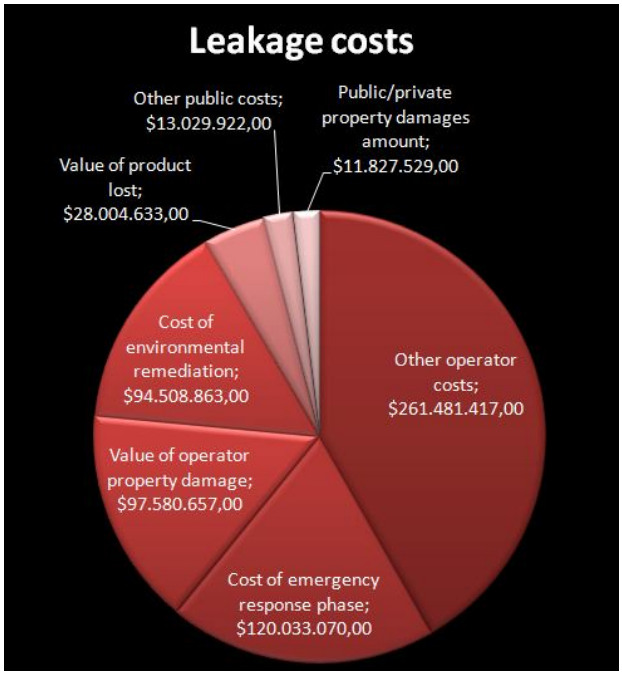
PIPELINE FAILURES
are
A Major Topic of Concern

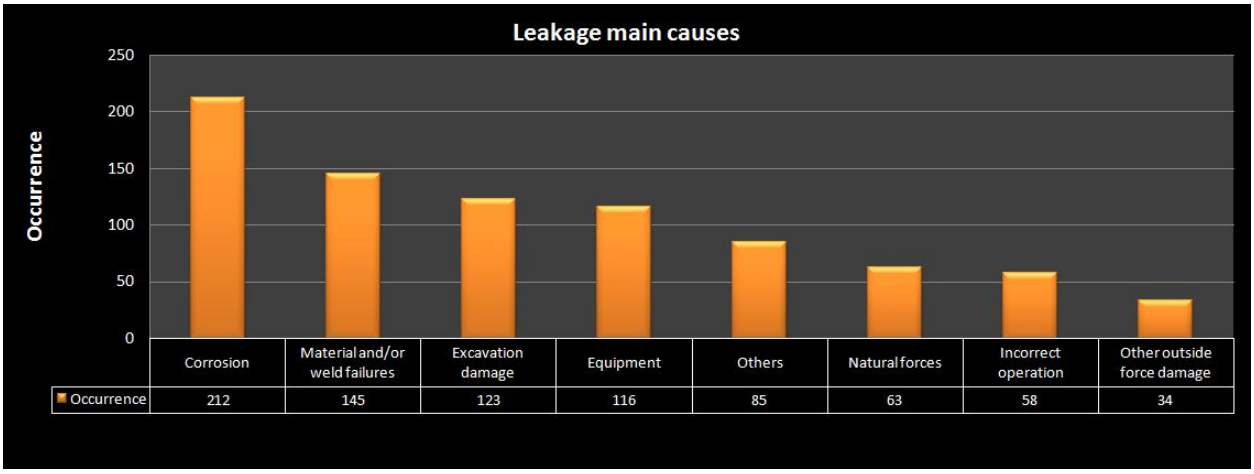
The following Data Graphs are directly from PHMSA – The Pipeline and Hazardous Materials Safety Administration (of the US Department of Transportation). The data is gathered from virtually all American pipelines companies from 2002 to 2009.

Environmental accidents with oil products and derivatives can be defined as unexpected product discharge events that directly or indirectly affect the safety, and or health of people and or the environment. These events not only impact health and the environment, but result in very high operating costs to pipeline operators, as shown in Graph 1. This chart shows that the direct (documented) costs of these events surpassed **$ 600M**. Indirect costs such as stock devaluation and lost revenue are not depicted, but are estimated to be substantially higher than direct costs – likely in the **$billions**.



