HASELOH INNOVATIONS

The **HASELOH PIPELINE LEAK DETECTION™** System provides unprecedented protection for pipelines. Leaks can be detected within two minutes from a hole smaller than the size of a pencil (1/4 of an inch). A unique proprietary isolation gland protects the electronic sensors that would normally plug off or freeze when installed on a pipeline. Mechanical temperature compensation allows all sensors to remain within 2° F of each other across the span of the pipeline. This temperature compensation allows the pressure sensors to be extremely accurate to one another without the need of highly complex computer software.

Acronym: IMELDA™ **I**ntelligent **M**onitoring **E**quipment, **L**eak **D**etection **A**ssembly

The Basics

The well head units (IMELDA™) reference each of their pressures to the satellite that is serving them. The satellite units are then referencing their pressures to the main pumping station, or other pressure source, that serves them. This gives a complete view from start to finish at each branch of the system. Each well head, satellite unit and main pumping station then acquires and stores a pressure reading every 2 minutes, giving a snapshot view of the entire system. This gives a view of the relationship between all points at the same time, so that any changes that occur between these pipeline elements can be displayed in a fashion that is usable by the operator.

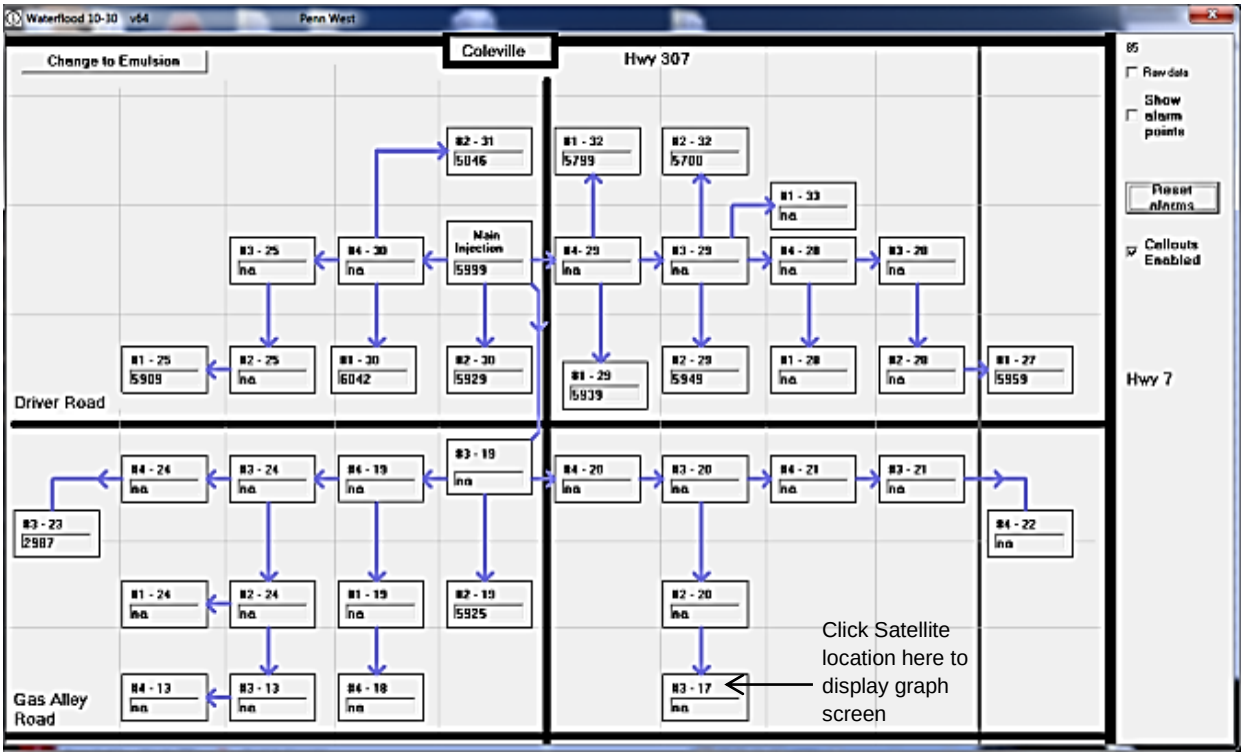
All **IMELDA™** units in the **HASELOH PIPELINE LEAK DETECTION™** system "wake up" at a predetermined time and capture and store the pipeline pressures. When not transmitting or collecting data, all the individual units will go into a "sleep mode" to conserve battery power which is maintained by solar panels. The individual **IMELDA™** units then wake up and transmit the data back to a computer during a specific time period so as not to overlap radio or cellular transmissions. The proprietary software and patented hardware then tracks any changes in pressure, temperature, and records the time of the reading. The data can then be displayed as a graph by clicking on the land location number on the satellite box of the main display.

