Panel 3: Valve Capabilities, Limitations and Research

An Overview of Currently Available ACV/RCV Technologies, Limitations & Research

Presented at the U.S. DOT PHMSA & NAPSR Open Meeting
Plaza Ballroom I & II, Hilton Washington D.C./Rockville
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"Panelist Charge"

1. Can you describe the differences in actuate/closure times for manually operated valves vs. ACV/RCV?
2. What are the CAPEX/OPEX costs for installing/maintaining (ACE/RCV/MCV) valves on existing vs. new pipelines?
3. How do external environmental and internal operating conditions impact valve (ACV,RCV,MCV) performance?
4. Has the performance of valves improved with new era designs? (i.e. inadvertent operation)
5. How do human factor issues impact valve performance?
6. Do valves leak? Does installing more valves create additional leak paths or improve drain down times?

Presentation Agenda

- Presentation Content
- Introduction
- Objective
- Risk Analysis & Risk Sensitivity Analysis
- Research Technology & Intelligence
- Case study on “sonic sensor technology”
  - Theory of Operation
  - System Architecture
  - Brief Description
  - Sonic Sesnors
  - Field Processing Units (FPUs)
  - Central Monitoring Station
- Conclusions & Recommendations

Introduction

Federal Pipeline Safety regulations require operators to install in-line sectionalizing ("block" valves) 49 CFR 192 and 49CFR195

Objectives:

To completely shut off (contain) product flow from both routine maintenance and emergency response

To be added to HCAs for added public safety & environmental protection

Benefits & Drawbacks of ASV and RCV

- ASV faster than RCV faster than Manual
- VS
- Unintended valve closure (Circumstantial, Mechanical, Human errors

Consequences: Safety impacts, customer outages, costs

- Gas VS Liquid Hydrocarbons

TECHNICAL TOOLBOXES

Risk Analysis

Use of a ASV/RCV should be determined by Risk Analysis.

If an operator determines and ASV or RCV would be an efficient means of adding protection to HCAs in the event of a “release” (49CFR 192.935(c) and CFR 195), an operator “must”, install the ASV or RCV.

In making that determination an operator must, at least, consider the following factors:
Swiftness of leak detection,
Pipe shutdown capabilities,
Type of “product” being transported.
Operating pressure.
Rate of potential release,
Pipeline profile,
Potential for ignition,
Location of nearest response personnel

Research- Technology & Intelligence

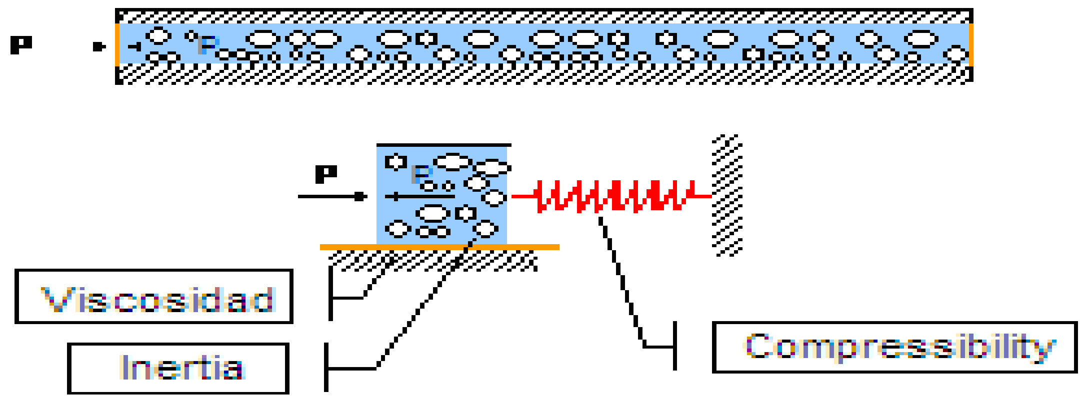
- ASV/RCV/MCV Hardware – Better, faster, cheaper, more robust & reliable
- Continuing SCADA integration & Technology Upgrades at lower and lower costs
- Introduction of Advanced sensor technology, software & Artificial Intelligence (AI) have been lagging BOTH in Pipeline Leak Detection and "containment" devices vs. other industries.
- WHY?

