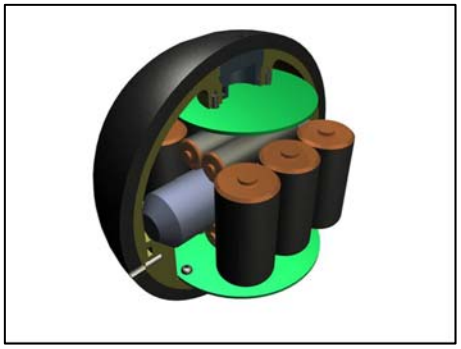
SmartBall® Leak Detection Survey



Prepared By:

Pure Technologies Ltd.

November 13th, 2008

1 Executive Summary

The SmartBall was deployed in order to inspect the pipeline. The survey took place on Wednesday October 22nd 2008. The SmartBall was inserted and extracted through the existing pig traps for the Pipeline. Total run length was approximately 52.25Km. One leak was simulated along the pipeline as both a test of the SmartBall's ability to locate leaks and as reference points for calibrating unknown leaks. Calibration leaks of varying sizes were also generated while the SmartBall was still inside the insertion trap prior to launch. A second acoustic event, indicative of a leak was seen in the pipeline. This was attributed to a densitometer close to 50km from the launch point.

The run successfully demonstrated the ability of the SmartBall to detect and locate acoustic events such as leaks, even of very small magnitude in the pipeline. A secondary objective of the run was to test the ability of the ball's magnetometer to detect metallic objects on the line, and ultimately to locate illegal taps. Some success was seen in detecting on-line valves, but it was evident that enhancements to the magnetometer configuration would be required if the ball was to be used for this purpose.

Summary of Pipeline Inspected

Total Length of Pi pe Surveyed:	52250 meters
Type of Pipe:	Steel
Diameter of Pipe:	12 Inches
No. of Events Detected	2

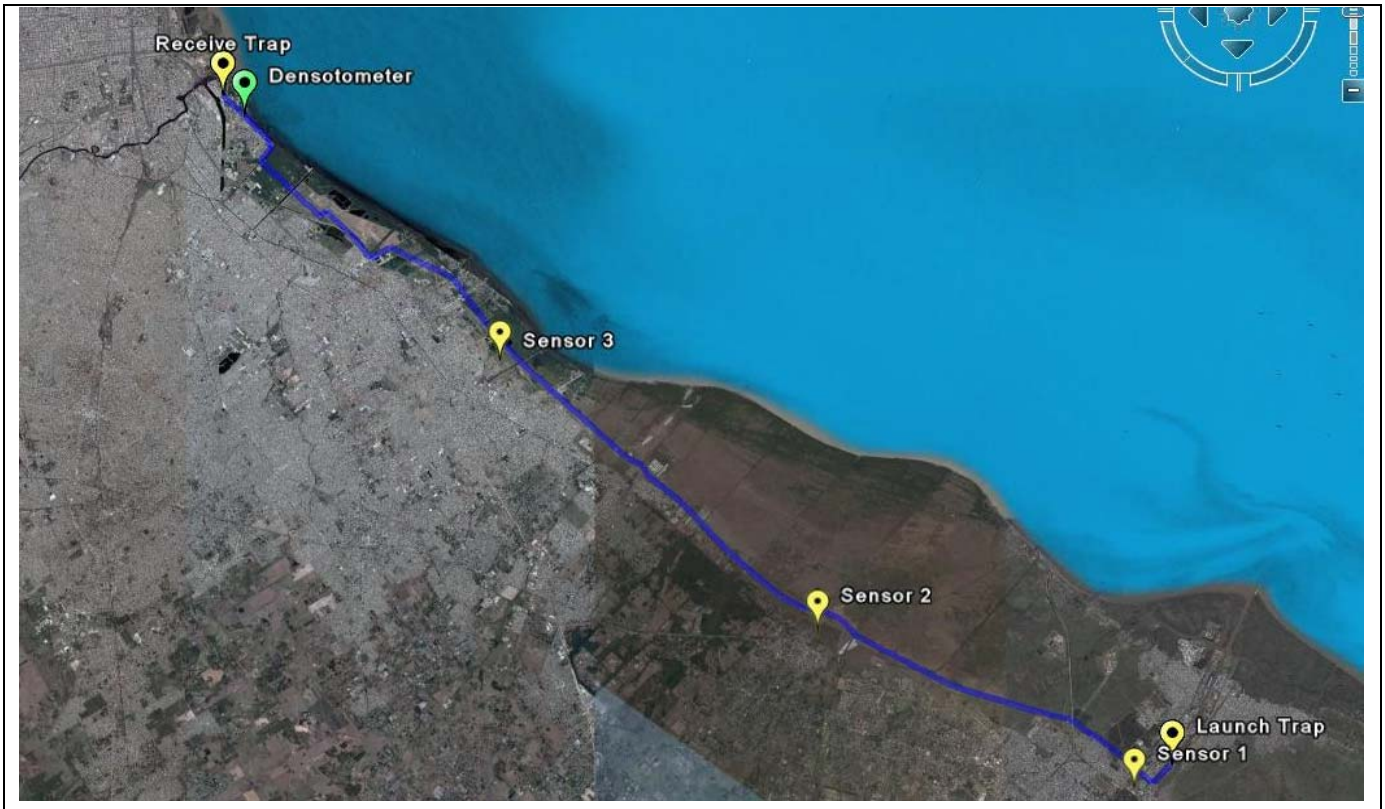
Summary of Leaks Identified

Leaks Number	Size (Gallons per minute)	Day Leak Detected	Classification
1	5 (estimated)	October 22nd, 2008	Calibration Leak
2	3 (estimated)	October 22nd, 2008	Calibration Leak
3	3.2	October 22nd, 2008	Simulated Leak
4	0.05	October 22nd, 2008	Unknown Leak

2 Pipeline Summary

The inspected pipeline is a 12 inch steel line that was surveyed using SmartBall technology on October 22nd, 2008. Preliminary details on the pipeline are listed in the table below. Exact flow rates, velocities, and pressures varied on the day of the survey.