Custom Built User Interface

The **HASELOH PIPELINE LEAK DETECTION™** System is designed to operate on Windows based PC's using a custom built graphical interface. Each operator interface program is specifically designed for your installation. An intuitive, map based interface allows operators to interact with the Patented system installed on your pipelines with minimal training. Each satellite unit (IMELDA™) is labeled and displayed on a basic map for ease of locating and identifying.

Main Program Screen

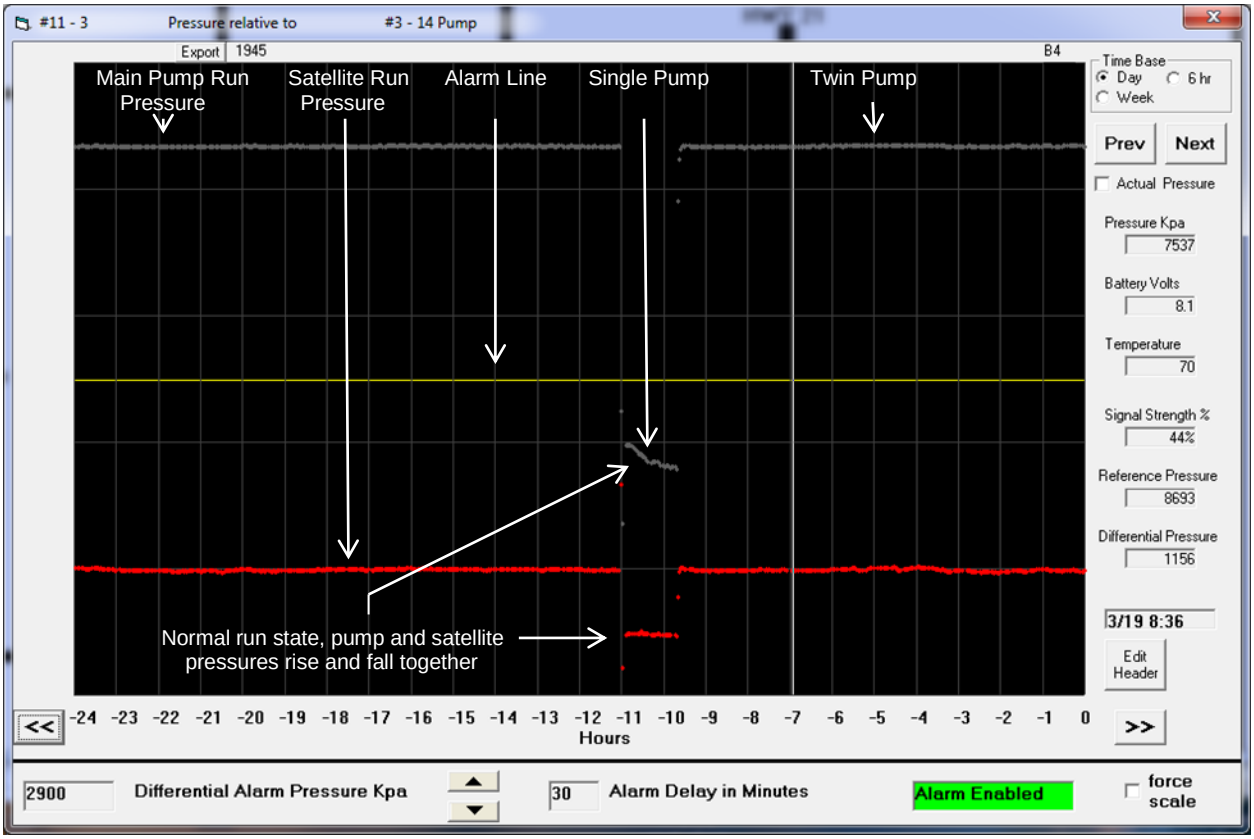
The main screen displays each unit location (IMELDA™**)** and current status, allowing operators to quickly view the status of all sites. Main and secondary roads are shown in black and pipeline direction is shown in blue



