Cost Savings Report Summary Page

Title: Ultrasonic Liquid Level Detection Technology **Date:** 03/08/00

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Summary Description:

Information on standing liquid in vessels or piping is needed for planning decommissioning activities. The Ultrasonic Liquid Level Detection System uses ultrasonic/acoustic wave transmission through solids and liquids to determine liquid levels. A pulse-echo technique is used that employs a single sensor.

The Ultrasonic Liquid Level Detection System was deployed in the 221-U Facility at the Hanford Site during fiscal year 2000. The results of the ultrasound examinations were identical to the results obtained using traditional methods and/or an infrared liquid level detection method. Analysis of the costs associated with the Ultrasonic Liquid Level Detection System indicates significant savings compared to baseline. Cost savings are realized due to significant reductions in work scope planning, engineering, and operations costs. In addition, personnel exposure to potentially hazardous conditions is significantly reduced using the Ultrasonic Liquid Level Detection technology.

Initial Capital Investment (C)	**$**	**4,000**	
Implementation Cost (E)	**$**	**1,820**	
Total Project Start Up Cost (C+E)	**$**	**5,820**	
Termination Cost (D)	**$**	**-**	
Annual Recurring Cost Before (B)	**$**	**32,200**	
Annual Recurring Cost After (A)	**$**	**2,455**	
Net Annual Recurring Cost (B-A)	**$**	**29,745**	
*** Useful Project Life in Years (L)**		**10**	
Total Savings ([(B - A) x L] - (C + E + D))	**$**	**291,630**	
Annualized Savings	**$**	**29,163**	
Return on Investment		**501**	**%**

* The useful project life of 10 years reflects the useful life of the equipment.
Project work requiring liquid level detection extends through 10 years.

1. Baseline Description (Brief description of current baseline technology and/or methods)

Direct visual inspection, boroscopic visual inspection, and dipsticks are the traditional baseline technologies for determining the presence or absence of freestanding liquids in equipment and piping. The equipment subject to examination for the presence of freestanding liquid falls into two general categories: tanks or vessels, and piping sections.

Tanks

Tanks, vessels, and other equipment installed as part of facility processes are typically constructed or equipped with removable piping connections, inspection ports, covers, manholes, etc. The baseline method to determine the liquid level within a tank located on the canyon deck includes, but is not limited to, the following steps:

- Develop work instruction package
- Erect scaffolding around the tank
- Open port or perform penetration of the equipment
- Perform vapor/gas measurements and radiological survey
- Perform liquid level detection using traditional baseline methods
- Close port or seal penetration
- Remove scaffolding.

Piping Sections

The baseline liquid detection in pipes is accomplished by finding low points and opening existing valves or tapping the pipe for insertion of sampling apparatus. Baseline level detection technology and application is similar to that associated with tanks and vessels.
The baseline method to determine if liquid is present within the pipe includes, but is not limited to, the following:

- Develop work package
- Prepare work area
- Hot tap pipe/verify liquid presence
- Clean up work area.

2. Improved Technology Description (Brief description of improved technology and/or methods)

The Ultrasonic Liquid Level Detection System was designed and manufactured by Pacific Northwest National Laboratory. The technology uses ultrasonic transducer (UT) pulse-echo-based instruments with custom electronics designed for the manual detection of freestanding liquid in drums, tanks, and pipes. The Ultrasonic Liquid Level Detection System provides the capability for real-time, simple "yes/no" electronic detection/determination of standing liquid.

The ability for liquids (e.g., water) to couple and support acoustic waves is the principle used to determine liquid levels. A gel is used to couple the acoustic wave from the piezoelectric-based sensor into the wall of the vessel to be tested. The metal wall has acoustic impedance similar to that of the gel. This acoustic impedance combined with low attenuation conducts the acoustic wave to the other side of the wall. If the tank contains water or a liquid with similar acoustic impedance, then the inner wall wave will be transmitted at the interface and coupled into the liquid. The liquid will support the wave transmission across the tank diameter to the far side, where some of the wave will be reflected back across the liquid. This reflected wave is coupled back into the near wall where it is detected as an "echo" by the same sensor that launched the wave.

In a scanning mode, the sensor is physically moved along an inspection axis. If the liquid level transitions to air, then the return echo disappears; this location is the fill-level line. The instrument will denote this point by lighting the "no liquid detected" light-emitting diode (LED) and turning off the "liquid detected" LED. Solids, such as sludges, are very attenuative and produce the same apparent result as air; therefore, this instrument is restricted to items that contain liquids.

Two similar devices comprise the Ultrasonic Liquid Level Detection System: a barrel/tank tester and a pipe tester. The barrel/tank tester model uses a 1-MHz transducer and is intended for use on single-walled steel vessels with diameters rangingfrom at least 0.3 to 3 m (1 to 10 ft). The pipe tester uses 5-MHz transducer and is intended for use on pipe diameters of 10 to 25 cm (4 to 10 in.). Both units use a high-voltage (385 V) excitation pulse source to launch the ultrasonic pulse. The width of the high-voltage pulse is tailored to the transducer frequency. The units are powered by a separate 12-V battery pack and will operate for at least 4 hours. An accompanying AC charger is available for overnight recharging of the battery pack.

