SLDS - Sonic Leak Detection and Location System

Asel-Tech's front-line leak detection system is their ILDS (Integrated Leak Detection System). This system combines a conventional mass balance system with Asel-Techs innovative and proprietary sonic leak detection system. Combined, these technologies comprise the most comprehensive and effective pipeline leak detection system available today. The following information focuses only on the new acoustic portion of Asel-Tech's system – the SLDS (Sonic Leak Detection System).

Asel-Tech has spent considerable time and resources over the past 5 years to improve this technology to the point where it is unparalleled in reliability and performance in the area of leak detection.

Asel-Tech's SLDS system is the only leak detection system that offers 100% pipeline coverage without any dead zones. The SLDS combines an Artificial Neural Network and several levels of algorithms and signal processing techniques which assure a very high degree of accuracy, and very low alarm rates.

Asel-Tech's SLDS - Sonic Leak Detection System is the most reliable and sensitive leak detection system available on the market today. The system is capable of reliably detecting and locating leak incidents in a matter of seconds. Some advantages of our acoustic leak detection and location system can be summarized as follows:

- Very fast – detects leaks at the speed of sound, and is not dependent on the size of the leak.
- Detection is not dependent on flow parameters
- The loss of communication network does not affect the sensors ability to detect leaks. Any communication failure is immediately posted, and the field processing units have internal buffers which store any recordable event for audit in case of communication failure along with time stamps.
- Does not require third person instrumentation
- The system works with liquids, gases and multiphase products
- Easily interfaced with SCADA systems
- Can be configured to automatically close valves in case of a leak,
- Calibration is not required
- There is no proprietary software
- There are no dead zones – 100% of the pipeline is monitored.
- Specially developed algorithms and methods for leak sensors ,
- User friendly interface
- GPS time stamping
- Acquisition of long-term data with the use of Data Loggers,
- Reprogramming of leak masks,
- Field test leak simulation without using rupture disks.

System Performance Metrics

In comparison with other leak detection and location methodologies, Asel-Tech's SLDS boasts unparalleled performance and reliability. This is attributable to its speed, simplicity, and straightforwardness in obtaining data without having to depend on third party instruments or proprietary software. Of particular importance in evaluating leak detection systems are the following criteria:

Response Time

Sonic Leak detection Systems are absolutely the fastest available today. The time it takes to declare an alarm is measured in seconds or minutes rather than hours or days as in some other detection methods. Asel-Techs system detects a specific and unique sonic wave which travels from the source of the leaks onset to strategically placed sensors at the speed of sound.

Sensitivity

> API 1130 defines sensitivity as follows:
>
> *"A composite measure of the size of a leak that a system is capable of detecting and the time required for the system to issue an alarm in the event that a leak of that size should occur".*

Unlike other leak detection systems, the leak size Asel-Tech's SLDS system is able to detect and the time required to declare the leak are unrelated. Our system can detect leaks of any size in a few minutes (max) from the time a leak occurs. That is, given the leak event generates enough energy for the leak wave to reach the FSS sonic sensor.

The SLDS systems sensitivity is a variable value, and differs according to pipeline arrangement. The maximum sensitivity permitted by any system depends on several factors and is unique to every segment of a pipeline. The main factors that determine system sensitivity are:

- Pipeline length and diameter
- Operational conditions such as pressure, temperature and flow
- Type of fluid being transported (liquid, gas or multiphase flow)
- Number and location of the installed acoustic sensors
- General arrangement of pumps, valves, separators, etc.
- Background noise and operational events produced under normal operational conditions

The system has varying degrees of sensitivity along the pipeline. The middle section (equa-distant from the sensors on either end of the pipeline segment) tends to have the best sensitivity because the signal has less distance to travel, than say a signal generated from a leak close to one of the sensors – in this case the signal has a longer distance to travel to the other sensor and may encounter additional attenuation.

Accuracy

Asel-Tech's ILDS and SLDS system boasts unprecedented accuracy in determining location of a leak. Theoretical leak location accuracy is 2% of the protected pipeline section length. Depending on local pipeline conditions, we have at times experienced better results. Most conventional Mass Balance systems sensitivity is in the 10% range.

Leak location is computed at the supervisory computer level using wave time of flight, which is calculated via the difference between wave arrival times at the two opposing sensors and length of the pipeline segment.