Graphical Interface Screen

Simply clicking on the particular unit location on the satellite box brings up the unit specific graphic display page. On this page the operator can adjust the alarm and other settings, as well as view a more detailed, past trend graph view of pressure readings. Default setting is for 1 day, or past 24 hours, the top right hand side of the screen gives a box where an operator can select Day, Week or 6 hours. Clicking the back arrow buttons on the bottom left corner of the screen allows an operator to go back and view the past 3 month history of the accumulated data.

The following depiction shows a normally running system that uses 2 main pumps that are supplied by 2 tanks. The pumps are controlled by a tank level switch and when the level in the tank drops one pump is shut down. When the level is replenished the pump starts back up again



It is important to note that this is a regular run screen without leaks. Note: that when one of the main pumps shut down (grey line) the satellite pressure (red line) drops downward accordingly. When a leak is detected you will see these conditions reversed, which is shown in the following page. This is to say that the Satellite pressure (red line) will be above the Main pump pressure (grey line).

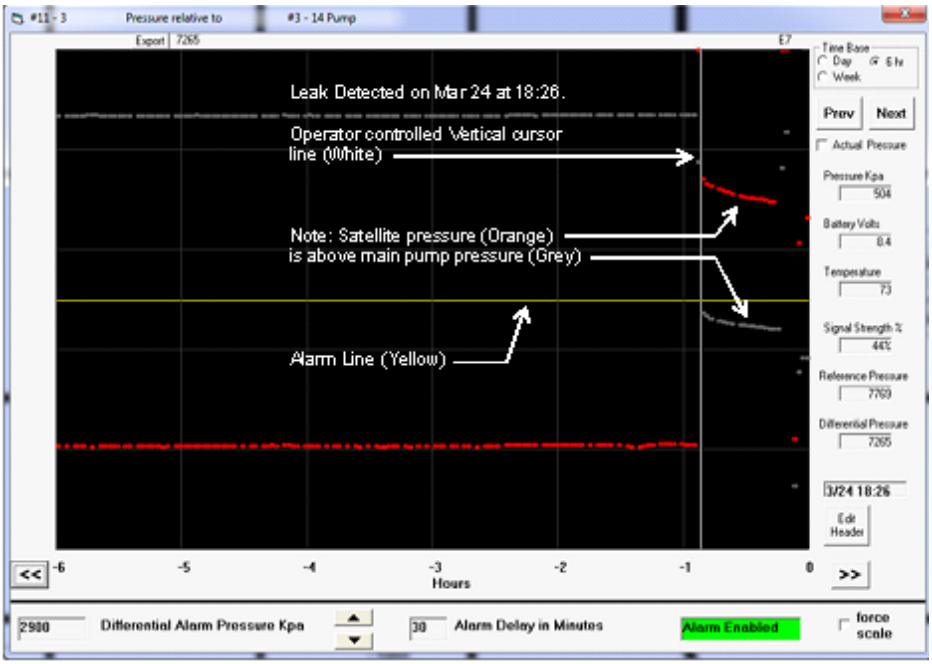
Alerting the Operator

The **HASELOH PIPELINE LEAK DETECTION**™ system can detect even minute changes in pressure. The computer at the main station then alerts the operator there is a leak in the pipeline. The built in diagnostics of the system can pin-point, through the point to point reference, the exact line where the leak occurred. This empowers the operator to take quick and decisive steps to mitigate the damage that would occur from this leak. Once the operator has taken the appropriate action, he will reset the unit to alert him if any other problems exist.