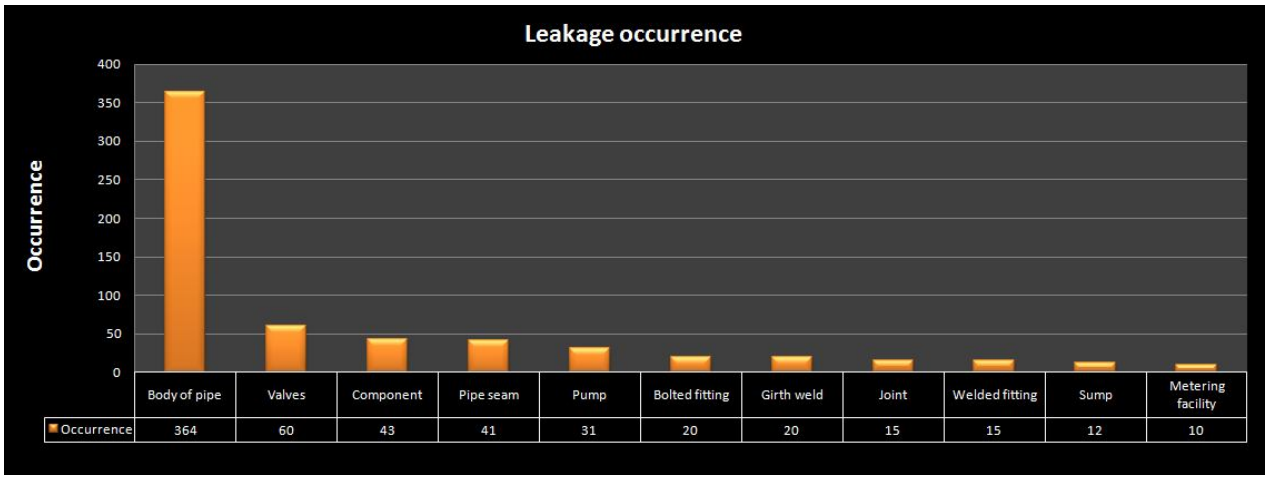
Source: PHMSA Significant Pipeline Incidents in the US, 2002-2009.

The Primary Causes of “Major” US Pipelines Failures



Source: PHMSA Significant Pipeline Incidents in the US, 2002-2009.

Where Failures Tend to Occur in Pipeline Systems.

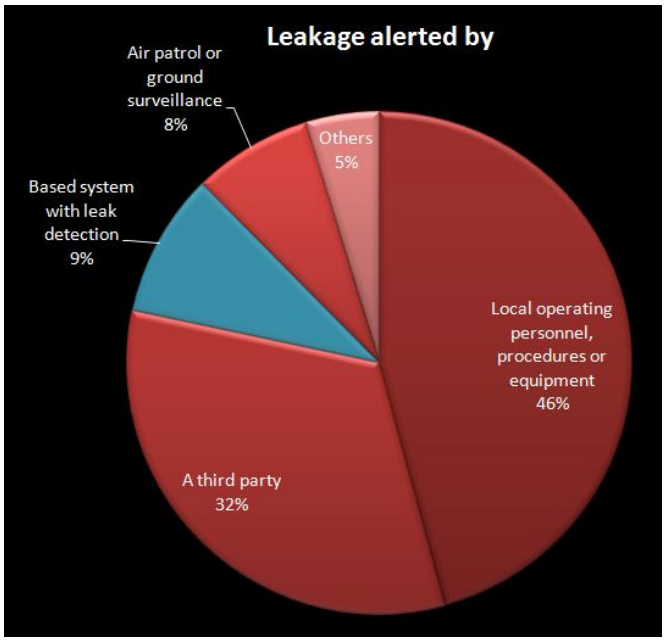


Source: PHMSA Significant Pipeline Incidents in the US 2002-2009.

