Research Experience as an FIU DOE Fellow

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Research Projects

- Development of Alternative Unplugging Technologies: The Peristaltic Crawler
- Low Level and Mixed Low Level Waste Treatment Technology Identification
- Development of Inspection Tools for DST Primary Tanks

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Background Information

- The first retrieval of radioactive material at the Hanford Site began in 1944.
- High level waste at Hanford has many different chemical compositions and physical characteristics.
- The earliest tanks to hold the HLW were single-shell tanks (SSTs). These SSTs have outlived their useful life and it has resulted in leakage of waste into the surrounding soil.
- The later double-shell tanks (DSTs) consist of a first tank surrounded by a secondary containment tank. The external shell of the DST provides an additional barrier.
- There is to be a complete transfer of this HLW to secure double shell tanks by 2040.
- This transfer is done via pipelines

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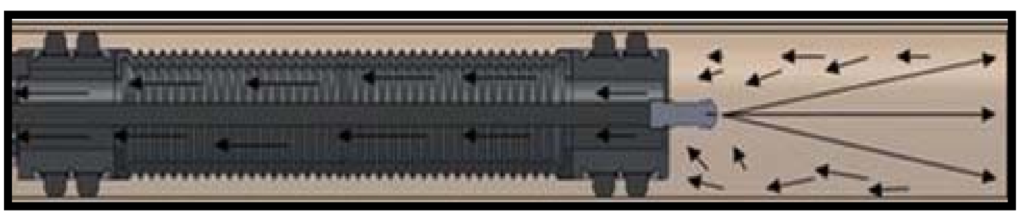
Objective

- High level waste at Hanford has many different chemical compositions and physical characteristics.
- Some of the pipelines have formed blockages due to particle settling, phase changes, or reactions accompanied by gel formation that occur during transport.

To continue the transfer of waste through the pipelines, our goal is to create a peristaltic crawler as an unplugging tool/technology capable of pulling its own weight to accurately locate the blockages and remove plugs that exist in pipelines



Design Metrics

Fit within 7.62 cm inner diameter pipes

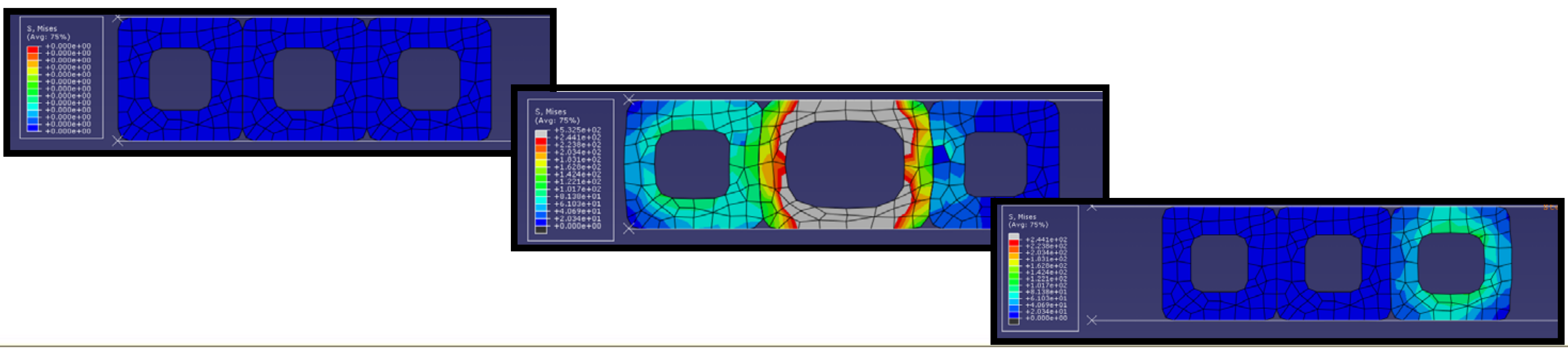
Survive in a RADIOACTIVE environment

Operate below 300 psi

Maneuver through a 90º ELBOW with a 4.25 inch turning radii

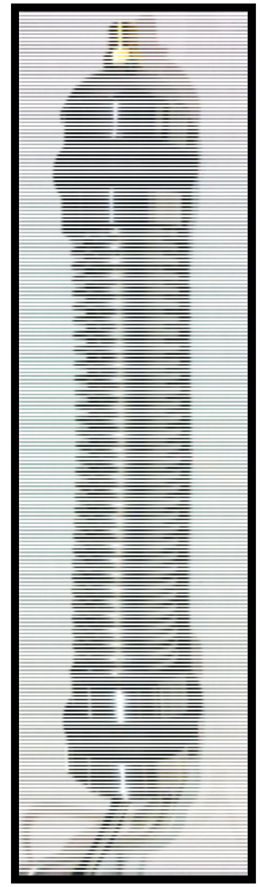
System Explanation

The peristaltic crawler is a pneumatic/hydraulic operated tool that propels itself by a sequence of pressurizations/depressurizations of its inner tubes. It has three air cavities with front and rear rims for the inner and outer bellows. The bodies inflate and deflate in sequence. The changes in pressure result in a worm like motion of the vessel by peristaltic movements. The crawler includes a frontal attachment that has a hydraulically powered unplugging tool.



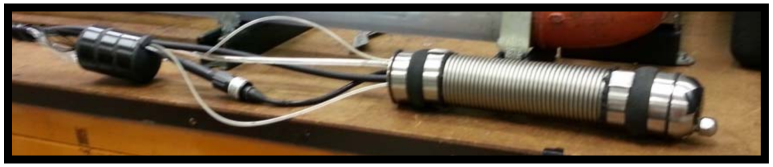
Third Prototype

- Outer hydroformed bellow so that it can be pressurized and when pressurized extends forward for forward movement
- Edge welded inner bellow to decrease the stiffness of the assembly
- Uses 316 stainless steel rims for HLW environment durability and stainless steel clamps on rubber
- All parts welded together eliminating potential leak points



Improved Third Generation

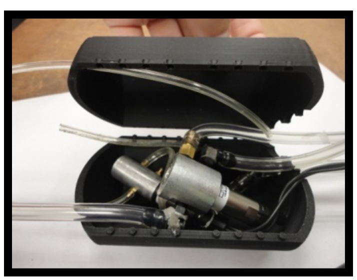
- Inspection camera mounted at front of crawler to provide visual feedback of pipeline conditions
- New design of front rim to improve packaging of features onto crawler
- Thinner walled outer hydroformed bellow to improve navigational maneuverability.
- Pneumatic valves are be located behind the crawler unit (not at the control station) to significantly reduce cycle time
- Improve automation of sequence to avoid kickback
- Separate elbow navigation program



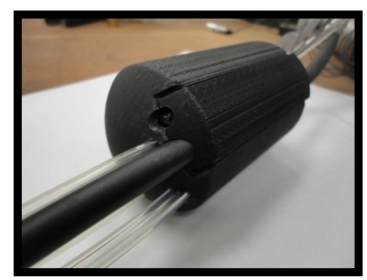
Components

Omron programmable logic controller (PLC) uses ladder programming and twin timers for automation of locomotion

500 ft long tether-reel assembly system of three pneumatic lines, one hydraulic line, and one multi-conductor cable jacketed together.



