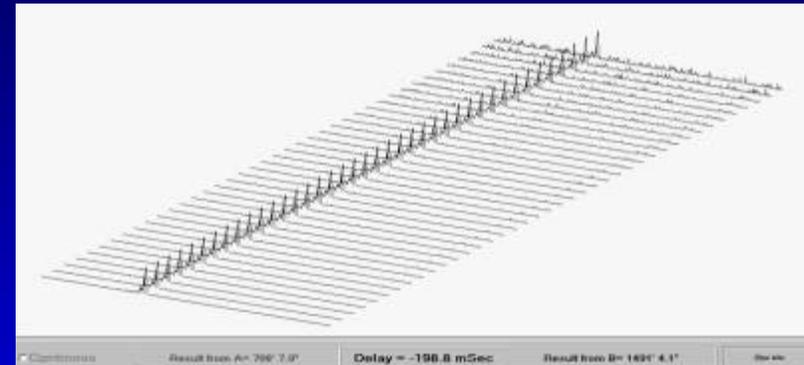
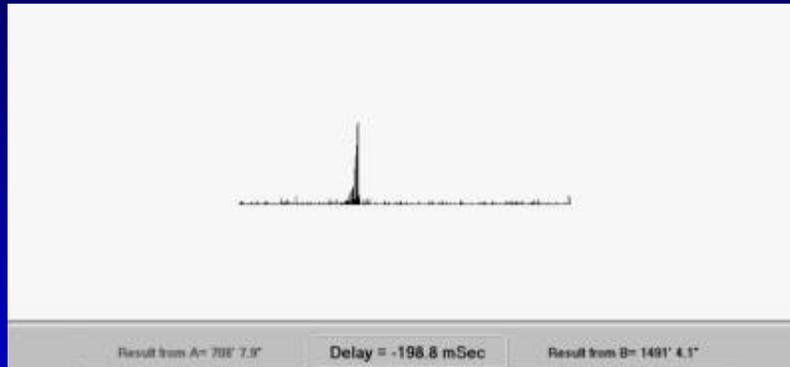


Range of Application

- **Useful on carrier lines with many purposes**
 - **Underground heating**
 - **Cooling**
 - **Fire Suppression/Deluge**
 - **Potable water**
- **Useful on material compositions**
 - **Ferrous**
 - **Copper**
 - **Transite**
 - **Bondstrand**



Pinpointing Location Through Noise Reduction Algorithms



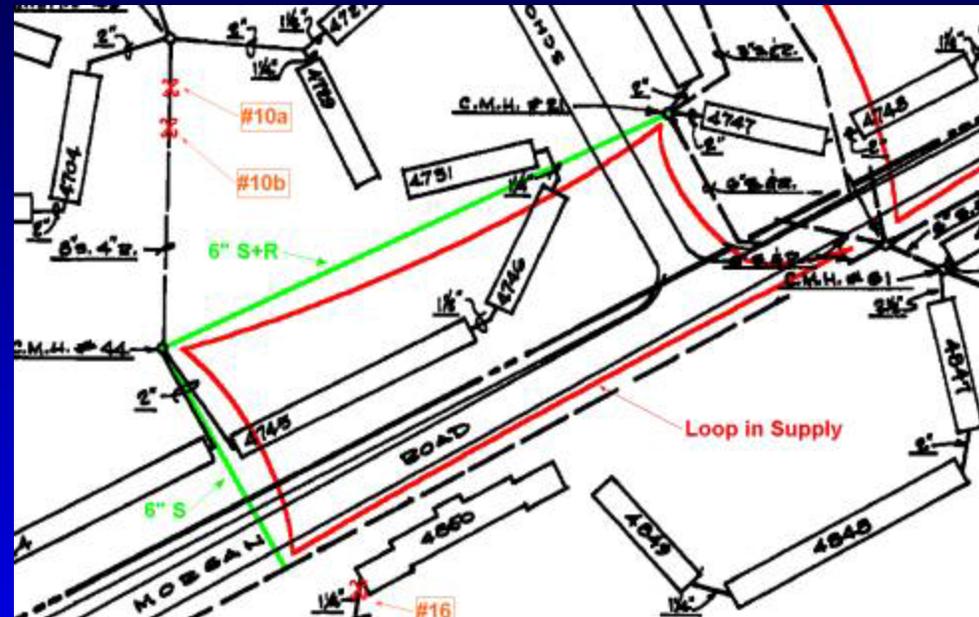
Dual Temperature Heating and Cooling System Leak Survey