In the event that no operator is present, the **HASELOH PIPELINE LEAK DETECTION**™ system is equipped to activate a call out system to alert the operator by paging, texting, phoning, or to contact him through an answering service. As well, the operator has the ability to log into the system from home to view any alarms from any computer with a web connection. This allows operators to answer alarms and determine the appropriate response from virtually anywhere.

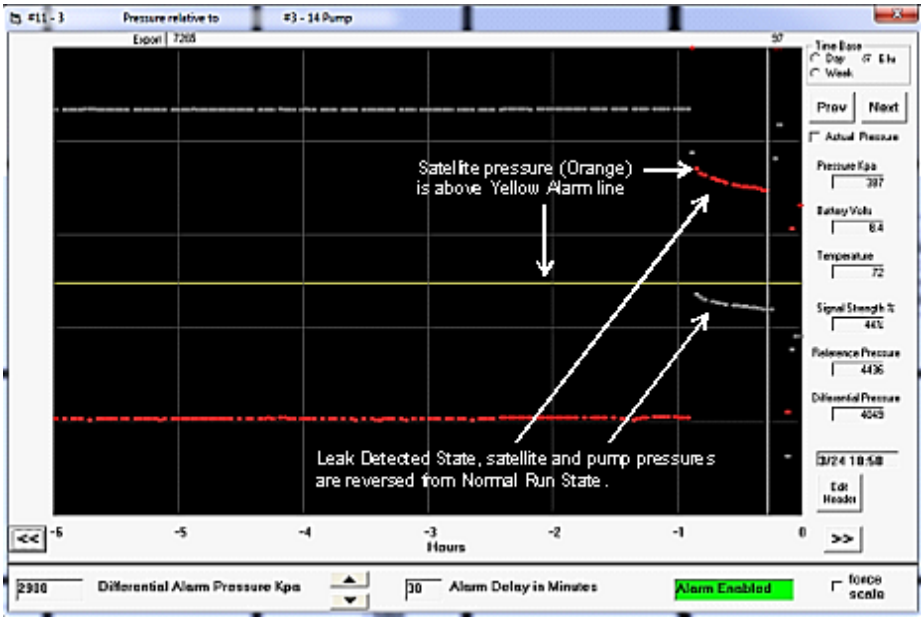
Detecting a Leak

Since liquids are incompressible, the pressure sensors at the main pumping station, satellites, and well heads will track each other very closely. Pressures can vary quite dramatically across a pipeline depending on pipe size and distance from the pumping station. So what we are tracking is a relationship between each point of the pipeline system. Sudden drop in pressure from normal pressures between given points indicate an external influence has occurred and caused a change to the system.



The graphic display to the right shows an actual leak on a water flood pipeline. The distance between the main pump and the satellite shown was approximately 4 miles. Note: that the satellite pressure (Orange line) has risen above the main pump pressure (grey line). This is the exact opposite to what a normal run profile is (See graph in page above). The date and time of when leak occurred was at 3/24 18:26 (white vertical cursor line at start of leak on graph below). The leak was detected 2 minutes after the last data transmission of 3/24 18:24

The Leak was detected by the **HASELOH PIPELINE LEAK DETECTION**™ system. An operator was called out by the system, and the operator lived about 15 Kms away from the site. The operator traveled to the Satellite located upstream from the leak that was highlighted by the Custom built user interface software. The operator shut down the pipeline at the satellite that was feeding this satellite. The elapsed time from the software detecting the leak to shut down of the pipe line that had the leak was 32 minutes. White vertical cursor line on graph shows time elapsed at shut down.