Example Research Case Study- Brazil (Petrobras-CUDTE)

- Intelligent Line Break Detection System (ILBDS) for both Gas & Liquid Hyrdocarbons
  - Theory of Operation
  - System Architecture
  - Brief Description
  - Sonic Sensors
  - Field Processing Units (FPUs)
  - Central Monitoring Station

Theory Of Operation

- Intelligent Line Break Detection (for ruptures and critical leaks) is based on the detection of a pressure transient created when a sudden change is pressure takes place, The pressure transients propagates as subsonic waves throughout the pipeline, in both directions, The pipeline walls work as a guide for the pressure waves allowing them to travel great distances until they reach sonic senors installed in the line.



TECHNICAL TOOLBOXES

Theory of Operation

- Sonic waves can be divided into frequency bands and focused:
- ILDBS uses extremely low and focused frequencies that propagate over long distances (20-40KM)
- Propagation speed depends on the fluid characteristics such as density, viscosity and other factors.

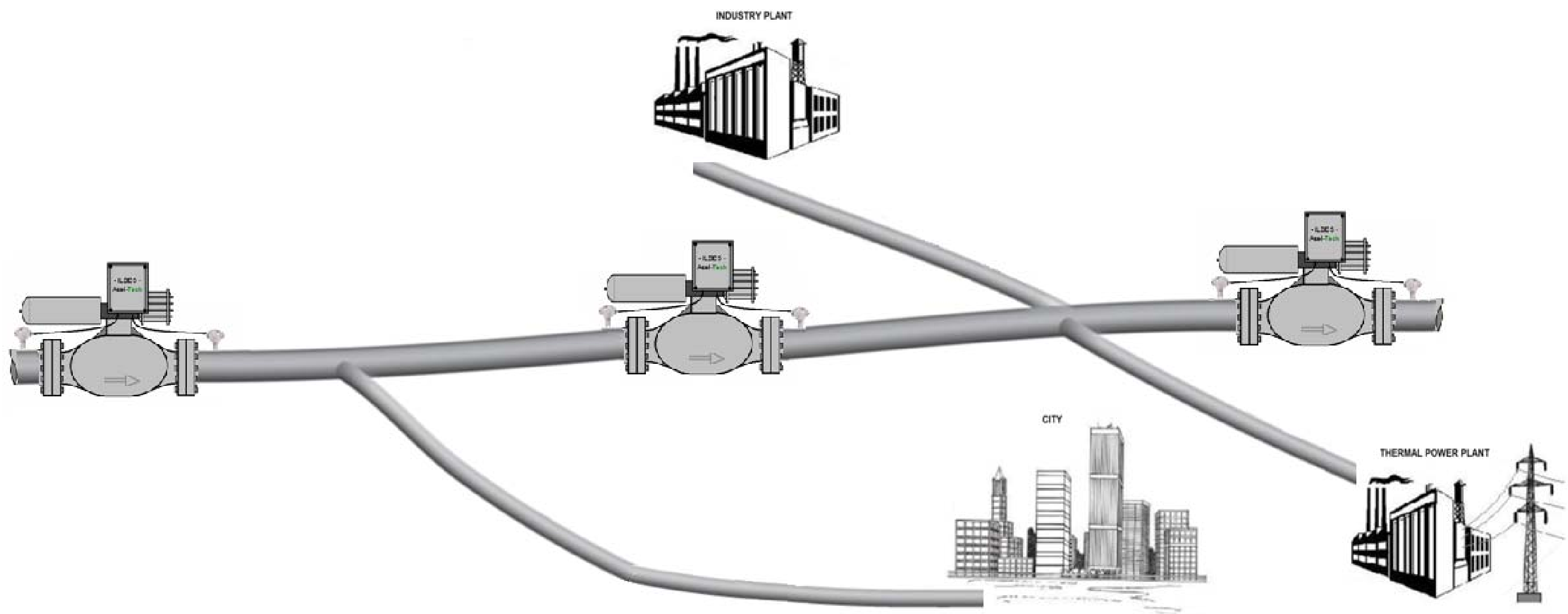
Frequency	Range	Example
> 20 kHz	Short Distances	Bats, for flights
20 Hz - 20 kHz	Average Distances	Human hearing
Subsonic Frequencies		
< 20 Hz	Long / Ultra-long distances	Elephants, Rhinoceros, SLDS, Earthquakes