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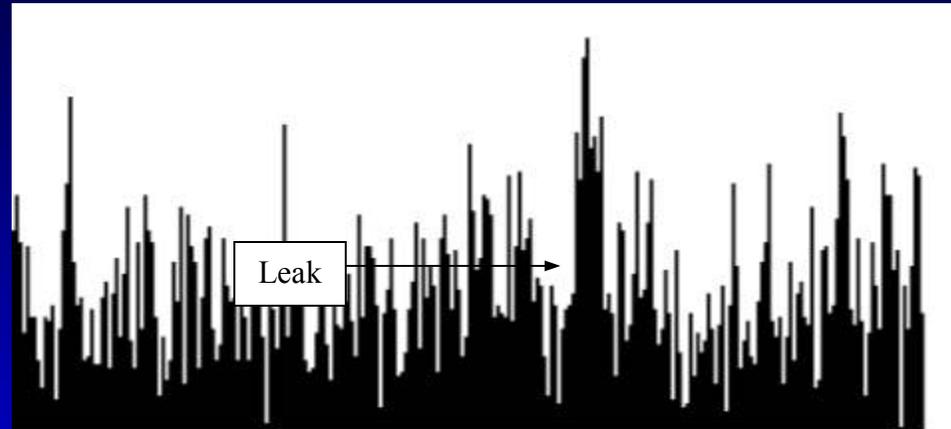
Dual Temperature System



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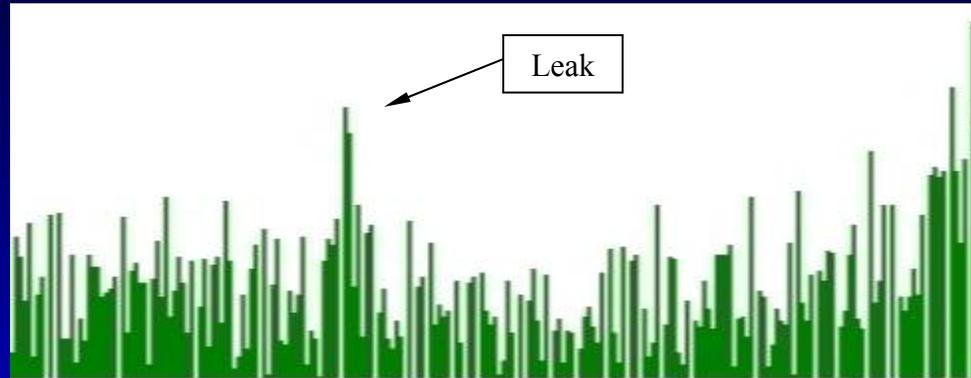
Dual Temperature System



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Dual Temperature System



Domestic Potable Water Leak Survey



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Acoustic Listening Instrument



Texas Sized Fire Hydrant



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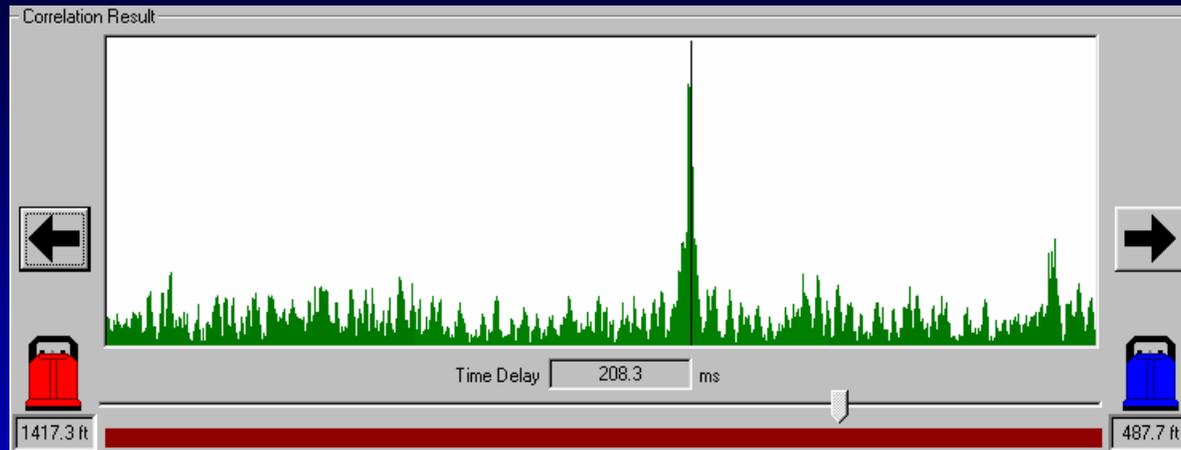
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Summary of Leaks Found