Survey Length		*52KM*
Product		*Crude Oil*
Line O.D.		*12.75inches*
Line I.D.		*12.00inches (TBC)*
Pipe Wall Thickness		*.375inches (TBC)*
10" S.B. Diameter		*8.75inches*
Bypass		*3.25inches*
Flow Rate	**Min**	*180m3/hr*
	Max	*500m3/hr*
Velocity	**Min**	*0.68 m/s*
	Max	*1.90 m/s*
Operating Pres.	**Min**	*5 bar (72psi)*
	Max	*60 bar (870psi)*
Simulated Leak Points (Dist. Start Point)		*Unspecified*
Max Incline within Survey		*12 degrees*
Max Incline into Riser		*Unspecified*
Time of Travel (50km)	**Min**	*7.3hours*
	Max	*20.3hours*



Route of Pipeline

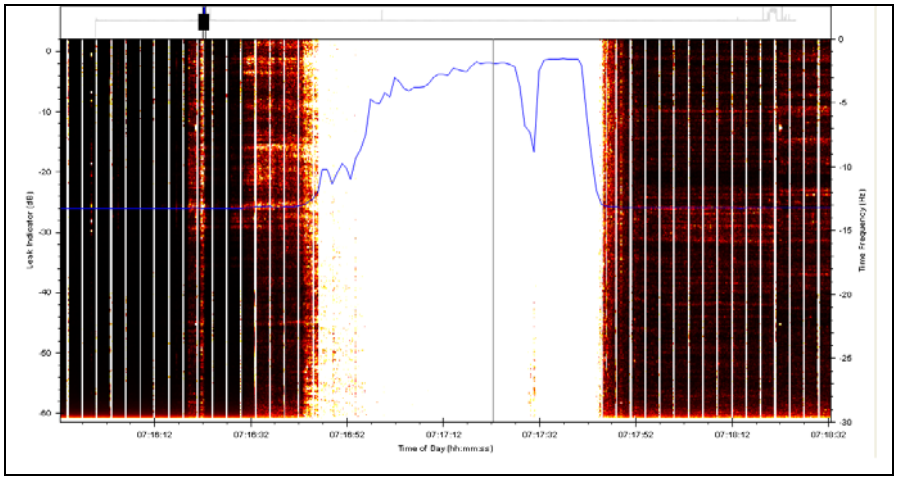
3 Leak Details

The location of each simulated leak is based on the distances between the valves used in the simulated leaks. The location calculated for the unknown leak is based on the accelerometer data recorded by the SmartBall in relation to known valve points and SmartBall Receiver data acquired during the survey.

Leak Details (October 22nd th, 2008):

Calibration Leak No.1
Estimated Size of Leak: 5 Gallons per minute
Leak Indication Power at Leak: -2 dB

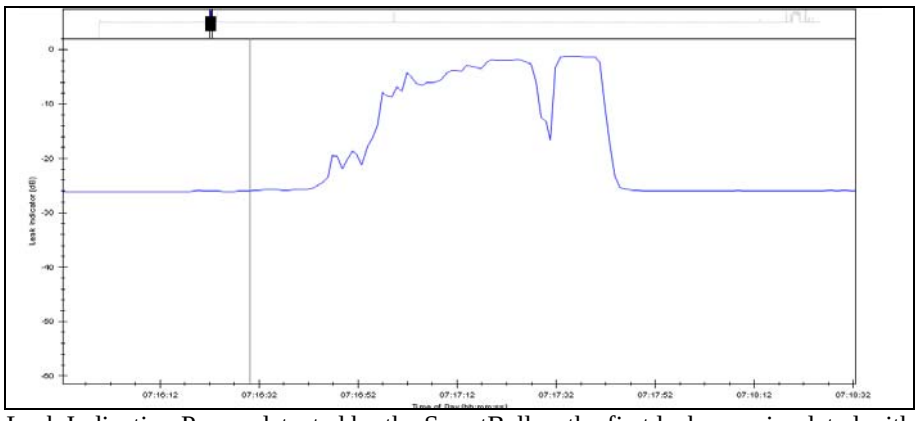
Distance Along Pipeline:
Ball stationary inside the insertion trap.



Frequency spectrum recorded by the SmartBall as the first calibration leak was simulated with the ball stationary inside the insertion trap.

Time Since Start of Rolling: Not Applicable
Time of Leak: 08:16:46 AM

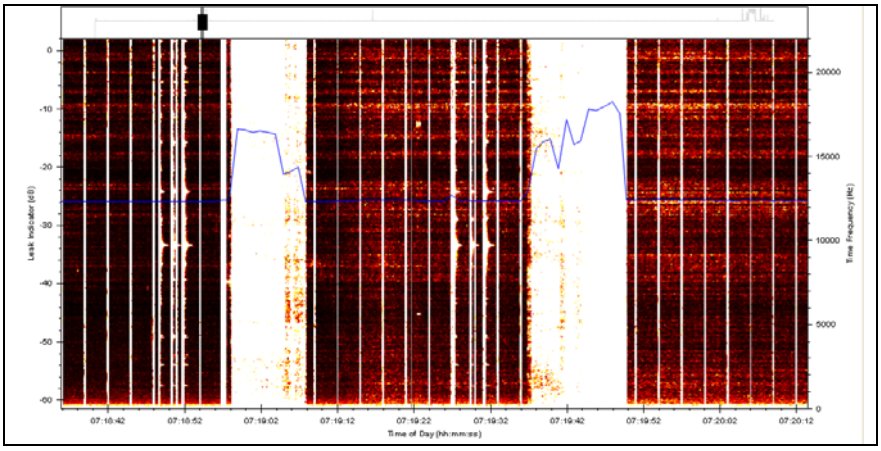
Details of Leak:
Calibration leak generated by gate valve coming off the vent port of the insertion trap.



