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Short-Term and Long-Term Technology Needs/Matching Status at Idaho National Engineering and Environmental Laboratory

Final Report – 04/28/1995 – 12/31/1999

S. L. Claggett

December 1999

Work Performed Under Contract No. DE-FC07-95ID13340

For
U.S. Department of Energy
Assistant Secretary for
Environmental Management
Washington, DC

By
Global Environment & Technology Foundation
Annandale, VA

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SHORT-TERM AND LONG-TERM TECHNOLOGY NEEDS/MATCHING STATUS AT IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

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SUBMITTED BY:
GLOBAL ENVIRONMENT & TECHNOLOGY FOUNDATION
7010 LITTLE RIVER TURNPIKE, SUITE 300
ANNANDALE, VA 22003-9998

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INEEL DECONTAMINATION AND DECOMMISSIONING (D&D) LONG-TERM TECHNOLOGY NEEDS

EXECUTIVE SUMMARY

This report identifies potential technology deployment opportunities for the Environmental Management (EM) programs at the Idaho National Engineering & Environmental Laboratory (INEEL). The focus is on identifying candidates for Accelerated Site Technology Deployment (ASTD) proposals within the Environmental Restoration and Waste Management areas.

The 86 technology needs on the Site Technology Coordination Group list were verified in the field. Six additional needs were found, and one listed need was no longer required. Potential technology matches were identified and then investigated for applicability, maturity, cost, and performance. Where promising, information on the technologies was provided to INEEL managers for evaluation. Eleven potential ASTD projects were identified, seven for near-term application and four for application within the next five years.

PURPOSE AND INTRODUCTION

This report identifies potential technology deployment opportunities for the Environmental Management (EM) programs at the Idaho National Engineering & Environmental Laboratory (INEEL). The focus is on identifying candidates for Accelerated Site Technology Deployment (ASTD) proposals within the Environmental Restoration and Waste Management areas. This is the final report on Task 1050, Subtasks 1 and 2, in which the Global Environment & Technology Foundation (GETF) conducted an independent evaluation of INEEL's published technology needs and assisted the owners of the needs by identifying candidate technologies and providing additional technical information on performance, maturity, cost, and other characteristics.

BACKGROUND

This final report updates information provided in three earlier reports. The first report field-verified INEEL technology needs in four specific EM programs; High Level Waste (HLW), Mixed Low Level Waste (MLLW), Environmental Restoration (ER), and Decontamination and Decommissioning (D&D). This was accomplished by obtaining the Site Technology Coordination Group (STCG) list of technology needs and validating these with each INEEL Point of Contact (POC). In some cases, additional needs were identified and in others, needs were found not to remain currently valid.

The second report (June 1999) listed potential technology matches for the INEEL needs that would be further investigated to ensure they were applicable and generated an interest by the users. The technologies identified in this report were obtained through several sources: information supplied through the Global Environmental Technology Enterprise (GETE); DOE and other technology databases; additional discussions with INEEL technical personnel; and information from recent conferences on environmental restoration, waste management, and robotic technologies.

The third report (August 1999) expanded upon the second report by adding a Technology Hits category. These are technologies that GETF introduced to INEEL and the INEEL contacts believe that they can resolve particular needs. From the original 37 identified potential technology matches, 14 technology hits were identified.

This final report updates information on the matching of INEEL's technology needs with available technologies and identifies the potential opportunities for ASTD projects.

RESULTS

When this project began, STCG listed 39 HLW needs, and GETF verified in the field that all were current.[1] Potential technologies were identified and evaluated for eight of these needs. These evaluations have identified three potential near-term ASTD projects: Corpex for ID-2.1.16, AEA for ID-2.1.35, and SpinTek for ID-2.1.64 (see Appendix A). One potential long-term project was identified: InnovaTech for ID-2.1.27 (see Appendix B). Additionally, InnovaTech has been proposed as a large-scale D&D demonstration to indirectly support ID-2.1.17.