Water proof Pneumatic valve container to protect pneumatic valves near the crawler



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Results: Speed

3rd generation:

- Bellows set to 50 psi and rims at 60 psi
- Straight line navigational speed: ≈ **19 ft/hr**

Improved 3rd generation:

- Bellows set to 10 psi and rims at 90 psi
- Straight line navigational speed: ≈ **38 ft/hr**

Results: Maneuverability

3rd generation:

- Bellows set to 50 psi and rims at 60 psi
- The crawler successfully travelled through a 4.25 inch radius elbow in **≈ 10 min**

Improved 3rd generation:

- Bellows set to 20 psi and rims at 90 psi
- The crawler successfully travelled through a 4.25 inch radius elbow in **≈ 6 min**

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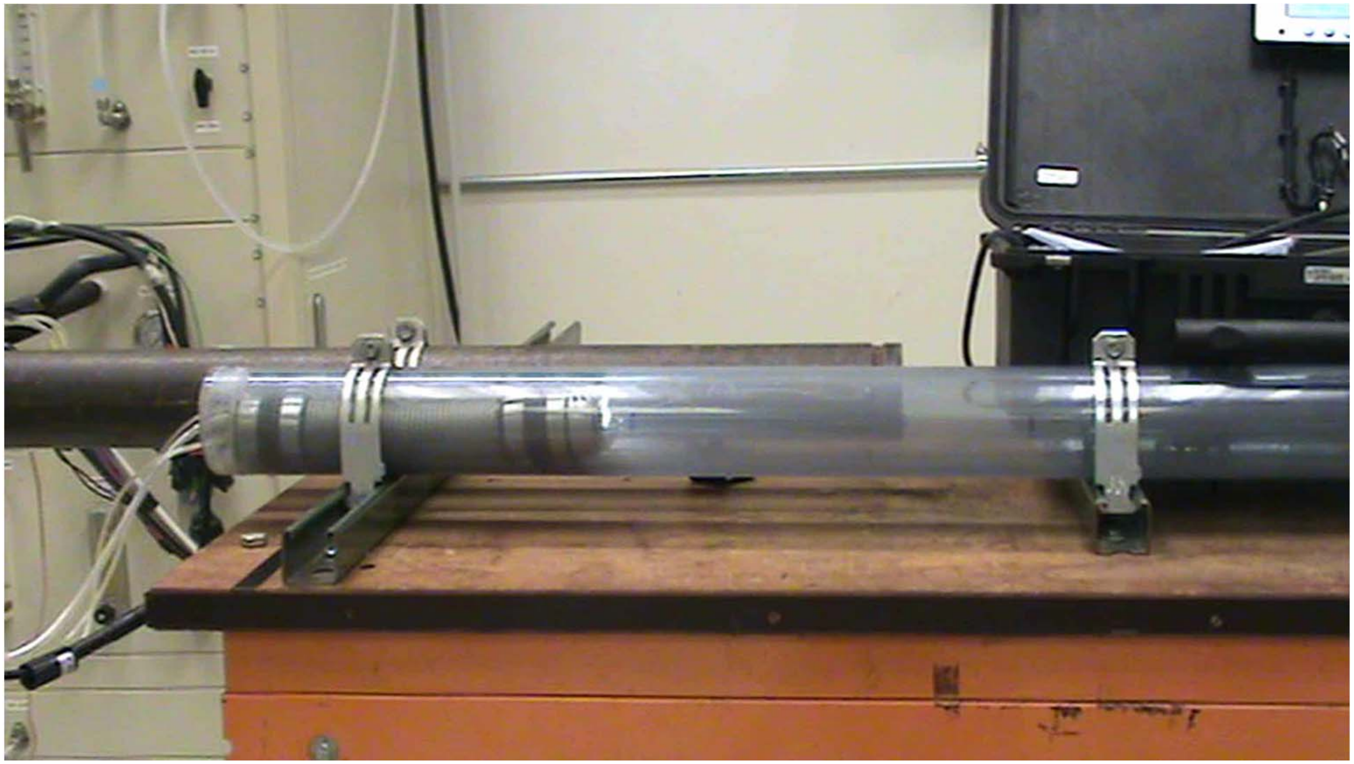
Large Scale Testing and Unplugging

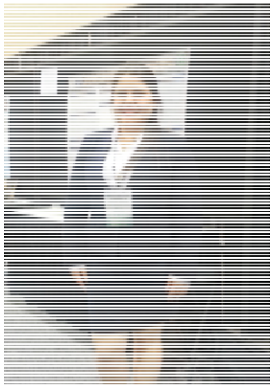



Research: The Peristaltic Crawler

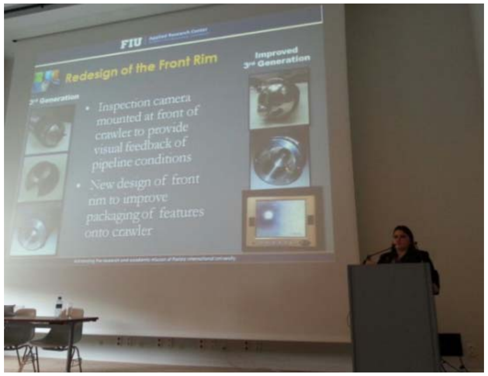


Conferences

Waste Management Symposia 2013
- **Location:** Phoenix, AZ
- **Outcome**
  - 1 Student Poster



15th ICEM 2013 Conference
- **Location:** Brussels, Belgium
- **Outcome**
  - 1 Published Papers
  - 1 Oral Presentations



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2012 Poster Competition

2013 Research Day

Low Level and Mixed Low Level Waste Treatment Technology Identification

Summer Internship at DOE Headquarters with
Office of Waste Management (EM-31)