Leak Indication Power detected by the SmartBall as the first leak was simulated with the ball stationary inside the insertion trap.

Calibration Leak No.2
Estimated Size of Leak: 3.0 Gallons per minute.
Leak Indication Power at Leak: -14 dB

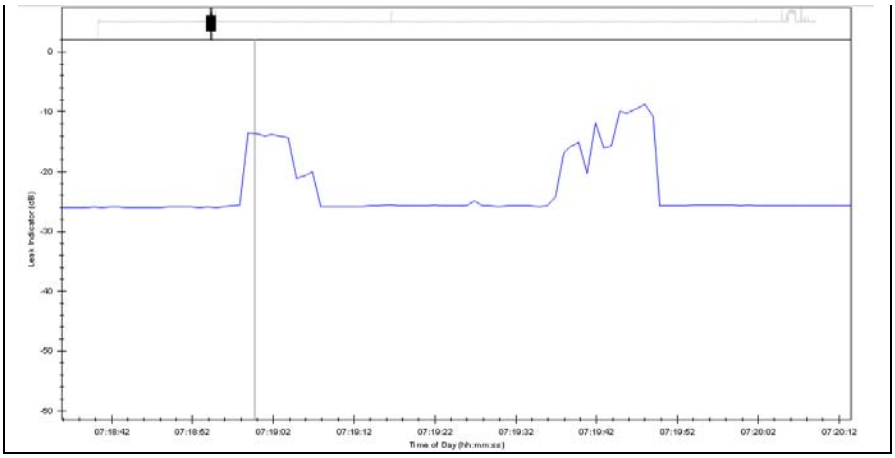
Distance Along Pipeline:
Ball was stationary inside the insertion trap.



Frequency spectrum recorded by the SmartBall as the second calibration leak was simulated with the ball stationary inside the insertion trap.

Time Since Start of Rolling: N/A
Time of Leak: 08:18:57 AM

Details of Leak:
Calibration leak generated by gate valve coming off the vent port of the insertion trap.



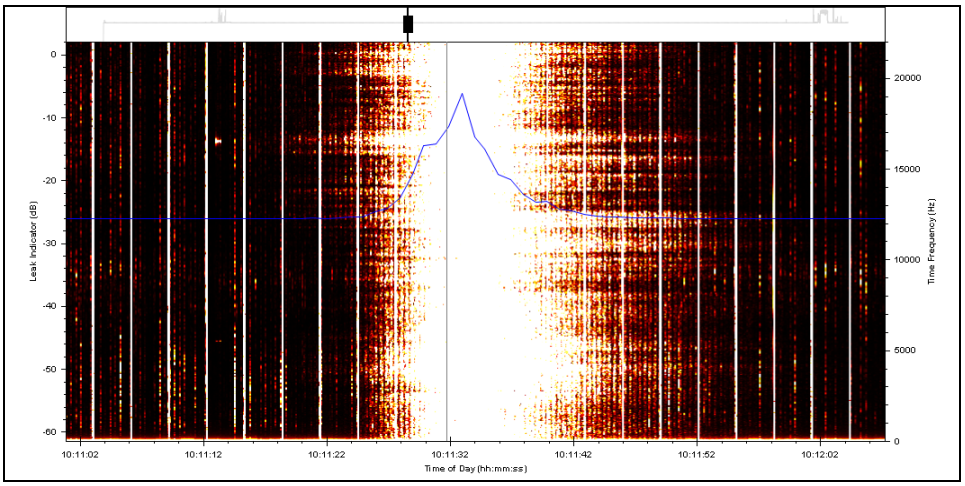
Leak Indication Power detected by the SmartBall as the second calibration leak was simulated with the ball stationary inside the insertion trap.

Location of Calibration Leaks and First Tracking Point

Simulated Leak No.1
Estimated Size of Leak: 3.2 Gallons per minute
Leak Indication Power at Leak: -6 dB

Distance Along Pipeline:
Approximate Distance From Insertion: 17+061 meters

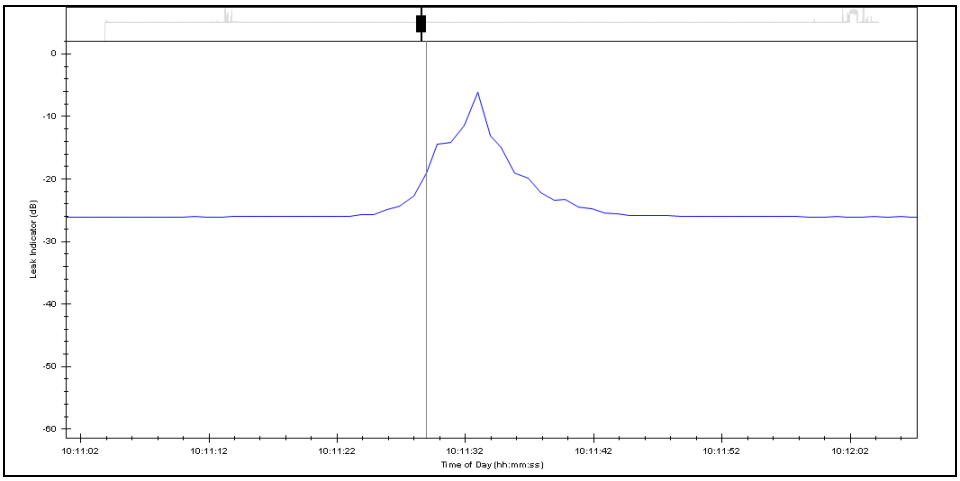
Distance From Nearest Sensor (2+043): 15+018 meters