TECHNICAL TOOLBOXES

System Architecture

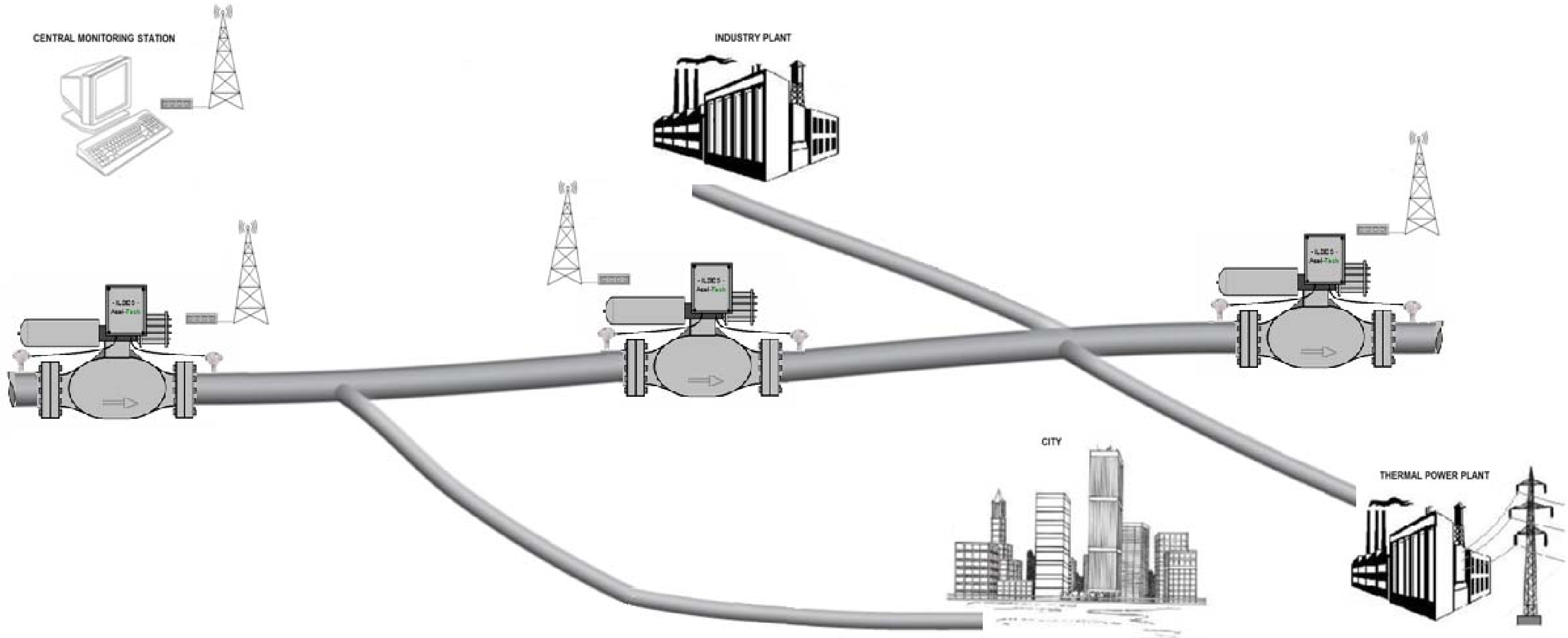
- When the sound wave reaches the sonic sensors, the information is transmitted to the iLBDS electronics, which is responsible for processing and identifying in real time the incoming events, The Field Processor Units (FPUs) employ several advanced techniques for signal processing and recognition including filtering, pattern recognition and Artificial Intelligence and Neural Networks.
- There are two main architectures available for ILBDS, the stand alone architecture and the distributed architecture.