Ms. Gabriela Vazquez

Mentors: Christine Gelles, Douglas Tonkay, and James Joyce

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Background

- The U.S. DOE and U.K. Nuclear Decommissioning Authority (NDA) entered into a mutually beneficial Statement of Intent in 2007 to exchange information concerning the management of radioactive waste and the decommissioning and clean-up of nuclear installations.
- Sharing information on radioactive waste treatment technologies will support waste management and clean-up objectives for both countries.
- The NDA commissioned a report that identifies opportunities to optimize the management of U.K. orphan waste, including identification of existing treatment capabilities.
- These opportunities and capabilities may also be applicable to the U.S. DOE

Purpose & Objective

- **OBJECTIVE:**

  Develop concise information describing current and historical United States (U.S.) commercial and federal low-level waste (LLW) and mixed low-level waste (MLLW) treatment capabilities and potential treatment technology needs for U.S. Department of Energy (DOE) waste streams

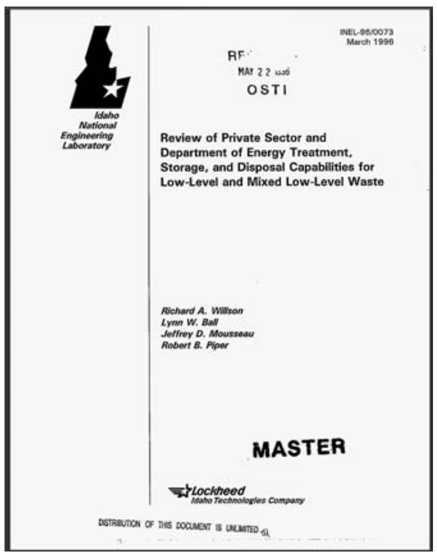
- **PURPOSE:**

  The information will be shared with the United Kingdom (U.K.) Nuclear Decommissioning Authority (NDA) to support exchanges on U.S. and UK MLLW treatment capabilities, with a particular focus on technologies to address orphan (challenging) waste streams that lack a disposition path.

Past Companies/Technologies

- Look Back – What companies and technologies used to exist

- 1996 Report "Review of Private Sector and Department of Energy Treatment, Storage, and Disposal Capabilities for Low-Level and Mixed Low-Level Waste"



INEL-96/0073
March 1996

OSTI

Idaho National Engineering Laboratory

Review of Private Sector and Department of Energy Treatment, Storage, and Disposal Capabilities for Low-Level and Mixed Low-Level Waste

Richard A. Wilson
Lynn W. Ball
Jeffrey D. Mousseau
Robert B. Piper

MASTER

Lockheed Idaho Technologies Company

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Table 3-1. Vendor summary.

Vendor	LLW Volume Reduction, Storage, or Disposal	Mixed LLW Treatment, Storage, or Disposal
ADCO Services, Inc.	X	
ADTECHS Corporation		X
Advanced Recovery Systems, Inc.	X	X
Afftrex, LTD.	X	
ALARON Corporation	X	
Allied Technology Group, Inc.	X	X
American Ecology Corporation	X	P
Applied Health Physics, Inc.		
B&W Nuclear Environmental Services, Inc.	X	X

Vendor	Current Website	Notes about Services and Past Technologies
ElChroM Industries, Inc.	-	-
Energy Solutions	http://www.energysolutions.com/	EnergySolutions, headquartered in Salt Lake City, Utah, is one of the world's largest processors of low level waste, and is the largest nuclear waste company in the United States.
Envirocare of Utah, Inc.	-	**Now Energy Solutions**
Environmental Alternatives, Inc.	http://eairolloff.com/	Environmental Alternatives, Inc. specializes in roll-off services for the collection, processing, and disposal of construction and demolition (C&D) debris in the Maryland, Washington D.C., and Northern Virginia Area. Our goal is to redefine solutions to meet our customers waste management, lead recycling, and roll-off service needs.
Fluid Tech, Inc.	http://www.marinesystems-usa.com/	The Fluid Tech (FT) products are solidification/stabilization agents, developed for the efficient and economical disposal of radioactive, hazardous chemical, and mixed wastes. They are slightly alkaline, non-flammable, non-reactive and non-corrosive, and are not biodegradable. These reagents immobilize wastes (liquid, sludge, or solid) through the action of complex bonding mechanisms and ion exchange reactions. The end result is an homogenous waste solid with excellent leach resistance. They are Aquaset, Aquaset II, Aquaset II-H, Aquaset II-G, Aquaset II-GH, Petroset, Petroset-H, Petroset II, Petroset II-G.
Framatome Technologies, Inc.	-	-
Frank W. Hake Associates	-	-
Gencorp Aerojet	http://www.envirogen.com/welcome/home/	Envirogen Technologies is an environmental technology and process solutions provider that combines experience in water and vapor phase treatment with process development expertise, delivering long-term, guaranteed solutions in a broad range of treatment and process-related applications Provide system design, process engineering, equipment and operating solutions for the treatment of groundwater, wastewater, VOC treatment & odor abatement as well as materials recovery for a range of industrial and non-industrial customers throughout North America. A fundamental part of Envirogen's offering to the marketplace is its broad, but targeted technology portfolio. This includes a strong position in high efficiency ion exchange and the use of a variety of adsorptive media that are adaptable to different types of organic and inorganic contaminants and process requirements. We also have a strong biological treatment platform with both modular and built-in-place systems for highly cost-effective treatment in a range of applications, including odor control, nutrient removal, water re-use, wastewater and groundwater. Other contaminant removal and destruction technologies include coagulation filtration, chemical purification and advanced oxidation. Envirogen's offerings are often modular in design for ease of installation and rapid start-up. Technolgoy categories: • Ion Exchange • Bioreactors • Air Treatment • Biofilters • Regenration • Mobile Treatment • Chemical Purification

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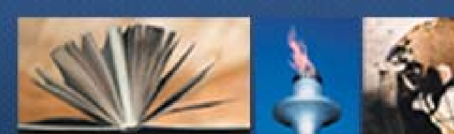
Past Companies/Technologies Conclusion

- From the 42 companies that existed in 1996 to treat and dispose of either LLW or MLLW only 24 continue to exist today.
- Of the 24 that exist today in 2013, only 11 continue to have treatment capabilities on site.
- Of the 11 identified with treatment capabilities, only 5 currently accept waste from DOE Sites.
  - Energy Solutions
  - Permafix
  - Philotechnics
  - Studsvik
  - Waste Control Specialists



B.1 ORPHAN WASTE GROUPS

The table below describes the 35 different orphan waste groups.