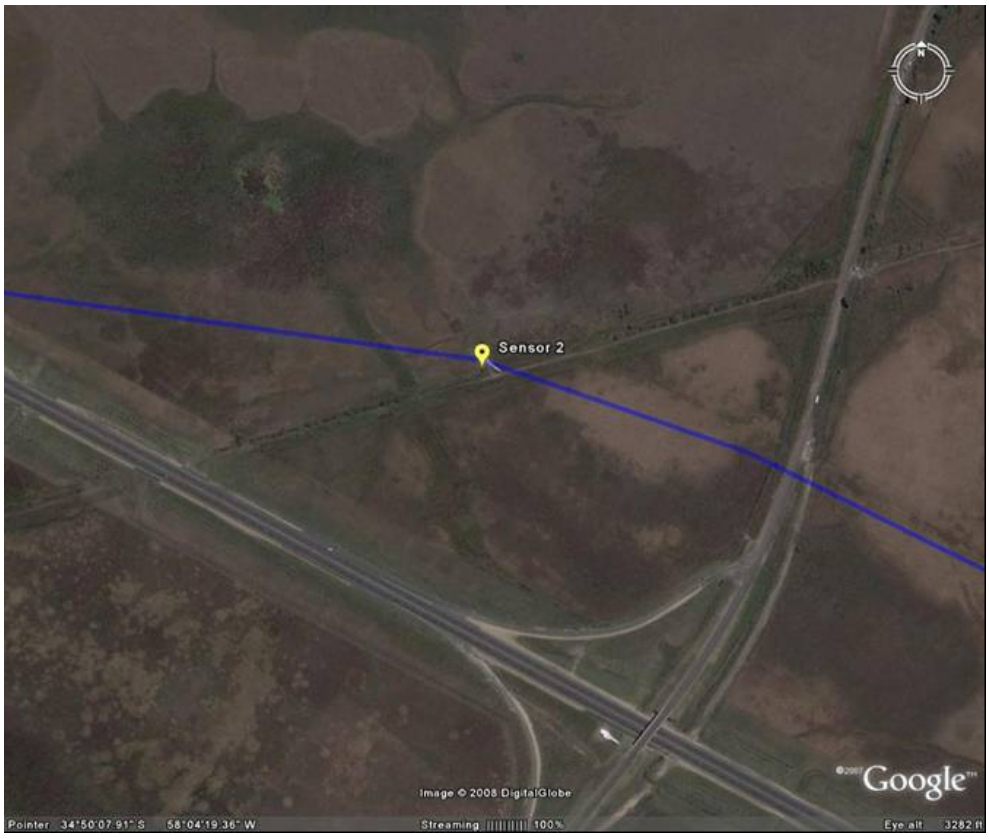
Frequency spectrum recorded by the SmartBall as it passes the first simulated leak.

Time of Tool Pass: 11:11:32 AM

Details of Leak:
Leak generated at the end of 20 foot length of plastic tubing attached to valve and riser pipe connected to the pipeline.



Leak Indication Power detected by the SmartBall as it passes the first simulated leak.

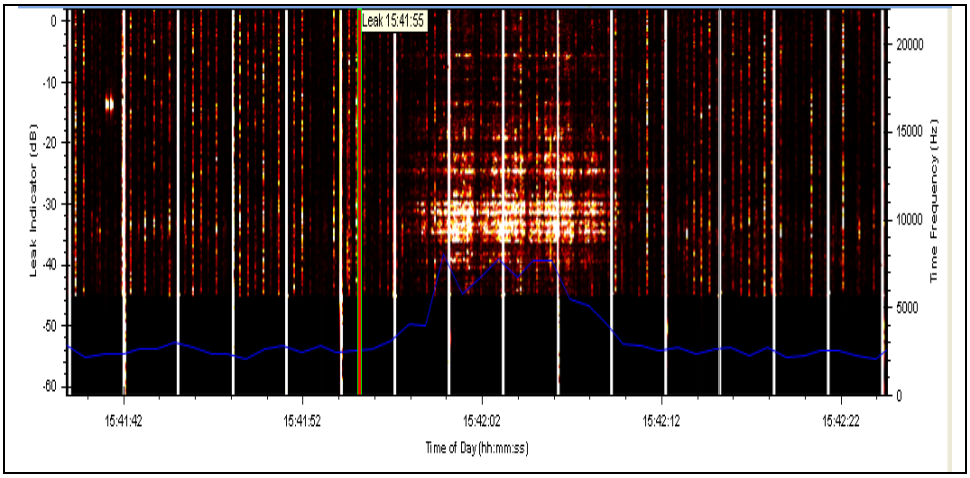


Location of Simulated Leak

Unknown Leak No.1
Estimated Size of Leak: 0.05 Gallons per minute
Leak Indication Power at Leak: -42 dB

