# PIPELINES CONFERENCE

Calgary, Alberta | July 27–31, 2024

## Multi-Sensor Autonomous Inspection Device (MSAID) for Infrastructure Assessment

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**Contents**

1. Introduction

2. The Need for the MSAID

3. Case Study: Municipality of Jasper

4. Details of the MSAID's Technology

5. Conclusion

## Introduction

- PICA Corp. in collaboration with Russell NDE Systems introduces the Multi-Sensor Autonomous Inspection Device (MSAID),
- End user-focused solution for evaluating the health of critical pressure pipe infrastructure
- Minimally invasive, low-resolution tool addresses asset managers' complex challenges in maintaining aging and intricate pipeline networks.
- MSAID overcomes:
  - logistical constraints
  - delivers rapid data acquisition and analysis
  - empowers informed decision-making
  - ultimately safeguarding vital water and wastewater systems

## The Need for the MSAID

Collecting accurate data to evaluate the state of critical pressure pipe infrastructure presents a myriad of challenges for asset managers:

- These include the inability to take pipelines out of service for extended periods
- Inaccurate record-keeping
- Accessibility due to private property constraints
- Unreported repairs
- Insufficient capital for full replacements

## Solution Offered by MSAID

In response to these challenges, PICA Corp. sought to develop a low-resolution, minimally invasive tool that can efficiently establish a baseline dataset to help develop a comprehensive condition assessment plan for critical water and wastewater infrastructure.

## Case Study: Municipality of Jasper

- Jasper, AB's municipality produced an extra 1,200 $m^3$ of water daily.
- Other leak detection methods, such as a data logger and ground microphone, attempted to find the leak.
- The GIS system was not up to date.

# Case Study: Municipality of Jasper

## Launch Hydrant

The MSAID was deployed in the distribution system

## Navigator

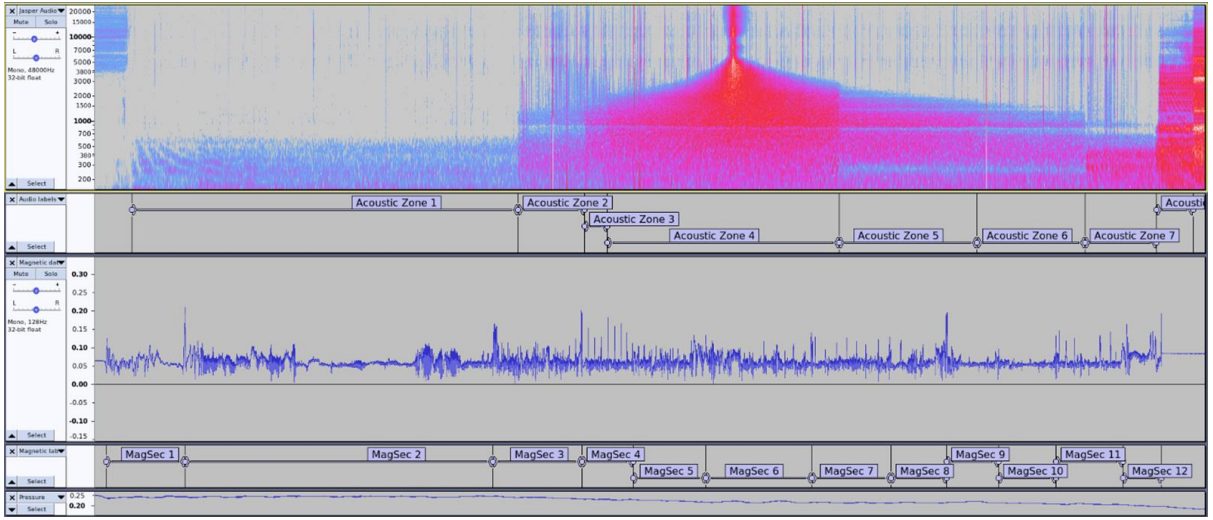
PICA's Navigator data collection device

## Retrieve Hydrant/Catch Mechanism

Device was inserted and retrieved through fire hydrants

## Details of the MSAID's Technology

- Super-Sensitive Ultrasonic Crystal
- Magnetometer
- Pressure Sensor
- Accelerometer and IMU



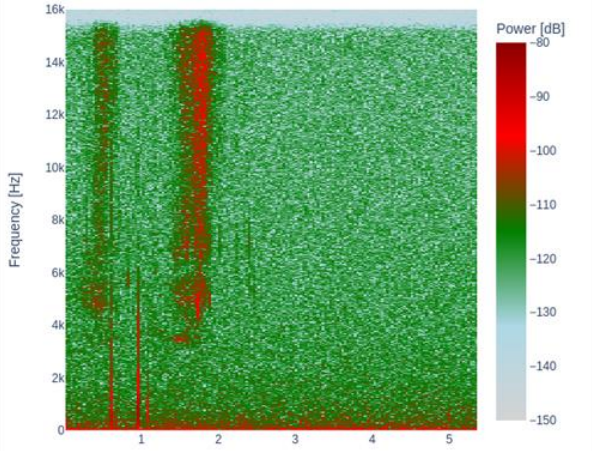
## Super-Sensitive Ultrasonic Crystal

- Uses piezoelectric materials to detect ultrasonic noises up to 30 MHz (human ear can detect up to 20 kHz).
- This sensor is ideal for detecting leaks and air pockets through acoustic anomalies.
- When there is a leak in a pressurized pipe, the water gets forced out due to the pressure difference between the inside of the pipe and the outside environment producing vibrations as the fluid interacts with the pipe material at the leak point.