Table B-1 Summary of Orphan Waste Groups

	Orphan category	Description
1	Bulk Fines or Particulates	Fines, particulate, vacuum cleaner bag contents, filings, sawdust, sand.
2	Reactive Metals	Highly reactive metals which can react with water e.g. lithium, sodium, potassium, NaK (sodium and potassium alloy), and metals that can react with cementitious grout to form hydrogen. E.g. aluminium, Magnox. Group also includes zinc which retards grout set etc.
3	Pyrophoric Material	Can ignite spontaneously on contact with air e.g. Uranium hydride (UH_3).
4	Organic Ion Exchange Materials	Organic ion exchange resins, i.e., those composed of high-molecular-weight polyelectrolytes such as DeAcidite FF (A400).
5	Inorganic Ion Exchange Material	Inorganic based ion exchange media such as zeolites, Ionsiv®, clays etc.
6	Radium/Thorium/Americium Contaminated Waste	Radium and thorium contaminated wastes emanate radioactive gas (radon and thoron).
7	ILW Fuel	Fuel not suitable (or planned) for reprocessing. Also excludes bulk irradiated fuel streams. This group includes fuel fragments, thorium, enriched uranium, natural uranium and depleted uranium.
8	Tritium Contaminated Waste	Tritium contaminated solid or liquid waste. The discharge of tritium during processing or storage must be minimised. Excludes tritiated oil.

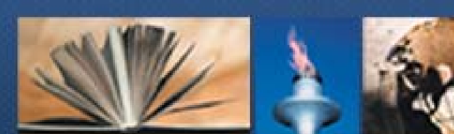
1) Waste Categories Table

2) U.S. M/LLW Technology Treatment Matrix

3) Supporting Summary Description of Current U.S. Federal and Commercial MLLW Treatment Capabilities

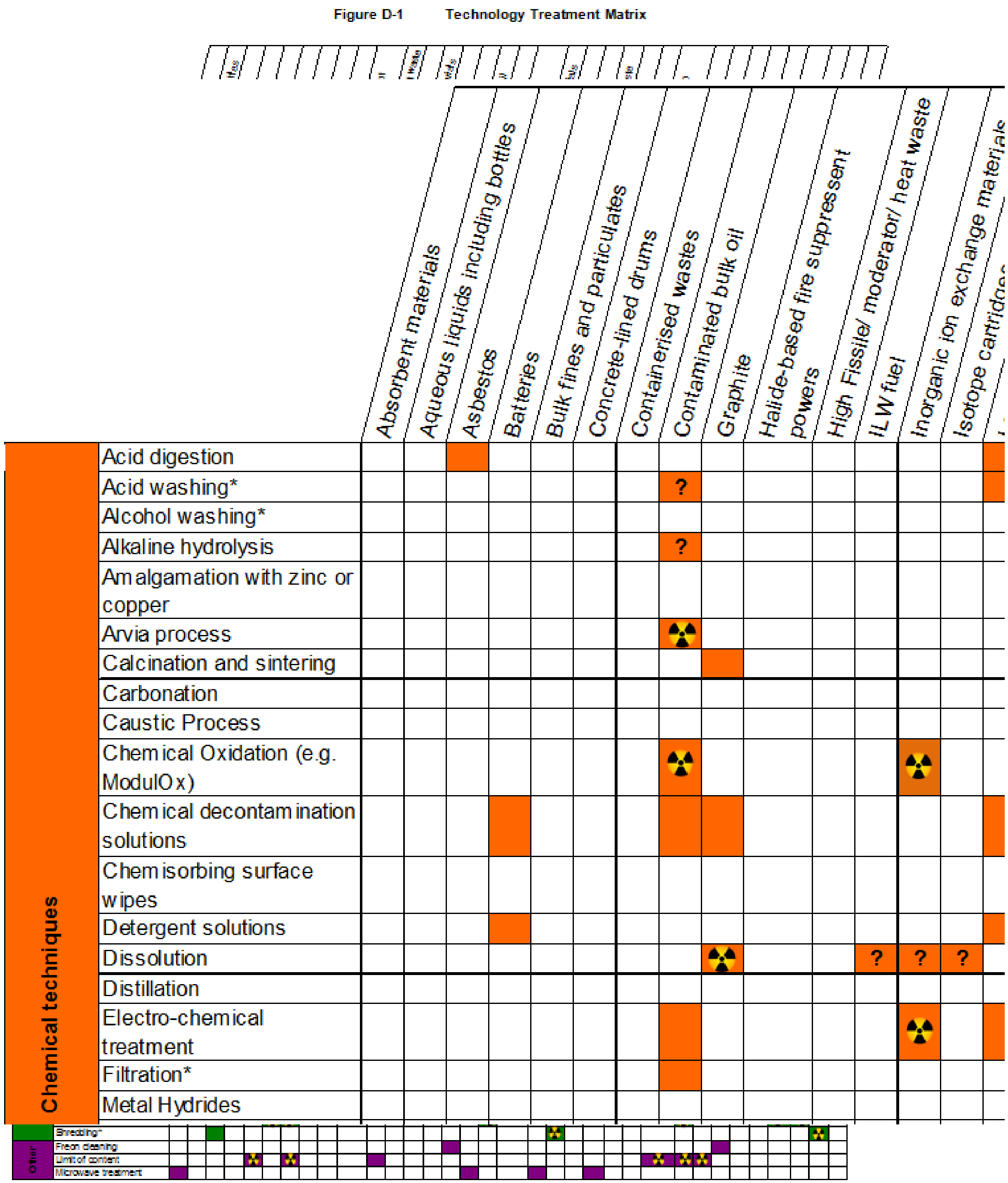
Waste Groups & Their Descriptions

- Using the DOE Waste Treatability Group Guidance report, six broad waste categories were identified.
  1. **Liquids / Aqueous Liquids / Slurries / Organic Liquids**
  2. **Solids / Homogeneous Solids**
  3. **Soil / Gravel**
  4. **Debris Waste**
  5. **Lab Packs**
  6. **Special Waste Forms**
- Descriptions were completed to go into further detail of what specific waste would be included in each category.
- Based on the interpretation of the descriptions provided by the U.K. of their waste categories, the table also lists the U.K. category titles that would fall into the broad U.S. categories.