Distance Along Pipeline:
Approximate Distance From Insertion: 51+057 meters

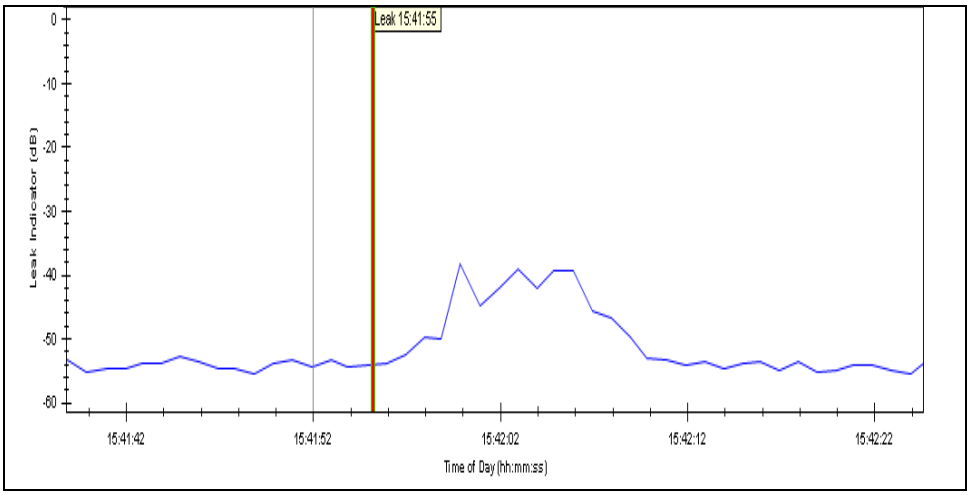
Distance From Nearest Sensor (52+250): 1+193 meters



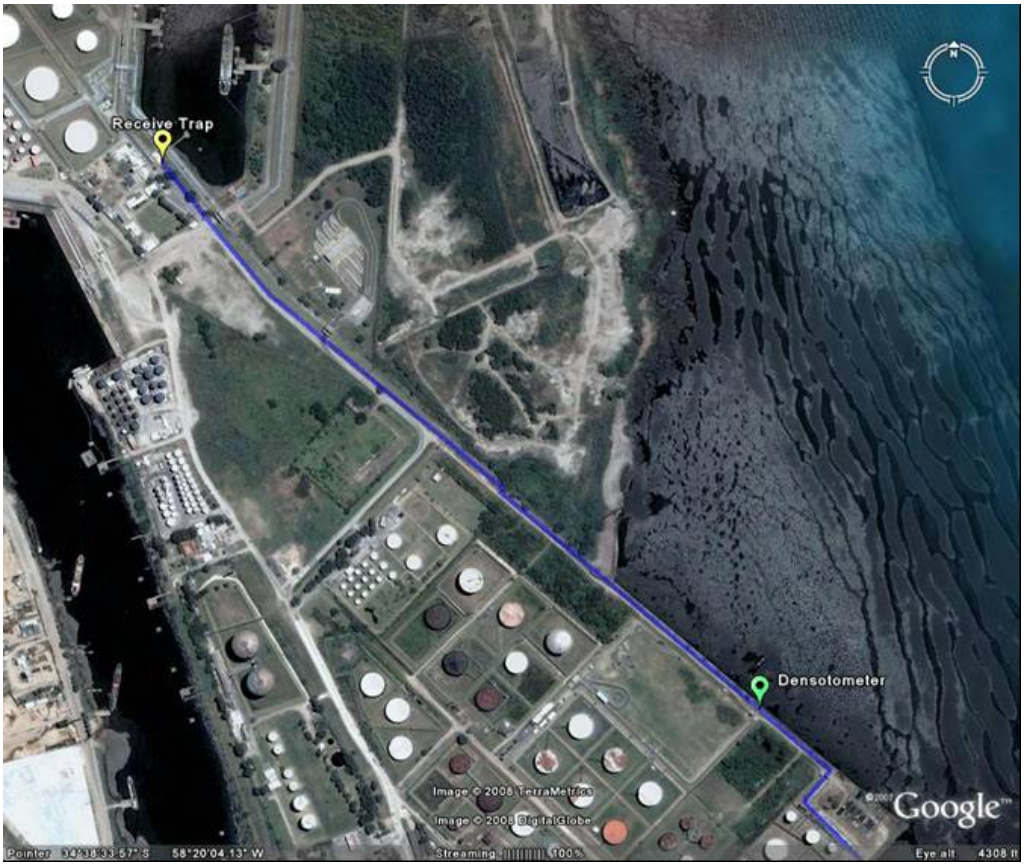
Frequency spectrum detected by the SmartBall as it passes the unknown leak.

Time of Tool Pass: 16:41:58

Details of Leak:
Unknown Leak. Determined to be a simulated leak at densitometer.



Leak Indication Power detected by the SmartBall as it passes the unknown leak.



Location of 2nd Acoustic Event (Densitometer) and Receive Trap

4 Simulated Leak Details

One simulated leak was generated along the pipeline in order to test the capabilities of the SmartBall. The leak was simulated using small diameter hose connected directly to a valve attached to riser pipe coming off the pipeline. The hose was approximately 20 feet in length and was directed to an empty oil barrel.

So as to not miss the leak the local field operations team turned the leak on when the SmartBall was approaching the valve site. The leak ran for about 3 minutes and was then turned off.

The simulated leak (3.2 Gpm), was successfully recorded and identified by the SmartBall tool.

Leak Details:

- Estimated Size: 3.2 Gallons per Minute
- Distance from Insertion: 17061meters
- Distance from closest sensor: 15018 meters

5 Overview of Data Collected During the Inspection

During the inspection, the SmartBall and SmartBall Receivers (SBRs) collected data to aid in determining an accurate size and location of all leaks detected.

Knowledge of the position of the SmartBall within the pipeline is critical for locating important features, such as leaks. The methodology used to track the tool involves obtaining a velocity profile using data obtained from the accelerometers and magnetometers on board the SmartBall. Then, absolute position reference points obtained from the SBRs are applied to time stamped data. Individual SBRs are able to track the ball's progress through the pipeline for up to 150 meters. The result of the rotation profile and SBR tracking is a position versus time relationship for the entire run of the tool.