For added leak location accuracy, the Asel-Tech system features:

- Time synchronization from a Global Positioning System (GPS).
- Actual wave propagation speed measurements are taken in the field and fed to the Central Monitoring Station computer for added leak location accuracy.

Robustness

> *API 1130 defines system robustness as "a measure of the CPM's ability to continue to function and provide useful information even under changing conditions of the pipeline (i.e. transients) or in conditions where data are lost or suspect. A system is considered robust if it continues to function under less than ideal conditions".*

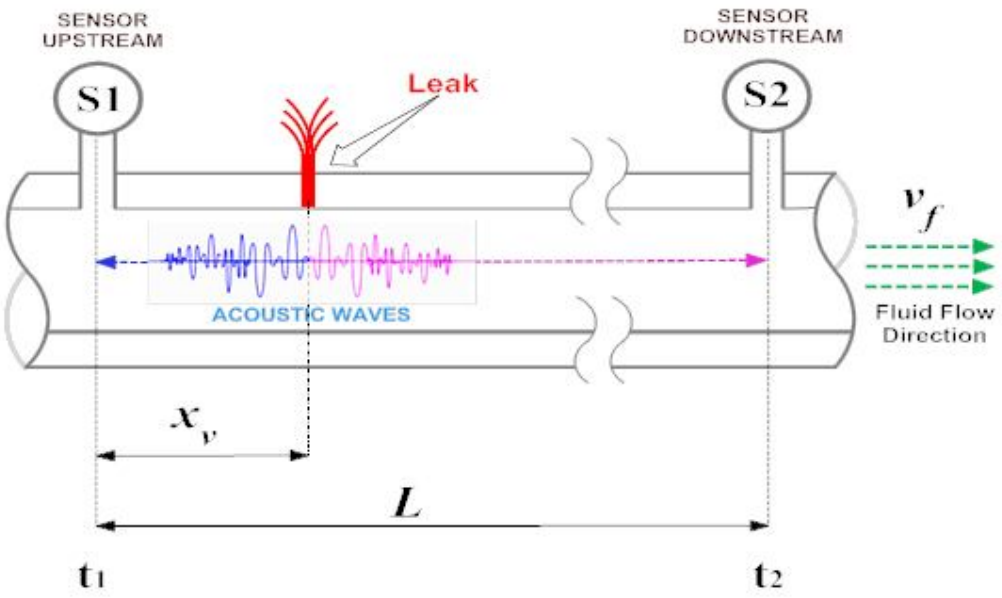
Asel-Techs systems have undergone extensive field trials, and are documented to be able to withstand extreme environmental conditions.

Asel-Tech's Sonic Leak Detection System

The SLDS technology can effectively be employed to detect leaks in pipelines that transport various types of products - liquids, gases or multiphase, and can be applied to above-ground, below-ground or subsea pipelines.

The SLDS operating principle is based on the detection of pressure transient waves caused by the onset of a pipeline leak. Unlike "Acoustic Emission" technology, Asel-Tech's system is not designed to detect the audible noise produced by leak flow, and does not detect sound in the pipeline material whether it be steel, stainless or HDPE etc.

Pressure transient waves are caused by the sudden drop in pressure, and the immediate line re-pressurization at the location of a leak onset. This onset causes pressure oscillations in the fluid pressure and propagates as a sonic wave signal at the speed of sound through the fluid or gas, away from the leak location in opposite directions guided by the pipeline wall.



Two acoustic sensors installed at opposite ends of the pipeline segment will detect and transmit the leak signal to corresponding Asel-Tech FPU-320 field processors. The FPU-320 field processor filters the signal from background and extraneous noises. Then, the filtered signals are passed to the event detection module which houses the Artificial Neural Network (ANN). The ANN is programmed to identify leak signals and differentiate them from normal background noise and transient operating conditions. The ANN is also programmed to learn new filtering parameters, thus drastically reducing false alarm rates.

When the Artificial Neural Network confirms an alarm, the FPU-320 generates a “LEAK EVENT” that will be communicated throughout the SLDS network. When this event is confirmed by other FPU’s on the same protected segment and when all the requirements that define a leak signal are satisfied, a “LEAK ALARM” will be declared by the Central Monitoring Station computer (CMS). Alarm conditions can be programmed to automatically shutdown the pipeline or alarm the operator giving him the option to shutdown.