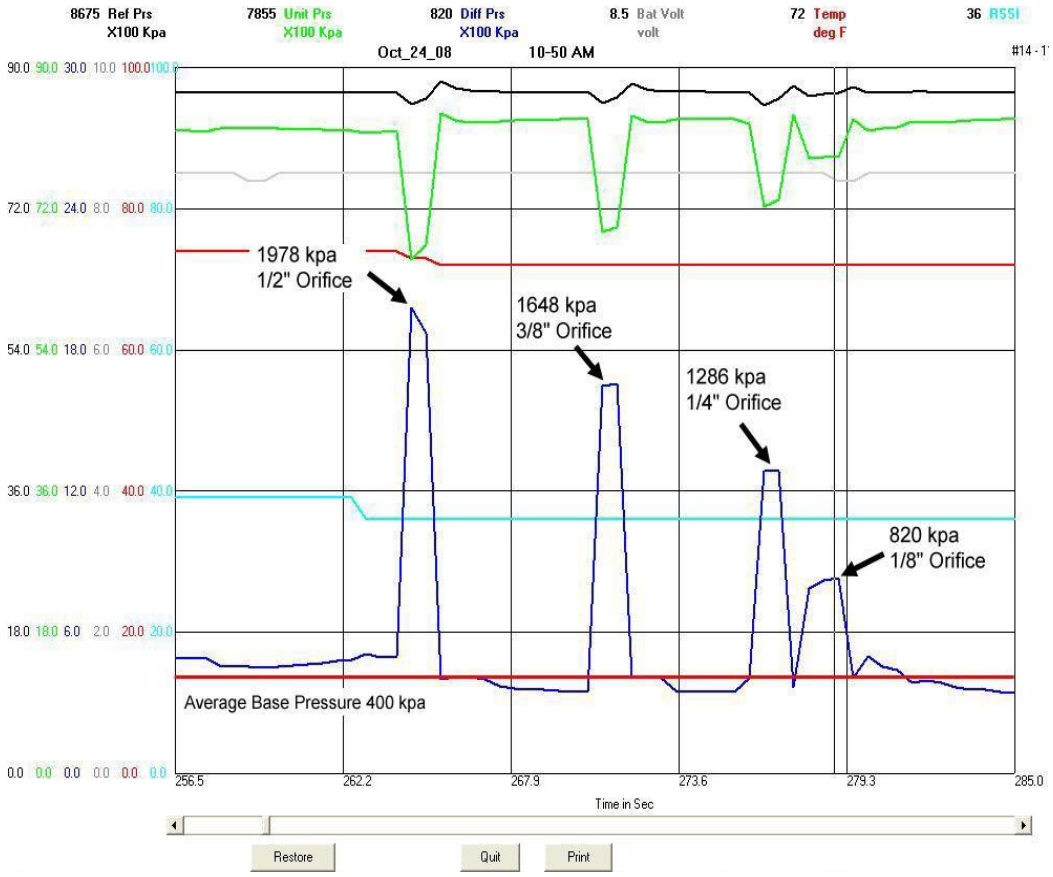
Upper Graph shows Leak Detected at 3/24 18:26

Graph at right shows leaking pipeline shut down at 3/24 18:58

Controlled Testing

In the first developmental installations of the IMELDA System, **HASELOH INNOVATIONS** performed a test of the system using orifices of different sizes. The orifices were installed above a ball valve in the pipeline, and a line was run to a large Vacuum Truck tank. This was done to simulate leaks, using different sizes of orifice`s. This simple test proved the accuracy of the IMELDA System and its ability to detect leaks as small as an 1/8” of an inch, and even smaller.

By measuring the pressure differential of the various orifices in a controlled state over a known period of time, we can set an approximate baseline of how big the leak was. This means the IMELDA System can also be used to determine the approximate amount of fluid that was lost for the duration of the leak.



Orifice Testing Differential Pressures

Looking at the graph, we can see the pressure differential between the main pump and the satellite in the field which corresponds with that orifice.

The top green line is the main pump pressure at the MCC. The bottom blue line is the pressure that was recorded at a satellite 8000 Meters (8Kms) distant. At the bottom of the screen is the amount of time the leak occurred.

As you can see, the bigger the leak, the higher the pressure differential will be, since the drop in pressure between the measuring points would be much more dramatic.