To assist in identifying the approximate rate of any identified leak, Pure Technologies can compare the leak indication power of the detected leak with that of a known leak rate. Known leak rates and corresponding leak indication power (in dB) are developed by holding the SmartBall in the launch trap at the start of the survey run and releasing product at a known rate. The acoustic analysis of the calibration leaks were compared with the leak rate of each leak detected during the inspection of the pipeline. The leak indication power is the single most important indicator of a leak's presence and size.

Because the simulated leaks are controlled and released through a threaded outlet, the comparison to actual field condition leaks may vary. This is because the acoustic frequency and power indication of any leak will vary with many factors, including pressure, pipe diameter, size and configuration (pin-hole, rolled gasket, split pipe, etc.). However, the leak calibration curve provides a useful tool in approximating leak rates for identified leaks. The leak calibration curve will increase in accuracy in time as more data points and calibration leaks are added to the curve.

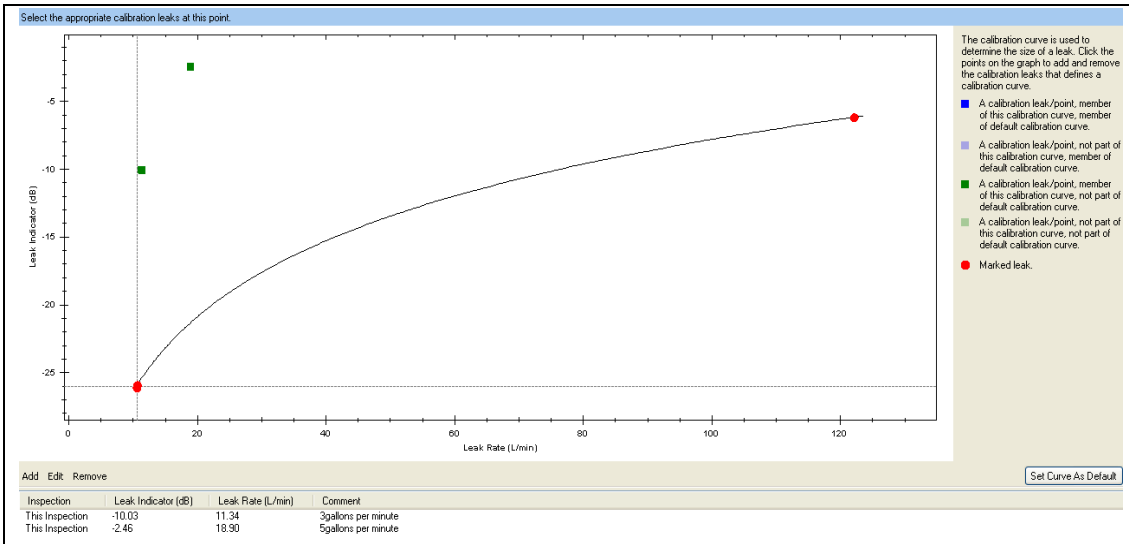
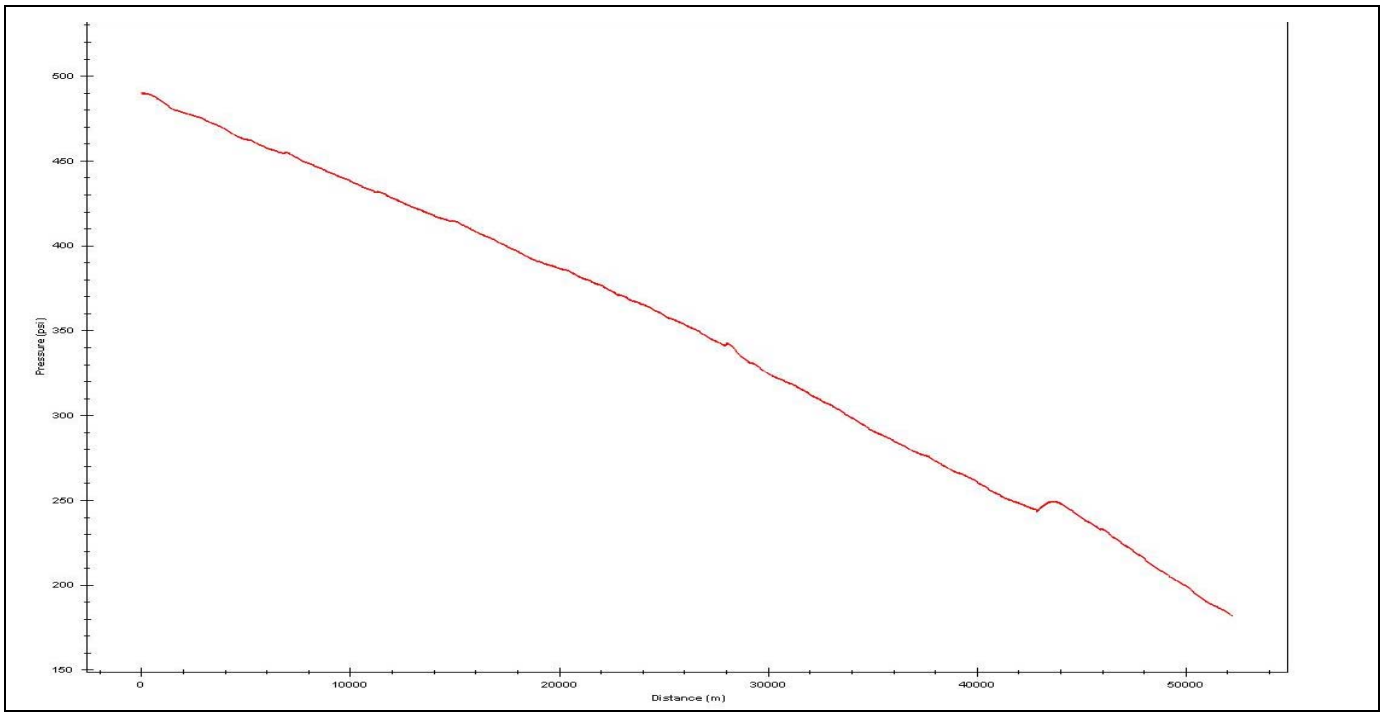
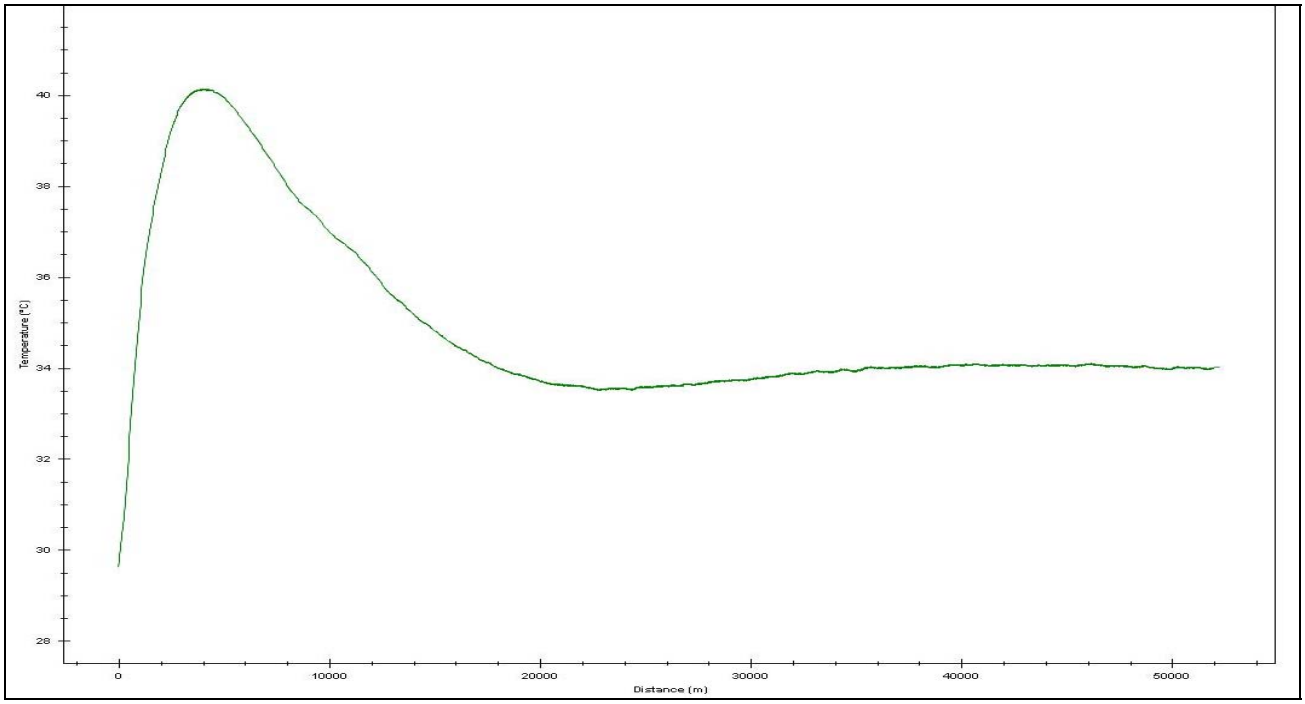