- **Number of Acoustic Measurements Made – 2344**
(for 328 miles, this is an average spacing of 738 feet)
- **Main Line Leaks Found**
 - **With water showing – 4**
 - **Without water showing – 2**
- **Leaks Found At Fire Hydrants**
 - **With water showing – 10**
 - **Without water showing – 57**
- **Leaks Found Inside Buildings**
 - **With water showing – 4**
 - **Without water showing – 33**



Supply Leak



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Leak 1



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Leak 2

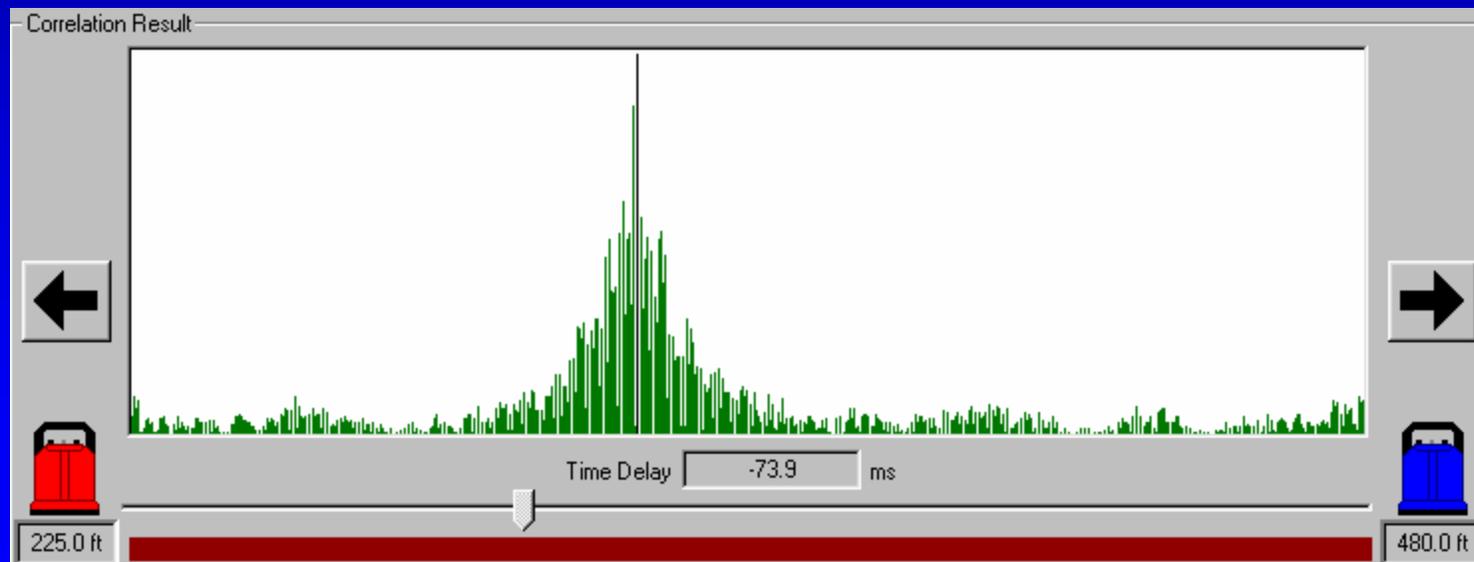


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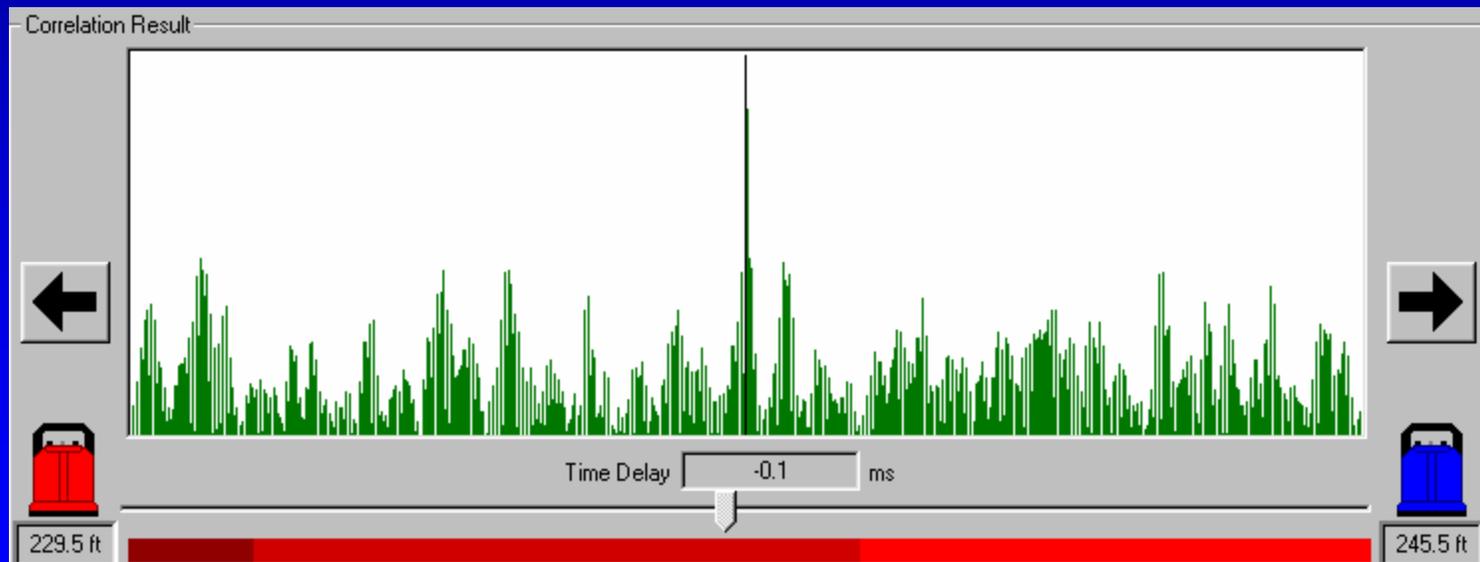
Building 1 Leak

- Although there was no visible surface water at this location, we obtained a strong correlation location. We also heard sounds of flowing water using a ground microphone.
- It is possible this is inside the house.



Building 2