In the Mixed Low Level Waste (MLLW) category, the STCG listed 18 needs. Seventeen of these technical needs were found to be current.[2] Potential technologies were identified and evaluated for two of these needs. An INEEL technology for pre-conditioning ash for stabilization with Portland cement is a potential short-term ASTD candidate for ID-3.1.41 (see Appendix C).

At project start, the STCG listed 10 needs for ER. GETF fieldwork identified six additional needs, one of which was later rescinded.[3] Potential technology matches were identified and evaluated for ten of these needs, but no ASTD candidates were found (see Appendices D and E).

Nineteen D&D needs were listed by the STCG, all field verified as current.[4] GETF identified potential technology matches for 16 needs. Three potential short-term ASTD projects were identified: Corpex for ID-7.2.03 and ID-7.2.14, and PCI Energy for ID-7.2.12 (see Appendix F). Three potential long-term projects were also identified: Corpex for ID-7.2.04, Rosie for ID-7.2.07, and MiniManip for ID-7.2.18. Additionally, both Rosie and PCI Energy have also been proposed for large-scale D&D demonstration funding, for ID-7.2.08 and ID-7.2.21, respectively. Furthermore, INEEL is purchasing two GETF-proposed technologies outright: Architect 3-D for ID-7.2.06 and an Inuktun robotic arm for ID-7.2.20.

Altogether, GETF found seven potential ASTD projects for the short term (FY2000) and four potential projects for the longer term. These results are summarized in Table 1.

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[1] In late November 1999, the STCG list was revised. For HLW, two existing needs were combined into one, and eight new needs were added. Time did not allow detailed verification and evaluation of these needs.

[2] The November revisions deleted two needs and split an existing need into three separate ones. Of the 18 needs on the November list, one has been found to be no longer current.

[3] Later, five of the STCG needs were deleted, including three for which potential technology matches had been found. In November 10 needs were added by the STCG, including one of the six identified by GETF fieldwork. The present STCG list contains 15 needs.

[4] The November STCG update subdivided three of the existing needs into a total of 10, bringing the present list to 26 needs.

	STCG Needs	Field Verified Needs	Needs with Potential Technology Matches	Potential ASTD Projects (short-term/long-term)
High Level Waste	39	39	8	3/1
Mixed Low Level Waste	18	17	2	1/0
Environmental Restoration	10	16	10	0/0
Decontamination & Decommissioning	19	19	16	3/3
Totals	86	91	36	7/4

TABLE 1–Summary of INEEL Technology Needs and Potential ASTD Projects

APPENDIX A

INEEL HIGH LEVEL WASTE (HLW) SHORT-TERM TECHNOLOGY NEEDS/MATCHES

ID-2.1.16 Decontamination Facility/Analytical Facility Waste Reduction and ID-2.1.17 Develop New Filter Leach Process (Subset of Waste Reduction)

Summary: Idaho Nuclear Technology and Engineering Center (INTEC) currently produces 100,000 to 150,000 gallons per year of liquid High Level Waste (HLW). DOE has promised Lockheed Martin Idaho Technology Company (LMITCO – the former M&O contractor) a substantial incentive fee to reduce the production of liquid wastes by 43% within five years. The waste is produced approximately as follows:

Waste produced from operation of the calciner	~80%
Waste from HEPA filter leaching	~18%
Waste from Decon facility	~1%
Waste from lab drains	~1%

In the last year, efforts have been directed to the smaller waste producing streams as the calciner shutdown. The calciner was authorized to operate on a one-year permit and it is advisable to look at reducing calciner waste. The calciner is currently shut down, and the current INEEL management is evaluating the advisability of restarting since the one-year permit is nearly half expended. If the decision is made to restart the calciner, the 43% reduction cannot be met without a reduction in the claciner waste.

Requirements: Any alternative wastes generated, as a result of process changes, should be environmentally acceptable.

Timing: The need is immediate since the award fee is based on a 43% net reduction over the five-year period.