Fig. 1

Pressure data throughout the run can also be a valuable piece of information for pipeline owners. The pressure of the pipeline is recorded in real time by the SmartBall by means of an onboard pressure transducer that is open to the ambient pressure inside the pipeline. The graph below details the pressure in the pipeline in relation to time and distance.



The SmartBall tool also records temperature data as it traverses the pipeline. The figure below shows a temperature versus time graphic of the portion of the pipeline surveyed by the SmartBall.



6 Magnotometer Results:

The magnetometer sensor within the SmartBall picks up changes in the magnetic field within the pipeline. This in short means that the sensor is able to pick up large changes in metal thickness along the pipeline. Appurtenances such as valves, insertion and extraction traps are all identified by the magnetometer.

The magnetometer's output is in voltage. Constant voltage equals zero change while large deviations in voltage identify points of the pipeline where the metallic make up of the line is different from the norm. All such instances within the survey of the pipeline are listed below within Table 1.

Time of Anomoly	Voltage Delta	Notes	Distance (m)
8:28:21	NA	Insertion Trap	0.00
8:28:32	5.5 - 3.3		14.39
8:39:32	5.0 - 4.0		1072.65
8:39:57	4.8 - 4.3		1112.62
8:43:39	5.0 - 4.0		1467.51
8:44:16	4.8 - 4.3		1526.65
8:44:34	4.8 - 4.3		1555.43
8:49:37	4.8 - 4.3	Sensor Point	2039.80
8:55:26	4.8 - 4.3		2857.31
8:56:06	5.0 - 4.0		2927.64
9:19:22	4.8 - 4.3		5382.29
9:22:24	5.0 - 4.0		5702.30
11:07:20	4.8 - 4.3		16772.83
11:07:37	4.8 - 4.3		16802.72
11:11:32	5.0 - 4.0	Leak Valve Point	17215.93
11:18:01	4.8 - 4.3		17631.76
12:39:32	4.8 - 4.3		26102.97
12:39:46	4.8 - 4.3		26127.22
12:42:54	5.0 - 4.0		26452.84
12:53:52	4.8 - 4.3		27592.49
1:10:52	4.8 - 4.3		29359.13
1:42:19	4.8 - 4.3		32627.42
1:52:19	5.0 - 4.0	Large Anomaly	33666.62
1:56:57	5.0 - 4.0	Large Anomaly	33398.90
2:30:50	5.0 - 4.0	Large Anomaly	36842.81
2:31:09	5.0 - 4.3		36874.99
2:33:31	4.8 - 4.3		37115.54
3:53:08	5.0 - 4.0		45207.78
3:56:52	5.5 - 3.5	Large Anomaly	45587.23