U.S. Waste Groups & their Descriptions Table

	Waste Category	Description	U.K. Waste Stream within U.S. Category
1	Liquids / Aqueous Liquids / Slurries / Organic Liquids	Wastes that are liquids, including slurries. Slurries are defined as liquids with a total suspended/settled solids VSS) content of 21% and <30%. Only liquids and slurries packaged in bulk, free form (e.g., drum, tank) are included in this category. Liquids and slurries packaged as lab packs are assigned to other MPCs. Includes liquids and slurries containing less than 1 % total organic carbon (TOC). This waste is further evaluated per the criteria of Wastewaters (Acidic, Basic, Neutral, Cyanide) and Aqueous Slurries (Acidic, Basic, Neutral, Cyanide). This summary category includes liquids and slurries containing 21% TOC. This waste is further evaluated per the criteria of Aqueous/Organic Liquids (Aqueous/Halogenated, Aqueous/Nonhalogenated) and Pure Organic Liquids (Halogenated/Nonhalogenated).	• Aqueous liquids including bottles • Contaminated bulk oil • Material contaminated with oil • Triturated Oil



1) Waste Categories Table

2) U.S. M/LLW Technology Treatment Matrix

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Data Collection

Surveys sent out to

- **Perma-Fix Environmental Services, Inc.**
  (Renee Echols, Senior Vice President)

- **Energy*Solutions***
  ***(*Paul J. Larsen**, Senior Vice President of Business Development)

- **Studsvik, Inc.**
  (Andy Avila, Sales Manager)

- **Waste Control Specialists LLC**
  (Matt LaBarge, Technical Services Project Manager)

TABLE 3

	Absorbent Materials	Aqueous liquids including bottles	Asbestos	Batteries	Bulk fines & particulates	Concrete-lined drums	Containerized Wastes	Contaminated bulk oil	Graphite	Halide-based fire suppressant powers	High Fissile / moderator / heat waste	LW fuel	Inorganic ion exchange materials	Isotope cartridges	Lead	Material contaminated with oil	Mercury wastes	Miscellaneous Activated Components (MAC)
Amalgamation																	X	
~~Carbon adsorption~~																		
Chemical Oxidation										X			X					
~~Chemical Precipitation~~																		
Chemical Reduction										X			X					
Compaction / Supercompaction																		X
Deactivation										X			X					
Incineration								X	X									
Macroencapsulation			X	X			X		X						X			X
Metal Melt Furnace																		X
Neutralization		X								X			X					
Solidification		X											X					
Sort / Segregate	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X
Stabilization	X	X			X					X			X		X			
Vacuum Assisted Thermal Desorption	X	X						X		X			X			X	X	
Other:																		
Other:																		
Other:																		
Other:																		

Table 3 U.S. Technology Treatment Matrix

		Low Level Waste				Mixed Low Level Waste				
		Debris Waste	Liquids / Aqueous Liquids / Slurries / Organic Liquids	Soil / Gravel	Solids / HomogenousSolids / Sludge	Debris Waste	Lab Packs	Liquids / Aqueous Liquids / Slurries / Organic Liquids	Soil / Gravel	Solids / HomogenousSolids / Sludge
Chemical Techniques	Amalgamation							X		X
	Chemical Oxidation	X	X	X	X	X	X	X	X	X
	Chemical Reduction	X	X	X	X	X	X	X	X	X
	Controlled Reaction		X		X			X	X	X
	Deactivation	X	X	X	X	X	X	X	X	X
	Decontamination	X								
	Neutralization		X	X	X	X	X	X	X	X
	Solidification		X	X	X			X	X	X
	Stabilization		X	X	X	X	X	X	X	X
High Temperature Techniques	Incineration	X	X	X	X			X		
	Metal Melt Furnace	X								
	Retort									
	Steam Reforming		X					X		
	Vacuum Assisted Thermal Desorption (Separation)					X		X	X	X
Immobilization Techniques	Dewatering	X	X	X	X	X		X	X	X
	Macroencapsulation	X			X	X	X			X
	Microencapsulation	X			X	X				X
Physical Techniques	Compaction / Supercompaction	X	X	X	X	X				
	Sort/Segregate	X	X	X	X	X	X	X	X	X

The 1st matrix correlates U.S. treatment technologies to U.S. waste streams.

Table 4. U.S./UK Treatment Technology Treatment Matrix

Category	Technique	Absorbent Materials	Aqueous liquids including bottles	Asbestos	Batteries	Bulk fines & particulates	Concrete-lined drums	Containerized Wastes	Contaminated bulk oil	Graphite	Halide-based fire suppressant powers	High Fissile / moderator / heat waste	ILW fuel	Inorganic ion exchange materials	Isotope cartridges	Lead	Material contaminated with oil	Mercury wastes	Miscellaneous Activated Components (MAC)	Organic ion exchange materials	Physically awkward waste	Pressurized wastes	Putrescible & cellulose waste	Pyrochemical waste	Pyrophoric material	Radium/ Thorium/ Americium contaminated waste	Reactive Metals	Sealed Sources	Sludge	Solvents	Tritiated Oil	Tritium contaminated waste	Undefined Waste	Ventilation Filters	Zinc Bromide
Chemical Techniques	Amalgamation																	■								■						■			
Chemical Techniques	Chemical Oxidation	■	■			■	■	■			■	■		■						■	■			■		■	■		■	■		■	■		■
Chemical Techniques	Chemical Reduction	■	■			■	■	■			■	■		■						■	■			■		■	■		■	■		■	■		■
Chemical Techniques	Controlled Reaction	■	■			■	■	■				■		■						■	■			■		■						■	■		■
Chemical Techniques	Deactivation	■	■			■	■	■			■	■		■						■	■	■		■		■	■		■			■	■		■
Chemical Techniques	Decontamination				■											■						■				■		■				■			
Chemical Techniques	Neutralization		■				■	■			■	■		■						■	■			■	■	■	■		■	■		■	■		■
Chemical Techniques	Solidification		■			■								■						■				■	■	■	■	■	■	■	■	■			
Chemical Techniques	Stabilization	■	■			■	■	■			■	■		■		■		■		■	■		■	■	■	■	■	■	■	■	■	■	■	■	■
High Temperature Techniques	Incineration		■						■	■	■			■			■			■			■	■	■	■		■	■	■	■	■		■	■
High Temperature Techniques	Metal Melting																		■		■					■									
High Temperature Techniques	Retort																	■								■			■			■			
High Temperature Techniques	Steam Reforming																																		
High Temperature Techniques	Vacuum Assisted Thermal Desorption (Separation)	■	■						■		■			■			■	■		■			■	■	■	■			■	■	■	■			■
Immobilization Techniques	Dewatering	■	■				■	■				■		■					■	■	■			■		■			■			■	■		■
Immobilization Techniques	Macroencapsulation			■	■		■	■		■						■			■		■		■			■	■	■				■	■	■	
Immobilization Techniques	Microencapsulation						■									■			■		■					■						■	■	■	
Physical Techniques	Compaction / Supercompaction			■															■			■				■	■					■		■	
Physical Techniques	Sort/Segregate	■	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

The 2nd matrix is for the purpose of collaboration with the U.K. Vendors identified which of their available treatment technologies would be capable of treating the waste.