Mitigation of risk associated with any pipeline failure is actively managed by implementation of a good mechanical integrity plan. Good Mechanical integrity plans are designed and implemented around many specific parameters associated with a particular pipeline, and generally focuses on failure prevention. Good plans however, must also include leak detection and failure response measures in the event of a leak.

Early detection of pipeline leaks is crucial to a good pipeline failure response program and can make the difference between a significant/major event and a less significant one.

PHMSA statistics (opposite) indicate that unfortunately 78% of leaks were only detected after significant damage had occurred, and only 9% of the failed pipelines that leaked were alarmed with Leak Detection Systems.



Graphic 5 - Source: PHMSA Significant Pipeline Incidents, 2002-2009.

A **reliable Leak Detection and Location System** is fundamental to reducing or even preventing major "events" as reported by PHMSA in the tables above.

An Innovative Approach to Pipeline Leak Detection

Leak Detection Systems (LDS) are specially designed tools that help operators to quickly identify and react to a pipeline failure. These systems continuously monitor pipelines operational parameters and will alarm when deviations associated with a leak are detected. Response time, sensitivity, reliability, accuracy and robustness are essential performance parameters used to evaluate LDSs.

The most common methodology in use for leak detection in liquid pipelines today is “Mass Balance”. A methodology whereby pressure & flow variations are detected in the flow metering equipment via complicated algorithms programmed into the system. The system will alarm when pre-programmed variables & data are detected. Mass Balance systems are effective in estimating the quantity of liquid product leaking. One of the drawbacks is the time it takes time to detect a leak – in some instances it can take days. Mass Balance Systems are generally not reliable to detect leaks with volumes less than 5% (10% in some cases) of the pipeline volume. The mass balance methodology is not suitable for multiphase or gas pipelines and has major issues with pipelines that experience variations in flow & pressure.

Asel-Tech has developed a new Integrated Leak Detection System (ILDS). This new system integrates conventional “mass balance” with a very new and innovative “Acoustic” technology system. The acoustic technology of the ILDS is designed to detect negative pressure wave signatures generated in a pipeline at the onset of a leak. Asel-Tech’s ILDS’ combination of Mass Balance & Acoustics offers pipeline operators the often recommended “redundant” leak detection systems for pipelines carrying hazardous materials. The combination of these two leak detection technologies in one system allows pipeline operators to take advantage of the synergy inherent between the two technologies.

Integration of mass balance and acoustics allows for a comprehensive and unique leak detection system unsurpassed on the market today. Mass Balance Systems alone provides leak quantification information, but tends to require a substantial amount of time to detect a leak. The acoustic system on the other hand will detect a leak in a matter of seconds, as the negative pressure wave travels at the speed of sound through the pipelines content. The Acoustic system is also able to indicate leak location, further complementing Mass Balance.

Negative Pressure Wave Methodology

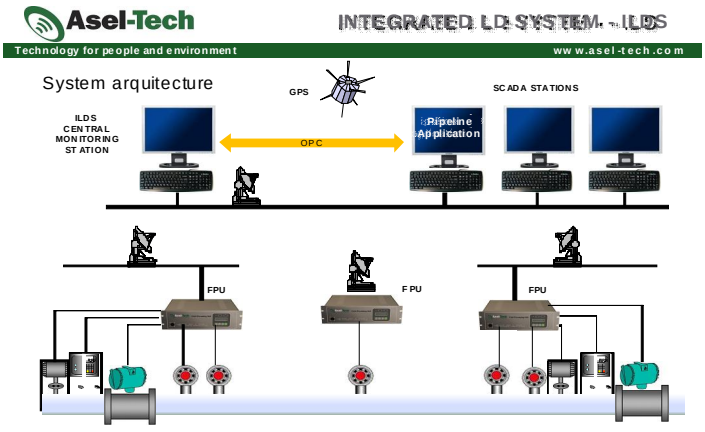
The negative pressure wave methodology of leak detection is an accepted technology and is mentioned in API 1130. Also known as sonic or acoustic LDS, it works based on the identification of hydraulic transients associated with the onset of a leak. The transients propagate as wave fronts through the fluid (or gas) in both directions at the speed of sound. The wave fronts are guided by the pipeline walls and can travel over very long distances. Distance is dependent on the pipeline product, pressure, temperature and diameter. Sensors installed at both ends of the monitored pipeline section detect the sonic waves.