Solving Pressure Sensor Failures

HASELOH INNOVATIONS has developed a three-part bladder system called the Isolation Gland. This system creates a three part physical barrier between the measuring device and the media to be measured.

Plugging Off of Sensors

A common problem with any pressure measuring device, be it a simple pressure gauge or an electronic transducer, is plugging up from contaminants or freezing off in subzero temperatures.

Each **IMELDA**™ pressure measuring unit incorporates a unique and proprietary Isolation Gland, which isolates the pressure transducer from the process media. The problem with any highly sensitive transducers is that they can be destroyed by any contaminate that gets inside of them. In an effort to protect these sensors/transducers, filters (Snubbers) are often installed between the process liquid and the transducer. These filters are a very fine mesh that will become rapidly plugged because of rust, dirt, and any other contaminates inherent in any pipeline. As these filters get plugged up by contaminates, the pressure transducer in any system will be rendered useless. The computer will read no changes in the pipeline pressure. During initial tests it was found that *every* system that had a pressure sensor in contact with any production fluid failed. These failures were sometimes within minutes, but always within days. The cause was always the same; the sensors were plugged off or destroyed completely. This was a major problem in the first systems that were tested during development of the **HASELOH PIPELINE LEAK DETECTION**™ system.

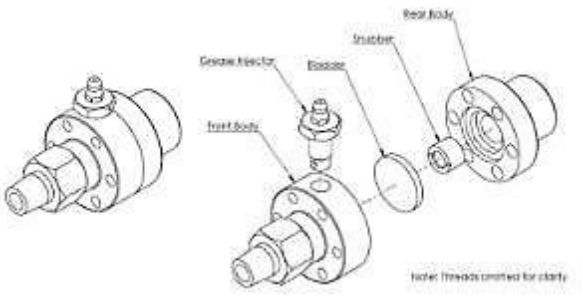
Sensor Freeze Up and H2S Corrosion

The proprietary Isolation Gland is also vitally important if the pipe line medium contains any H2S, which is highly corrosive and destroys gauges and sensors *very quickly*. the three part physical barrier between the measuring device and the pipe line media ensures that the measuring device will remain unaffected.

The proprietary Isolation Gland also has another function of eliminating freeze off. If you screw a gauge or transducer to a pipeline, it is generally screwed into a ball valve, and is about 6” above the pipeline. The water, oil, emulsions, and contaminates that are present in any pipeline will migrate up through this opening in the pipeline. Cold temperatures can freeze the medium and the gauge, or transducer, will become inactive or even burst.

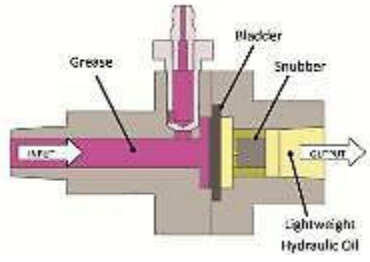
The **HASELOH PIPELINE LEAK DETECTION**™ bladder system has grease and oil filling these cavities, thus preventing it from freezing, bursting, H2S infringement or becoming impacted with debris.

Isolation Gland Construction



The output side, or Rear Body, of the Isolation Gland connects to the measuring device, such as a pressure transducer or gauge, and a cavity extends back through the housing. This cavity has internal threads to receive a filter (Pressure Snubber) near the bladder end.
The measuring device and the output side body are filled with clean, lightweight hydraulic oil. The filter (Pressure Snubber) is then screwed into the cavity and the remaining area above this filter is also filled with clean oil. A chemically inert bladder or diaphragm is then inserted into the larger cavity above the filter. The input half of the Isolation Gland body then bolts to the output side, or Front Body, and the bladder seals the two halves. Subsequently, this bladder also isolates the two chambers from one another. The input side is then connected to the medium that needs to be measured, such as a pipeline. The input side of the bladder system contains a Grease Input nipple, similar in operation to an automotive brake bleeder.
The Grease Input is opened and grease is pumped into the system. The grease fills the cavity of the input side from the bladder all the way back through all connections and instrument tubing to the liquid surface inside the pipeline. Once all the cavities are filled with grease, the bleeder is closed and tightened. The bleeder and the body of the Input half of the Isolation Gland have a machined taper, which effectively seals the Grease Input.