E.1 TREATMENT TECHNOLOGIES

Table E-1 Summary of Treatment Technologies (C = chemical techniques, H = high temperature techniques, I = immobilisation techniques, P = physical techniques and O = other).

	Technology name [References]	Summary of Description	Applicability	Specific examples of applicability	Advantages (+) and disadvantages (-)	Stage of development
C	**Acid digestion (strong)** [1, 59, 63].	The acid digestion technique uses hot, strong mineral acids (nitric, hydrochloric, phosphoric and sulphuric acids) to oxidise the organic components of waste. Products include sulphur and nitrogen oxide, which may require extensive off-gas treatment. Aqueous sludge consisting of inorganic oxides is also produced, which may require treatment (e.g. neutralisation before immobilisation in cement).	• Asbestos. • Ion exchange material (organic). • Lead • Mercury. • Pyrophoric material. • Solvents.	Mercury can be dissolved in nitric acid and then precipitated as mercury sulphide by adding ammonium sulphide. Acid digestion destroys asbestos fibres, thereby eliminating the hazardous component of the asbestos waste.	+ Can treat a range of organic wastes as well as mercury. + Operates at low pressure. - Acid mixture used is extremely corrosive. - Process needs to be performed in equipment made of expensive, corrosion resistant materials. - The process has the potential for creating large volumes of liquid secondary waste.	In use within the UK nuclear industry.
C	**Acid washing** [2, 3].	A washing processing in which radioactive material is soaked in an acid solution for a period of time to remove surface contamination. The acid-depleted solution can be regenerated with H_2O_2, as an oxidising agent, which precipitates the insoluble compounds. Formic acid is added to the depleted solution to achieve the initial concentration, and the acid solution can be reused. The solution containing the dissolved metals is electro-chemically processed to recover the metals. The acid solution from the electrolysis is returned to the decontamination tank for reuse.	• Contaminated bulk oil. • Lead. • Mercury. • Physically awkward wastes. • Solvents.	Used as part of the Inutec process to remove soluble contaminants. The DECOFOR process involves immersing lead contaminated metal samples in dilute formic acid for a short period of time, or the samples can be sprayed with acid solution. Springfields Fuels Ltd is working with NNL to develop a method for cleaning contaminated oils and solvents using an acid washing process. LLWR is assessing the suitability of 'de-rad' wipes for a nitric acid washing process. Pond skips at Hunterston A have been chemically decontaminated with nitric acid. Surface contamination of metal objects with dilute fluoroboric acid has been carried out at Wylfa.	+ Numerous acid washing systems available. - This process will only be economic for large quantities of contaminated material. - The process has the potential for creating large volumes of liquid secondary waste.	In use within the UK nuclear industry.
C	**Alcohol washing** [4, 5].	This process uses hot denatured liquid ethanol to react with any residual sodium left on the component after draining.	• Reactive metals.	Propylene glycol ($CH_3CHOHCH_2OH$) is a dihydric alcohol with two potentially reactive hydroxyl groups that can be used to treat very small quantities of NaK.	+ Caustic stress corrosion cracking of the component is minimised. - The process has the potential for creating large volumes of liquid secondary waste.	Used in the US nuclear industry.
C	**Alkaline hydrolysis** [59].	Alkaline hydrolysis is a wet, chemical extraction process in which a liquid organic waste is put into contact with an aqueous alkaline solution. This produces odourless kerosene which may require separation for treatment in a vortex combustor. In addition, sodium hydroxide requires treatment using flocculation and cementation processes.	• Contaminated bulk oil. • Solvents.	It is the main chemical treatment method employed at the Solvent Treatment Plant (STP) at Sellafield, UK. The STP is designed to treat 750 m^3 of Tri-N-Butyl Phosphate/Odourless Kerosene (TBP/OK) from both the THORP and Magnox reprocessing operations.	+ Low operating temperature. + Size flexibility for operation. - Limited application for organic waste. - Produces complex products that require further treatment.	In use within the UK nuclear industry.
C	**Amalgamation with zinc or copper** [1].	An amalgam is defined as an alloy of mercury and at least one other metal, such as copper, zinc, nickel or silver. Solid waste produced may need additional encapsulation or containerisation.	• Mercury.	Fine copper/zinc powder is washed with nitric acid and then milled. Elemental mercury is added to the mixture and then milled. It is then allowed to harden and later crushed into a powder.	+ Produces a stable solid waste. + Simple process.	In use within the US nuclear industry.

1) Waste Categories Table

2) U.S. M/LLW Technology Treatment Matrix

3) Supporting Summary Description of Current

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Summary of Treatment Technologies

- Specific details of each available technology were researched
  - Summary description
  - Applicability
  - Specific example of applicability
  - Advantages/disadvantages
  - Stage of development

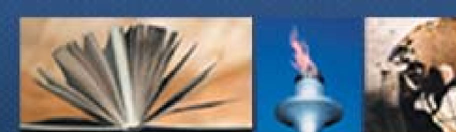

Table 6.Summary of Treatment Technologies

KEY: (C = chemical techniques, H = high temperature techniques, I = immobilization techniques, and P = physical techniques)