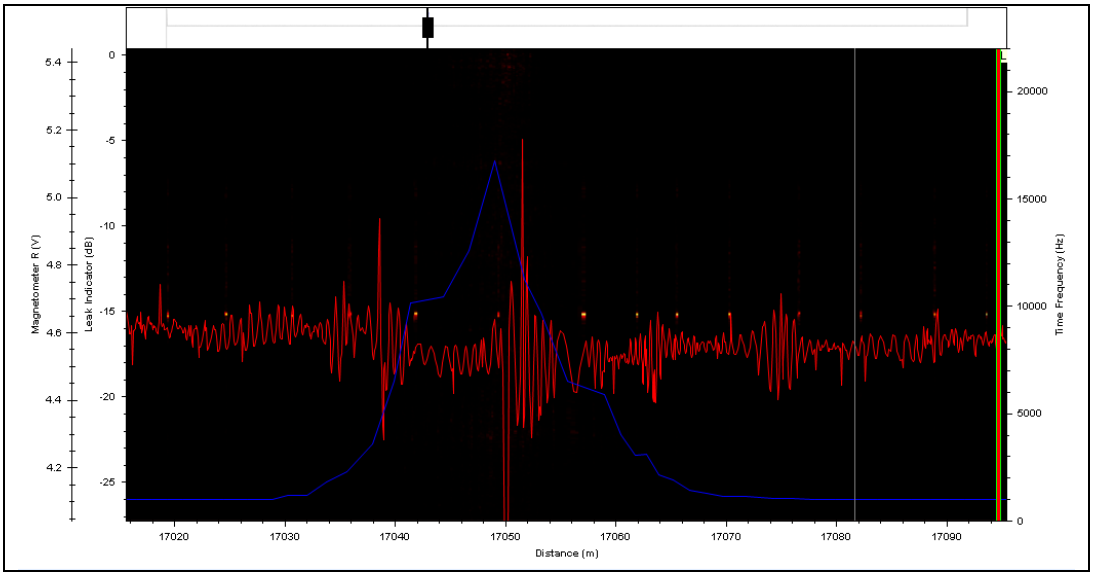
Table 1: Magnetometer Summary

For large appurtenances within the line (valves, insertion, extraction traps) the magnetometer is very accurate in identification of such items. An example of this can be seen below with the identification of the valve where the simulated leak was created.

As can be seen by the diagram below, the acoustic profile clearly identifies the point within the pipeline where the simulated leak was created which is at a valve. This valve clearly is identified by the magnetometer.

Magnetometer Output at Simulated Leak:

- Blue Line: Acoustic Profile (Simulated Leak at 17+061)
- Red Line: Magnetometer Output



Magnetometer Output at Valve point for Simulated Leak.

To accurately identify the much smaller fittings associated with illegal taps within the pipeline refinement to the magnetometer sensor within the SmartBall would be required. This would involve increasing the sensitivity of the sensor and adding additional sensors around the circumference of the ball. This would allow the ball tofind smaller metallic changes within the pipeline, or illegal taps.

7 Summary of Results

Using the calibration leaks as reference points, it possible to create a leak calibration curve in order to determine an approximate rate for leaks found during the SmartBall survey. However, in this instance, the inability to measure the release rate during the calibration leak process means that a reliable calibration curve could not be generated. However, a qualitative comparison of the leak sizes was possible and an approximate estimate of the leak sizes was made using generic data for the SmartBall's response. The ability to detect and locate leaks was not affected. The table below lists the calculated leak rates generated from the calibration curve and the actual leak rates at each location. The percent error of the calculated values versus the actual values is also listed.

The ability to accurately locate any leaks detected is paramount to the efficacy of the SmartBall tool. Using the simulated leaks and SmartBall receiver data as reference points it was possible to calculate the location of the unknown leak to an accuracy of 0.02%.

	Calculated		**Actual**		**% Error**	
	Leak Rate	**Location**	**Leak Rate**	**Location**	**Leak Rate**	**Location**
Known Simulated Leak Valve	3.2 Gal/min	17056m	Unknown	17061	NA	0.03
Unknown Leak	0.05 Gal/min	51056m	Unknown	51068	NA	0.02

Appendix A: Sensor Locations & Simulated Leak

October 21st, 2008

Sensor Location #0:

Sensor Location ID		Insertion Trap
Distance from Launch		0 meters
Time of SmartBall tool launch		08:29:00
GPS Position	Lat:	34°53'37.45463"S
	Long:	57°54'45.20703"W

Sensor Location #1:

Sensor Location ID		Ituzaingó Water Crossing
Distance from Launch		2+043 meters
Time of SmartBall tool Pass		08:49:39
GPS Position	Lat:	34°53'41.73"S
	Long:	57°55'45.65"W

Sensor Location #2:

Sensor Location ID	Valvula de Bloqueo 1 Poli	
Distance from Launch	17+061 meters	
Time of SmartBall tool Pass	11:12:00	
GPS Position	Lat:	34°50'5.60"S
	Long:	58° 4'19.96"W

Sensor Location #3:

Sensor Location ID	Valvula de Bloqueo 2 Poli	
Distance from Launch	34+540 meters	
Time of SmartBall tool Pass	14:00:09	
GPS Position	Lat:	34°43'56.95"S
	Long:	58°12'54.98"W

Sensor Location #4:

Sensor Location ID		Receive Trap	
Distance from Launch		52+250 meters	
Time of SmartBall tool Pass		16:54:22	
GPS Position	Lat:	34°38'20.57"S	
	Long:	58°20'24.63"W	