How it Works



The liquid pressure inside the pipeline pushes against the grease, which transmits the force to the bladder. The bladder transmits the force, through the lightweight hydraulic oil, to the pressure sensor. With this system, the pressure transducer and filter (Snubber), the parts most likely to plug off from foreign particles, are never in contact with the process medium. The transducer only ever comes in contact with clean, lightweight hydraulic oil; preventing any freezing or plugging off.

The **HASELOH INNOVATIONS** Isolation Gland provides a simple, maintenance free solution for your pressure measuring needs.

Temperature Compensation

The accuracy of the **HASELOH PIPELINE LEAK DETECTION™** system is based around placing very accurate pressure transducers with mechanical temperature compensation at intervals all along the pipeline system. All of these units then reference their pressure to the pressure found at the main pumping station. This data is then transmitted to the main office computer which tracks these pressures

.

Temperature variation has always been a factor in maintaining the collection of accurate data from any electronic sensor. Thus it is a vital component to the **HASELOH PIPELINE LEAK DETECTION™** system to maintain sensor temperatures within an acceptable range at all the sites where the system acquires pressure readings for data transmission and analysis.

It is a known fact that sensitive electronic pressure sensors may have wide variations in electrical outputs, even when dealing with two of the exact same transducers, if they are measuring in different temperature zones. One of the key elements to this patented system is the mechanical temperature compensation at each of the sensor locations.

HASELOH INNOVATIONS has developed a clamping fixture that assures the temperature at each pressure transducer remains consistent, based on factory tested criteria, with the liquid media being measured. This clamping fixture is bolted to the bottom of the explosion proof enclosure. This fixture is accurately machined to fit the exact size of pipe it will be mounted to. Thermal grease is placed between the aluminum fixture and the aluminum explosion proof box, and between the aluminum fixture and the pipeline. This grease coupled with the heat transferring properties of aluminum enhances the radiation of the liquid temperature from process medium up to the pressure transducers that are mounted in the aluminum Class 1 Div. 1 Haz. Loc. Explosion Proof Enclosure.

This is part of the patented system that keeps all the electronic pressure transducers within an acceptable temperature range. This temperature is usually within plus or minus 2 degrees F of each of the pressure transducers placed along the length of the pipeline. This simple but elegant mechanical temperature compensation allows all the electronic pressure transmitters to accurately detect and track minute pressure changes.

Other systems have to rely on complex look-up tables in the software to track and adjust the pressures due to temperature variance between sensors. This makes the software extremely complex, and correspondingly expensive. Temperature compensation done with look up tables requires a very powerful computer to run the system. The more complex that the software is, means more things that can go wrong with the system.

Due to mechanical temperature compensation, the **HASELOH PIPELINE LEAK DETECTION™** system does not require complex look-up tables in the software to adjust the pressure due to temperature variance between sensors.

The **HASELOH PIPELINE LEAK DETECTION™** main system computer requires minimal processing power and thus can be offered to a client at minimal cost to them.

Thermal Grease between Explosion proof box, saddle clamp, and between the saddle and pipe.

Exp. Proof Box being clamped onto Pipe
Note: Explosion Proof fitting for Haz. Loc.

Placement of the IMELDA™ Units

There is a main IMELDA™ unit placed at the pumping station and IMELDA™ units placed at satellites all the way to the end of the pipeline. IMELDA™ units should also be placed at each well head. This gives a point to point reference for quick and easy determination as to where the leak has occurred. This gives the operator the opportunity to respond decisively to the situation and know exactly where the leak is occurring.

Radio tower, solar panel, and electrical box mounted to outside of Satellite

IMELDA unit mounted to pipeline and plumbed to ball valve

Standard IMELDA Satellite Package

Isolation gland system is manufactured to be replaced as a modular unit. This unit can be changed in minuets and does not require removal of the explosion proof box and related electronics and wiring from the pipeline.

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