	Technology Name	Summary of Description	Applicability	Specific examples of applicability	Advantages (+) and disadvantages (-)
C I	Amalgamation	Amalgamation requires a patented process that uses proprietary reagents that meets the EPA technology treatment standard (AMALGM). The process treats elemental mercury waste to meet the requirement of AMALGM using chemical reagents that bind the mercury and render it non-leachable.	· Elemental Mercury · Radium / Thorium / Americium contaminated waste · Tritium contaminated waste	Fine copper/zinc powder is washed with nitric acid and then milled. Elemental mercury is added to the mixture and then milled. It is then allowed to harden and later crushed into a powder.	· + Produces a stable solid waste. · + Simple process.
C	Chemical Oxidation (Ultraviolet Photolysis and Photo-Oxidation, Photo-Catalytic Oxidation, Electron Beam Oxidation, Chromox, Mixed Oxidants (MIOX), Wet Air Oxidation, Wet Oxidation (WETOX), Catalyzed Wet Oxidation-Detox, Nitric Phosphoric Acid Oxidation, Silver Mediated Electrochemical Oxidation (MEO), Cerium Mediated Electrochemical Oxidation (MEO), Cobalt Mediated Elctrochemical Oxidation (MEO))	Chemical oxidation offers the potential for selectively converting undesired organic compounds in a mixed waste stream to CO2 and water, while converting any radioactive compounds to reusable materials. Advanced Oxidation Processes including ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off gases from the treatment tank and downstream units where ozone gas may collect, or escape.	· Halide-based fire suppressant powers · Inorganic ion exchange materials · Organic ion exchange materials · Radium / Thorium / Americium contaminated waste · Reactive Metals · Sludge · Solvents · Zinc Bromide	Direct chemical oxidation involves the use of sodium or ammonium peroxide sulphate, a strong oxidant for decomposing organic waste. The operating temperature is normally 80-95°C and the final bisulphate ion is recycled to produce new oxidant by conventional electrolysis. The organic compounds are converted to carbon dioxide and the inorganic residue products can be collected for immobilization in cement.	· + a low risk treatment option that offers the potential for selectively converting undesirable organic compounds in a mixed stream containing radioactive impurities into reusable materials provide a less harmful and environmentally friendly option for treating radioactive organic waste · + provide the potential for the recovery and reuse of waste materials. · + the ability to use processing temperatures of between about 250-700° F and low pressure as compared to processes such as incineration, which require the use of high temperatures (up to 2000° F), or wet-air oxidation, which requires the application of pressure up to 5,000 psi. · + the use of inorganic acids may speed up the degradation and hydrolysis of organic waste into less toxic compounds

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Conclusion

- This information will be useful for future collaborations
- The U.S. has been able to learn from past challenges and improve the development of new technologies. Many countries can benefit from our lessons learned.
- The five companies surveyed are the main treatment options for the U.S. DOE waste streams.

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2013 Poster Competition

Outcome: 2nd Place

Conference

Waste Management Symposia 2014

- **Location:** Phoenix, AZ
- **Outcome**
  - 1 Student Poster
  - 1 Panel Presentation
- **Others:**
  - 092 Panel: UK/USA Partnering Across the Pond - Accomplishments and Lessons Learned
  - 021 Emerging Treatment Technologies for LLW, ILW, and Mixed Waste
    - Innovative Treatment of Problematic (Orphan) and Other Organic Wastes: An Excellent Example of International Technology Transfer between the US and the UK

Development of Inspection Tools for DST Primary Tanks

Ms. Gabriela Vazquez and Ms. Jennifer Arniella

Mentors: Dr. Dwayne McDaniel and Mr. Tomas Pribanic

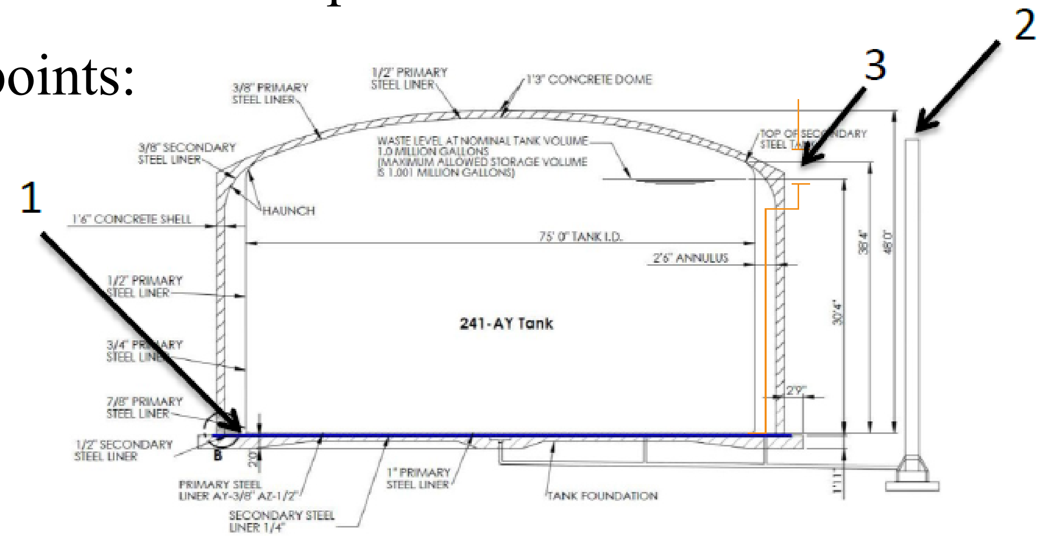
Background

Tank waste was found in the annulus of tank AY-102.

An inspection tool is required to isolate and pinpoint the source of the material entering Tank AY-102 annulus space

There are three possible entry points:

- Air Channels Under Tank
- 6” Leak Detection Piping
- 4” Air Supply Piping



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Background

Washington River Protection Solutions (WRPS) has contracted three companies to modify their existing inspection technologies to travel into the piping and/or refractory pad channels to provide visual feedback of the tank bottom.

FIU has had discussions with engineers at Hanford and will propose alternative designs – specifically for traveling through the cooling channels.

It is believed that the waste leaked from the tank bottom and flowed through the cooling channels of the refractory pad to the annulus.

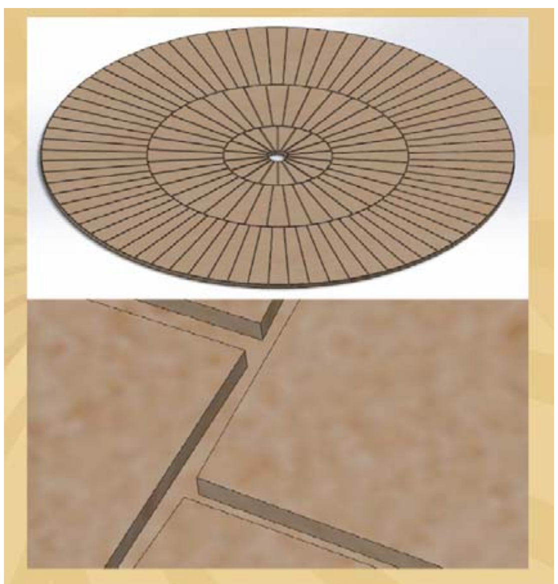
FIU has begun developing technologies based on lessons learned from industry proposed designs