Standalone Architecture



TECHNICAL TOOLBOXES

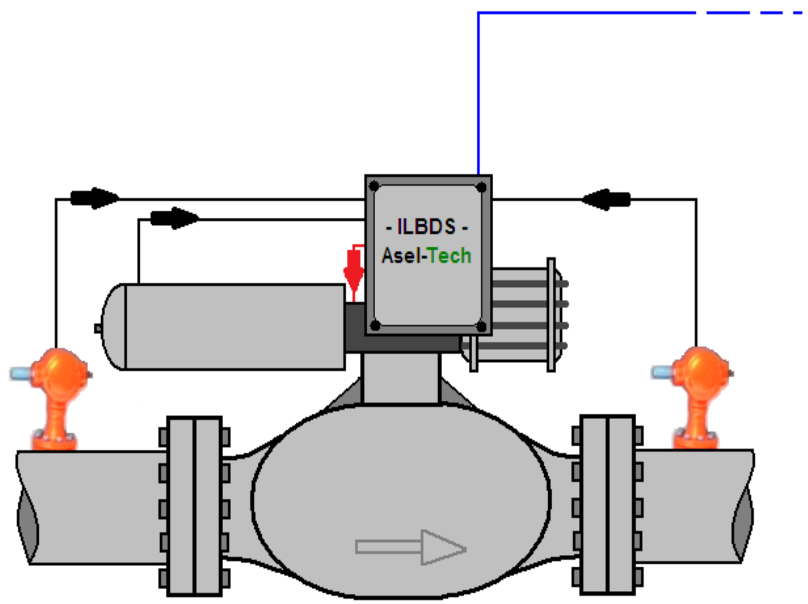
Distributed Architecture



Brief Description

- The ILBDS can detect and identify events in seconds avoiding erroneous actions and mistakes that can create unexpected situations such as pipeline shutdown based on partial or poor information.
- The spurious noise databases, filtering combined with Artificial Intelligence (AI) and Neutral Networks integrated into the acoustic sensor offers a unique system for pipeline break detection and protection (containment)
- Combined with other scientific principals ("internal",etc.) for pipeline line break and leak detection, reliability and confidence increase dramatically while minimizing False Alarms.

ILBDS Main Components



ILBDS Main Components

- Whenever possible, pairs of sensors are used, observing adequate distance from each other. The installation of redundant sensors eases the identification and filter out interferences. The sensors are assembled in adequate enclosures to proper mechanical protection, as displayed earlier, flanges connect them to the process.
- The installation in the line can be made using “Hot Tapping Machines,” without needing to stop pipeline operation. Therefore, there is a reduction in the system installation cost, as there are no production losses during installation.
- Besides working as a redundancy, the installation of a pair of sensors allows them to be used as a phase detection filter, providing the origin of events identification. It is important to observe the distance between these two sensors as they operate complementarily.

Field Processing Unit (FPU)

- The Field Processing Units are responsible for the acquisition and processing sensors' signals. The FPU monitors continuously the output signals of the acoustic sensors, and executes a complex processing to properly identify the line break signal event discarding all the other operational interference.
- GPS (global positioning system) antennas are used in the distributed architecture to synchronize the clocks in each unit. Thus, the time synchronization between the units is guaranteed regardless of the communication system.
- In the distributed architecture the event information along with its exact time stampis sent totheCentral Monitoring Station through the FPU network.

Field Processing Unit (FPU)

- One of the main algorithms used in the FPU processing is the artificial neural network. An artificial neural network is a system based on the operation of biological neural networks, in other words, is an emulation of biological neural system. The original idea comes from the brain structure itself, or more specifically, the brain neurons.
- Artificial Neural Network is a method to solve problems similar to the human brain behavior of learning. Computational technique model inspired on the neural network of intelligent organisms are able to create knowledge from experience.
- Each neuron or processing unit is able to send and receive information and it is connected to all other neurons. They can also have a local memory. This structure works similar to the brain neuron, where all the inputs are summed and there is an output depending on the result of that sum.

Conclusion & Recommendations

- MCV and RCV require human intervention
- No ASV can ever be smart “enough” without “human intervention”.
- Integration with other independent scientific principles is required to develop a “fail safe” operating procedure.
- You can NEVER totally eliminate risk – Lets all be honest!
- Human Factors, selection, education & constant testing is critical.

Thank You

For more information contact:

Joseph Summa
President & CEO
Technical Toolboxes, Inc.
(Strategic Partner of the Pipeline Research Council International)
3801 Kirby Drive, Suite 520
Houston, Texas 77098 USA

E-Mail: jsumma@Ttoolboxes.com
Cell: 713-828-1318
Office: 713-630-0505 Ext 203
Fax: 713-630-0560