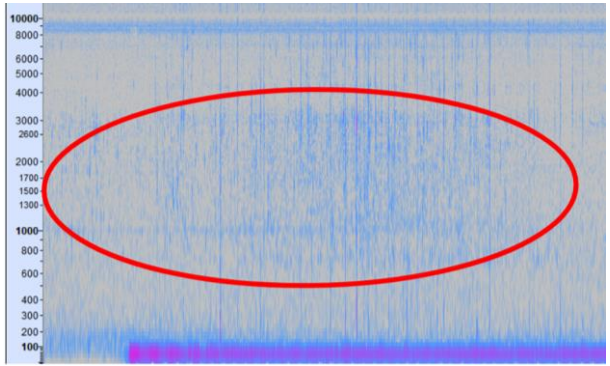
# Use of Acoustic Data for Leaks and Gas Pockets

- The strength and frequency of these vibrations vary based on factors such as the size of the leak and the water pressure.
- These vibrations generate sound waves.

Leak Signature




Gas Pocket Signature



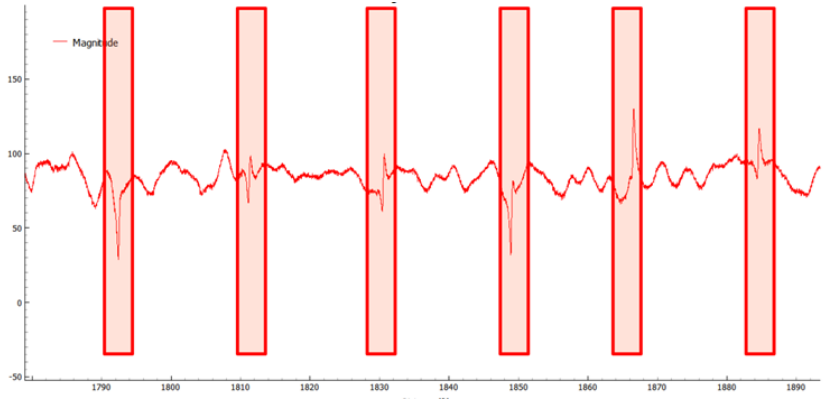

Frequency (Hz) X-Axis, Time (s) Y-Axis

## Magnetometer

- Collects baseline magnetic data in pipes, useful for detecting metallic features in nonmetallic pipelines and changes in magnetic properties due to corrosion in metallic pipelines.
- The Earth's magnetic field can be harnessed to inspect metallic pipes.
- As this natural magnetic field interacts with a pipe's structure, features like joints, bends, and inconsistencies alter the magnetic field flow in specific ways.

## Use of Magnetometer Data to Correlate Acoustic Data

- By analyzing magnetic patterns, we can understand of the pipe's internal structure and condition without physically accessing or visually inspecting it.
- During the inspection observed joints are used to refine speed estimates to determine acoustic anomaly location.




Magnetic Field (uT) X-Axis, Distance (ft) Y-Axis

## Pressure Sensor

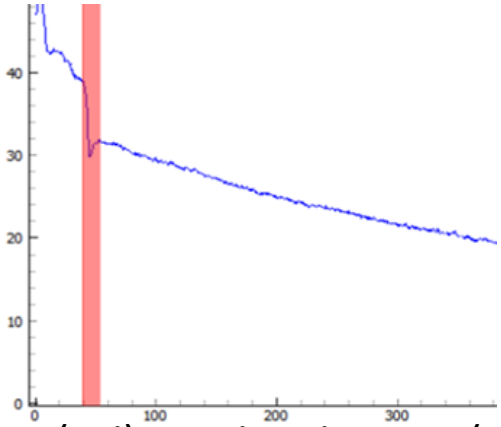
Identify pressure anomalies such as:

- Blockages: Pressure fluctuations can indicate obstructions, debris buildup, or narrowed pipe diameter.
- Deposition buildup: pressure drops can signal the accumulation of deposits
- Leaks and gas pockets: pressure patterns help identify leaks or the presence of gas pockets

## Use of Pressure Sensor to Correlate Acoustic Data

- Pipeline pressure is correlated to the elevation of the pipe.
- Any deviation from that correlation is an anomaly.
- Leaks present a change in pressure from the expected value.

Pressure Anomaly Highlighted Bar




Pressure (Psi) X-Axis, Distance (Ft) Y-Axis

## Accelerometer and IMU

- Used to enhance the accuracy of pipeline condition assessments.
  - Accelerometer - measures the acceleration of the inspection tool traveling through the pipeline. By analyzing these accelerations, analysts can identify changes in the pipeline's curvature and potential bends.
  - IMUs (Inertial Measurement Units) – a sensor that combines accelerometers with a gyroscope. Gyroscopes measure angular rate (how fast the tool is turning). Together, these sensors provide a more complete picture of the tool's orientation and movement within the pipeline.

## Use of Accelerometer and IMU to Correlate Acoustic Data

- Improved location data - By analyzing the acceleration and orientation data, analysts can more accurately determine the position of the inspection tool within the pipeline.
- Enhanced defect detection - The data from these sensors can help pinpoint anomalies in the pipeline's shape, leading to a more comprehensive condition assessment.
- These sensors provide valuable insights that complement other inspection methods, leading to a more precise and reliable understanding of the anomaly location.

Hydrant Launch and Retrieve

Leak Identified within Hours

Data Upload Same Day

Multiple Sensors allowed for narrowing down leak location

## Conclusion

- PICA's autonomous inspection solution represents a fundamental shift in the assessment of critical water and wastewater infrastructure.
- By integrating state-of-the-art technologies and overcoming technological and logistical challenges, MSAID empowers asset managers with a tool that enhances the reliability, efficiency, and overall integrity of pipeline inspections, while also providing a preliminary assessment that helps target high-risk pipelines more effectively.



# Thank you!

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