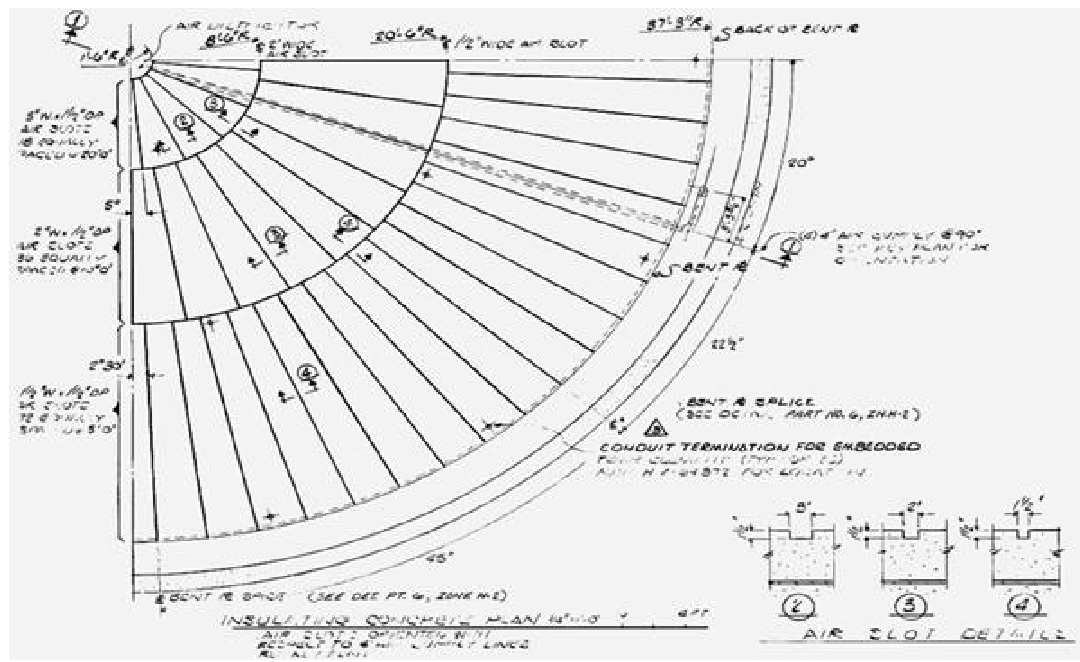
Path

Channels arranged in 3 sections: (1) 17 feet of 1 ½“by 1 ½“ square slots (2) 12 feet 1 ½“by 2” square slots (3) 7 feet of 1 ½“by 3“ square slots

Channels are of small size slots with sharp 90° turns connecting sections

72 outer ring entry points





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Development of Inspection Tools for DST Primary Tanks

Objective: To develop an inspection that navigates through the refractory pad air channels under the double shell tanks at Hanford

Design parameters

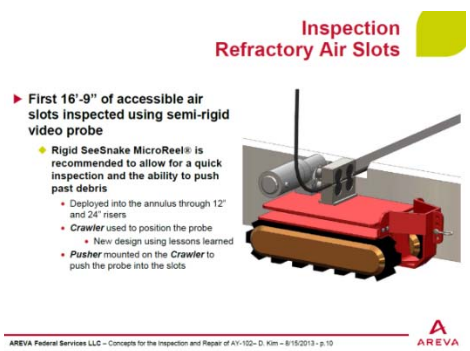
- Device will be remote controlled
- Device will be inserted through a riser to the annulus floor
- Images would be videoed for future reference
- Device will need to be radiation hardened
- Device will withstand relatively high temperatures
- Device must not subject the channel walls to pressures greater than 200 psi, the compression strength of the refractory material.

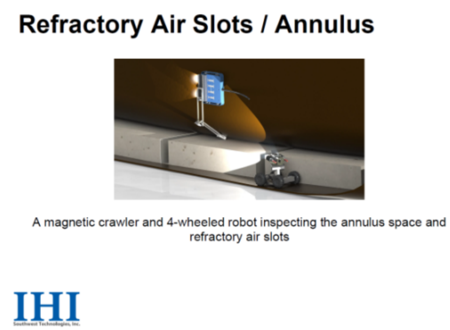
Potential Limitations and Risks

- Debris in channel may limit travel of inspection tool
- Damaged refractory channels could impact inspection
- Not able to inspect channels that have excessive dried salt
- 90° turns present a challenging design parameter
- Excessive corrosion on tank
- Equipment Failure
- Depending on conditions in channel, the tool could possible become stuck

Development of Inspection Tools for DST Primary Tanks

Sample of proposed technologies from companies

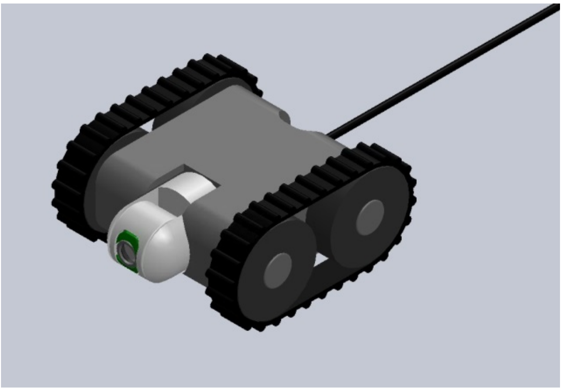




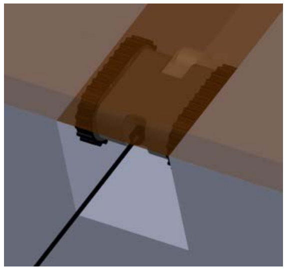
Development of Inspection Tools for DST Primary Tanks

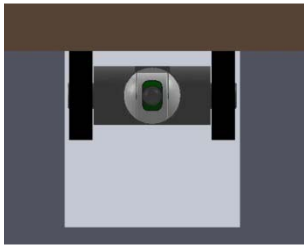
Proposed Concept:

The body would consist of a camera with attached tether and motors connected to magnetized "tank tread" wheels.



To avoid building up debris while crawling through the channel on the refractory pad and potentially destroying the refractory pad, the proposed design has magnetized wheels so that it can run upside down along the bottom of the tank. The continuous track was favored over wheels so as to increase the surface area along the tank.





The "tank tread" and its wheels would also be sized larger than the body of the inspection tool so in case it falls from the top, the tool can continue to run on the refractory pad.

Path Forward

- System Design
- Procurement of Components and Fabrication for Proof of Concept Prototype
- Functional Testing
- Modifications required as a result of testing

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- Team Member: Jennifer Arniella, Carmela Vallalta, Jose Matos, and Eduardo Garcia

Worlds Ahead