Contacts: INEEL	James Valentine	(208) 526-3267
	Diane Croson	(208) 526-3402
	Ric Demmer	(208) 526-3412

Status: Idaho Nuclear Technology and Engineering Center (INTEC) is actively researching ways to reduce the liquid waste from system HEPA filters. They have enlisted the Corpex Corporation to assist them in finding ways to reduce this waste. The liquid waste from the decontamination facility is particularly bad since it is very high in sodium, which causes clinkers in the calciner, which cannot be sent to the storage bins. To solve this problem large volumes of aluminum salts must be added resulting in more liquids into the calciner and more solids to be stored. A second option being pursued to process the high sodium liquid wastes is by increasing the operating temperature of the calciner. This will permit successful calcination of the high sodium wastes.

Technologies Evaluated:

- **InnovaTech Spinning disk system.** The InnovaTech system has been demonstrated in laboratory tests to remove 95% of particulate greater than one micron from a simulated gas stream fed to a HEPA filter. InnovaTech pre-cleaning is projected to reduce the number of HEPA filters to clean for a typical laboratory exhaust system by

a factor of two or three. Installing an InnovaTech system at INTEC itself was considered and found to be impractical because the number of filters generated is small (about 20 per year) and 2/3 of them are generated by operation of the calciner. Modifications to the calciner are prohibitively expensive and no near-term modifications are planned.

Use of InnovaTech is still being considered as a means to reduce the number of HEPA filters coming to the filter leach facility from non-INTEC generators. The D&D focus area has performed a pre-screening analysis and a detailed evaluation of the technology and approved it for a large-scale demonstration. They are now looking for an appropriate application of the technology. A vacuuming application was considered and rejected. The current focus is on welding and cutting applications, where the fumes tend to significantly shorten HEPA filter life.

- **MSE Decontamination Technology.** The MSE decontamination technology was investigated and found to be not pertinent to the decontamination needs at INTEC
- **Corpex Decontamination Technology.** INTEC is presently planning a laboratory test program of the Corpex decontamination technology. If the results are positive the Corpex system may be a candidate for full scale ASTD testing.

ID-2.1.18 Continuous Emissions Monitor for Offgas Analysis

Summary: The HLW program recently demonstrated an offgas monitor for the calciner, which satisfied the State of Idaho and permission to continue operations has been granted for another year ending in June 2000. However, Maximum Achievable Control Technology (MACT) requirements are expected soon and improved monitors may be required. In addition, new facilities with offgas streams will require monitors. INEEL will be processing very acidic wastes and it is unlikely that any one complete system will be acceptable.

Requirements: The need defines thirteen detailed requirements including the ability to detect all Resource Conservation and Recovery Act (RCRA) and MACT materials, nineteen chemical and gaseous contaminants as well as traces of nuclear materials. The system is required to operate in extreme environmental conditions, be portable, and fully automated.

Timing: A demonstration unit is required for use on a pilot plant by the end of FY 2000 and to be implemented on the New Waste Calcining Facility (NWCF) by 2005.

Contacts: INEEL Richard Boardman (208) 526-3732
Arlin Olsen (208) 526-3852

Status: An active development program is underway. During April of 1999 an offgas analysis system was used on the New Waste Calcining Facility (NWCF), which satisfied the State of Idaho and the calciner has been permitted to operate for another year. However, MACT requirements are expected in the relatively near future and a continued aggressive development effort will be needed.

Technologies Evaluated:

- **PSI Continuous Emissions Monitor.** In the previous report it was suggested the PSI system might be useful even though it did not meet all EPA requirements. After discussions with the INTEC PI in this area, the idea was rejected. The cost of demonstrating a new system in the Calciner is so great that only a fully qualified EPA system would even be considered.

ID-2.1.35 Direct Immobilization of INTEC Sodium-Bearing Waste (SBW) and Newly Generated Liquid Wastes (NGLW)

Summary: An alternative to the baseline disposal plan is to remove cesium from the existing liquid wastes and to directly grout the remaining liquid as a low-level transuranic (TRU) waste. This approach could also be used on the wastes that are currently being generated at INTEC. It is planned to investigate several grouting procedures to determine which would result in the highest solids loading.