System Components

The SLDS hardware system is made up of the following subsystems:

- FSS Sonic Sensors.
- FPU-320 processor.
- CMS Central Monitoring Station.

FSS Field Sonic Sensors

The intrinsically safe field sonic sensors are the components responsible for pressure signal acquisition and transmission. The sensor elements are mechanically mounted inside all-weather casing and are bolted to the pipeline using 2" taps.

The sensors require 10-30 volt supply provided by the FPU-320 field processors and they output a 4-20mA current signal. The connection between the sensor and the FPU-320 field processor requires a two wire instrumentation cables.

Sensors are strategically installed at various locations along the pipeline. The distances between sensors vary and depend on many factors including: the particular characteristics of the pipeline, the fluid, and or gas in the pipeline, the overall SLDS system performance requirements, and calculated acoustic signal attenuation in the fluid and or gas.
The use of a pair of sensors at the two ends of the pipeline segment allows for the identification and rejection of external operational noises generated outside the monitored segment that otherwise would cause false alarms.

Sensors are generally installed on the pipeline while it is pressurized using Hot-Tapping procedures thus eliminating costly shut downs.

FPU-320 Field Processors

The FPU-320 field processors are installed in the close proximity to the sensors. They are normally in a standard 19" cabinet. One FPU-320 can up to 6 FSS sensors mounted on different but closely laid out pipelines. The main functions and features of these processors are:

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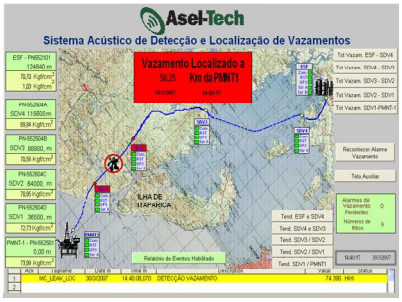
- Carry out complex multi-layer signal filtering and data processing.
- Utilize analog and digital filters (band pass filters, differential filters, phase filters, floating average filters, correlative filters, mask filters, neural filters, and adaptive gain blocks).
- Compare acquired signals with embedded masks.
- Analyze and evaluate data and events received from sensors to validate and confirm an event (leak).
- Report to the Central Monitoring Station.
- Employs a GPS receiver to synchronize clocks among all FPU-320's in use.
- Reprogrammable leak masks.
- Performs internal diagnostic tests and reports faults.
- Employs MODBUS as a standard communication protocol.
- Can be linked with the Central Monitoring Station via various communication methods: hard wire, optic fiber, GPRS, radio, or satellite.
- Remains functional during communication network faults.

CMS Central Monitoring Station



System configuration and operations are performed on a dedicated computer running non-proprietary supervisory software. CMS is the "Human Interface" (HMI) unit, and features customized pictographic screens illustrating pipeline aerial views, and highlights monitored points along with other vital system details.

Configuration parameters and operating conditions are input into the supervisory software via user friendly interface screens. The above screen capture demonstrates the layout of a pipeline segment and the monitoring stations where normal operational conditions are represented in green and alarm conditions are displayed in red. When a leak is detected and confirmed, an alarm will sound, and the screen will change to show the exact location of the leak with date and time. The HMI screen can be customized to client's requirements.

The Central Monitoring Station supervisory computer is easily interfaced with any existing SCADA where all local and remote operations, including operational parameters, can be viewed, controlled and adjusted through the client's SCADA thus allowing access to the CMS' supervisory system whenever necessary.
The supervisory computer system is responsible for various information, communication, security and diagnostic functions. In addition, it manages and maintains an intricate database, reports, and historical event logs.

Installation Process

Pre-Installation/Pre-assessment

An Asel-Tech engineer will be dispatched to the site upon consummation of contractual arrangements for an order. The primary objectives of this visit will be to conduct a pre-assessment of the site, gathering all relevant information necessary to proceed with:

1. Design and subsequent fabrication of the equipment.
2. Formulation of a comprehensive scope of work document for the equipment installation.
3. Formulation of a general Site Survey

SYSTEM DESIGN

Asel-Tech's Engineering group will generate a detailed design of the system including instrumentation and electrical design documents, including the following:

- Panel drawings:
  - Dimensional drawing
  - Internal layout
  - Internal interconnection diagram of each pane
- Detailed procedures of acoustic sensor installation and interconnection
- Network diagram

*A project manual will be given to the customer including all the above documents

FAT and SAT Tests

FAT (Factory Acceptance Test) tests will be performed before delivering the system to the client. 30 days prior to execution, a detailed procedure of these tests will be presented to the client for approval. Documents for client approval will include:

- Test parameters & objectives
- Programming protocols & procedures
- Parameters to be measured;
- Simulations to be performed;
- List of installation, instruments, configuration, software, project documents, services and other, manpower required for it perform.
- Criteria for test acceptance.