Detection of the wave is timed at each sensor which is then able to calculate the leak location based upon time of flight of the wave. Time accuracy is assured by a GPS interface, which keeps all the Field Processing Unit clocks precisely synchronized.

False Alarms can be an issue with in any LDS. The Asel-Tech alarm validation and trend analysis module comprises special algorithms incorporating artificial neural networks (ANN). This improves the system's ability to distinguish real leaks from various operational events (i.e. pump start/stop, valve openings etc.), and thus dramatically reduces false-alarms.

System Architecture

The ILDS architecture and its primary components are shown in the figure opposite. The ILDS System is compromised of Acoustic Sensors (FSS), Field Processing Units (FPU) and a Central Monitoring Station (CMS). The Mass Balance requires transmitters at both ends of the pipeline (pressure, temperature, flow and density) also sharing the Central Monitoring Station (CMS).



Summary Statements – Asel-Tech's ILDS

- ✓ Integrates 2 complementary leak detection methodologies compliant with API 1130 - Acoustics & Mass Balance
- ✓ Stand alone sonic system (SLDS) is suitable for multiphase & gas pipelines
- ✓ Suitable for pipelines with varying flow & pressure
- ✓ Adaptability to different operational conditions with AI learning capability
- ✓ Easy integration with SCADA using OPC and commercial supervisory packages
- ✓ High sensitivity and fast response time
- ✓ Location accuracy better than 2% of the monitored length
- ✓ Detects progressive, pre-existing, and sudden leaks
- ✓ Detects leaks even in shut-in condition
- ✓ Complete leak report with leak location, time stamp, rate, spilled volume and graphical trends
- ✓ Sophisticated signal processing including artificial neural networks and multi layer detection algorithms
- ✓ Mass balance algorithms relying on Computational Fluid Dynamics (CFD) models
- ✓ Precise line pack calculation including transient regimens
- ✓ Cross checking alarm validation and trend analysis
- ✓ Very Low false-alarm rate;
- ✓ Easy installation and set-up

Following is a table comparing features of Asel-Tech's ILDS, Asel-Tech's SLDS, a competitive acoustic system, and a stand-alone mass balance system.

	ILDS (Acoustic + Mass Balance)	SLDS (acoustic only)	Acoustic	Mass Balance
MANUFACTURER	*ASEL-TECH*	*ASEL-TECH*	*Competitor*	*Various Vendors*
Suitable for Liquid, Multiphase, and Gas	Yes	Yes	No	No
Suitable for varying line pressures & flows including slack line conditions	Yes	Yes	No	No
Detection Algorithms	Sophisticated Processing techniques including the use of artificial intelligence programmed with actual event signals + Mass Balance Algorithms	Sophisticated Processing techniques including the use of artificial intelligence programmed with actual event signals	Conventional Algorithms based on Static Masks	Classic/Conventional Mass Balance Algorithms
Detection Sensitivity	High	High	Average	Average
Gives Leak Location	Yes - Accuracy better than 2% of line lenghth	Yes - Accuracy better than 2% of line lenghth	Yes - Accuracy unknown	No
Leak Quantification	Yes	No	No	Yes
Leak Time Stamped	Yes - GPS	Yes - GPS	Yes	Yes
Response Time	Fast - Seconds	Fast - Seconds	Fast	Slow - can be days
Detection of Pre-Existing Leaks	Yes	No	No	Yes
Coverage	100%	100%	Partial - Dead Zones	100%
Performance & Reliability	High Probability of Detection - reliable for leaks less than 2% of pipe flow	High Probability of Detection - reliable for leaks less than 2% of pipe flow	Limited Performance Criteria	High Probability of Detection reliable for leaks of 10% of pipe flow
False Alarm Rate	Very Low	Low	High	High
Artificial Intelligence	Yes	Yes	No	No
Leak Volume Total Calculations	Yes	No	No	Yes

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