3. Description of Benefits (List of benefits expected from deployment of improved technology)

Safety and Health

The use of the Ultrasonic Liquid Level Detection System to detect liquids in vessels and pipes eliminates the need to physically open or perform intrusive penetration of equipment stored or installed in a facility. Workers must still come in direct contact with the vessel or pipe being examined. Potential risks to workers, which are reduced using this technology, include the following:

- Exposure to unknown or unsafe air space in the equipment under examination
- Contact with unknown materials (contents)
- Exposure to potentially pressurized piping or equipment
- Fall hazards associated with working from scaffolding
- Heat stress concerns from much greater physical exertion
- Radiological exposures dose to personnel due to closer proximity and extended contact with the equipment subject to examination.

Scheduling and Time Management

Use of the Ultrasonic Liquid Level Detection System methods requires significantly less planning and may typically be accomplished using existing routine work procedures. Regularly assigned facility personnel are capable of performing liquid level examination without the need for extensive support from specially skilled technicians.

Direct Cost Savings

Depending on the type of equipment to be examined, cost reduction factors of 17 to 18 may be realized using Ultrasonic Liquid Level Detection System technology versus traditional baseline methods.

Worksheet 1: Operating & Maintenance Annual Recurring Costs

Expense Cost Items *	Before (B) Annual Costs	After (A) Annual Costs
1. Equipment	$ -	$ 400.00
2. Purchased Raw Materials and Supplies	$ 2,900.00	$ 10.00
3. Process Operation Costs:		
Utility Costs	$ -	$ -
Labor Costs	$ 16,260.00	$ 1,176.00
Routine Maintenance Costs for Processes	$ -	$ -
Subtotal	$ 16,260.00	$ 1,176.00
4. PPE and Related Health/Safety/Supply Costs	$ 6,280.00	$ 381.00
5. Waste Management Costs:		
Waste Container Costs	$ -	$ -
Treatment/Storage/Disposal Costs	$ -	$ -
Inspection/Compliance Costs	$ -	$ -
Subtotal	$ -	$ -
6. Recycling Costs		
Material Collection/Separation/Preparation Costs:		
a) Material and Supply Costs	$ -	$ -
b) Operations and Maintenance Labor Costs	$ -	$ -
Vendor Costs for Recycling	$ -	$ -
Subtotal	$ -	$ -
7. Administrative/other Costs	$ 6,760.00	$ 488.00
Total Annual Cost:	$ 32,200.00	$ 2,455.00

* See attached Supporting Data and Calculations.

Summary Worksheet : Itemized Project Funding Requirements*
(i.e., One Time Implementation Costs)

Category	Cost $
INITIAL CAPITAL INVESTMENT	
1. Design	$ -
2. Purchase	$ 4,000
3. Installation	$ -
4. Other Capital Investment (explain)	$ -
Subtotal: Capital Investment= (C)	$ 4,000
INSTALLATION OPERATING EXPENSES	
1. Planning/Procedure Development	$ 660
2. Training	$ 500
3. Miscellaneous Supplies	$ -
4. Startup/testing	$ -
5. Readiness Reviews/Management Assessment/Administrative Costs	$ 660
6. Other Installation Operating Expenses (explain)	$ -
Subtotal: Installation Operating Expense = (E)	$ 1,820
7. All company adders (G & A/PHMC Fee, MPR, GFS, Overhead, taxes, etc.)(if not contained in above items)	$ -
Total Project Funding Requirements=(C + E)	$ 5,820

Useful Project Life = (L) 10 Years Time to Implement: 0 Months

Estimated Project Termination/Disassembly Cost (if applicable) = (D) $ -

(Only for Projects where L<5 years; D=0 if L>5 years)

RETURN ON INVESTMENT CALCULATION

Return on Investment (ROI) % =

$$\frac{\textit{(Before - After) - [(Total Project Funding Requirements + Termination)/Useful Life]}}{\textit{[Total Project Funding Requirements + Project Termination]}} \times 100$$

$$\text{ROI} = \frac{(B-A)-[(C+E+D)/L]}{(C+E+D)} \times 100 = 501\ \%$$

O&M Annual Recurring Costs:				Project Funding Requirements:			
Annual Costs, Before=	$	32,200	(B)	Capital Investment=	$	4,000	(C)
Annual Costs, After=	$	2,455	(A)	Installation Op. Exp=	$	1,820	(E)
Net Annual Savings=	$	29,745	(B-A)	Total Project Funds=	$	5,820	(C+E)

Note: Before (B) and After (A) are Operating & Maintenance Annual Recurring Costs from Worksheet 1.

* See attached Supporting Data and Calculations.

Supporting Data and Calculations

Basis of Recurring Labor Costs		
Before Labor Costs	6 tanks @$2,270 ea	$13,620
	10 pieces of pipe @$264 ea	$2,640
	Subtotal	$16,260
After Labor Costs	6 tanks @$141 ea	$846
	10 pieces of pipe @$33 ea	$330
	Subtotal	$1,176
Planning/Procedure Development	10 hrs @$66/hr	$660
Basis of Training Costs	5 people for 1 hr @$66/hr	$330
	$70 instructor time	$70
	$100 instruction materials	$100
	Subtotal	$500
Administrative Costs	10 hrs @$66/hr	$660

For additional informaiton see the Cost/Performance Report for Ultrasonic Liquid Level Detection Technology.