The system's operational results obtained during the tests will be recorded and sent to the client for approval. The client is welcome to be present for this testing.

FAT tests - the following equipment will be checked:

- FPU 320 units functionality;
- Acoustic sensors FSS functionality;
- Leak detection station functionality.

FAT Test results will be sent to client for approval prior to shipping the equipment.

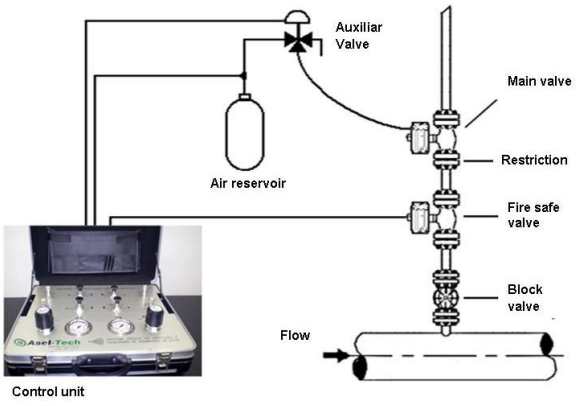
SAT

SAT tests will be performed in the presence of client on-site following commissioning. The SAT Testing is primarily a test or series of tests administered to assess the equipments ability to detect an actual leak. The leak will be simulated by Asel-Tech technicians utilizing special equipment designed for the express purpose of leak simulation. Following successful completion of this leak test, the leak simulation equipment will not remain with the client.

A schematic of the test equipment is illustrated below.

Test Equipment

Diagram and photo of Asel-Tech testing equipment



FIELD INSTALLATION

Field Installation of Asel-Tech's Equipment is generally to be performed by the client, though Asel-Tech can do a turn-key project. Asel-Tech will supply an engineer to supervise the installation. Installation of the sensors is primarily a matter of standard "hot-Tap installation, and the FPU, and CMU are very basic control panel installs possibly involving minor civil work and running of cable and setting up the communication network.

Asel-Tech shall supply an experienced engineer/project manager to:

- Supervision of assembly and acoustic sensors interconnection;
- Supervision of assembly and communication cable interconnection, panels power supply, system communication and GPS antennas;
- Configure the FPU 320
- Execution of (SAT) Leak simulation tests to confirm systems proper operation and to record background noise from the pipeline, that will be used in the filters configuration and to adjust the parameters that will define normal pipeline operation
- Program/Development of new filters, if necessary
- Adjustment of the system configuration parameters on the control monitoring station
- Integration of the supervisory system to the clients system (i.e. SCADA) if desired by client.

SYSTEM CONFIGURATION

The SLDS system will be configured during the commissioning and again during the SAT leak test. A System Manual (1 hard copy + 1 CD) will be provided to the customer.

Operation and Maintenance Training

Following Commissioning of the system, Asel-Tech's project manager will deliver a training session to the client. The training session duration is one full day, and will be held at the clients nearest facility to the site. This training session will cover:

- Presentation of technology, theory of operation and involved concepts
- Presentation of the specific project and its application
- Resources, system performance, potential for possible upgrade;
- SLDS operation - operator and engineering screens, with functions and resources details
- Communication System - Applicability to the SLDS, resources and care
- Review of Installation, configuration and commissioning
- Review of Field acceptance tests (FAT) with leak simulations.
- Review of leak simulation tests and test system.
- Diagnostics and maintenance of the system, sensors, remote units (FPU), GPS, etc. Maintenance routines (cables, valves, blocking, antennas, etc.)
- Maintenance and parameterization of replaced FPU, measures for possible needs for modifications (introduction of the control valves in pipeline, derivations, etc.).
- Scope Asel-Tech support.

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