- Although there was no water showing at this location, we obtained a strong correlation location. We also heard sounds of flowing water using a ground microphone.
- There is no alternate explanation for this result.



Conclusions

- **Conclusions**
 - **Acoustic listening equipment is effective at rapidly finding leaks with a sensor placement spacing of up to 1000 feet**
 - **Acoustic listening instruments can listen to flow noise through sensors coupled to a pipe magnetically, mechanically, or through the soil using a ground microphone**
 - **Acoustic Correlation leak detection is highly effective at locating leaks as small as 0.1 gal/hr**
 - **Both instruments are effective on a wide range of pipe materials such as metallic and PVC, and less sensitive on Transite**



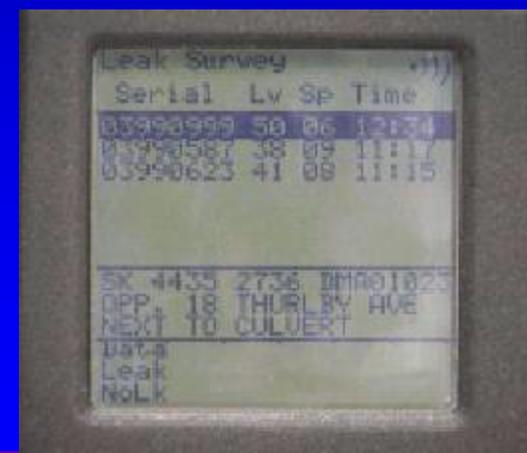
Backup Slides



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Permalog Sensors



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Permanently Installed Sensors