Requirements: The produced grout must meet the requirements of either TRU waste or LLW Class C waste.

Timing: Demonstrate a satisfactory product by 2002, prior to plant design.

Contacts: INEEL Allan Herbst (208) 526-3939
Diane Croson (208) 526-3402

Status: Work is ongoing at INTEC using simulated waste streams. Grout has been made with Portland cement, blast furnace slag, and fly ash. Laboratory tests indicate two technologies have potential for meeting requirements. The PI is enthusiastic for ASTD tests to demonstrate the technologies.

Technologies Evaluated:

- **Phosphate Bonded Ceramic Technology.** In the prior report this technology was suggested as a potential candidate for ASTD testing. The PI indicates this technology has been looked at in the laboratory and was not successful. This technology will be dropped
- **Membrane Separation Technology. 3M Empire.** This technology was discussed with the INTEC PI for separation of cesium. He has considered it but rejected it for the technology currently being used in the INTEC laboratory testing. This technology will be dropped.
- **Denitration Technology.** INTEC has developed a denitration technology in the laboratory, which produced a satisfactory grout. The liquid waste was heated to 650°C driving off the acidic components and the remaining material was successfully grouted. For ASTD funding, it would be necessary to find a vendor willing to demonstrate this technology in a pilot scale operation. Discussions with INEEL ASTD personnel indicate this may be within the scope of ASTD testing.
- **AEA Technologies**, a British R&D firm has successfully demonstrated an alkaline process for grouting INTEC liquid waste. They produced a barrel of material, which met requirements. ***This technology should be a good candidate for ASTD testing.***

ID-2.1.36 Mercury Removal from Liquid Wastes
ID-2.1.56 Mercury Treatment for Aluminum Oxide

Summary: Liquid wastes currently being stored at INTEC contain mercury. Processing this waste by calcining or by the proposed processes involving denitration of high activity waste (HAW) and low activity waste (LAW) will volatize greater than 90% of the mercury. The mercury accumulates in scrub gas solutions and will cause offgas to exceed MACT requirements. A basic understanding of the behavior of mercury in nitric acid solutions containing chloride is required in order to determine a best removal approach. Unless this problem can be solved, the calciner will not be restarted.

There is also mercury in the calcine stored at INTEC. Recent tests have demonstrated that mercury will be removed from the LAW but it may be affecting separation process efficiency and some waste streams may require mercury removal.

Requirements: The process shall be capable of >95% mercury removal from 4 molar nitric acid 100% complexed with chlorides. The mercury should be in a form ready for disposal or with a minimum of additional processing. An upset in the mercury removal process should have a minimum effect on other processes.

Timing: End of 2003, completion of pilot plant demonstration of satisfactory removal from liquid wastes and 2005 for design of the calcine dissolving and separation facility.

Contacts: INEEL	Terry Todd	(208) 526-3365
	John DelDebbio	(208) 526-3429
	Diane Croson	(208) 526-3402

Status: INTEC has just completed an 80-hour run of an integrated plant, removing simulated nuclear materials from a simulated dissolved calcine. Mercury was removed from the final LLW but there are still questions on the most cost-effective way to handle it. Investigations are underway searching for technologies to separate mercury from current liquid wastes.

Technologies Evaluated:

- **Recovery of Mercury; ADA Technologies Inc.** ADA Technologies is in Phase II of an SBIR project to develop a technology for removing mercury from aqueous wastes. Their SBIR money will fund a demonstration and INTEC aqueous wastes were among the demonstration candidates identified in their SBIR proposal. Until recently, ADA had been unable to get interest from INTEC personnel, even though INTEC would not have to fund the proposed demonstration. GETF furnished another contact name to ADA, in an attempt to break the deadlock. In November, ADA and INTEC reached agreement. INTEC will furnish surrogate wastes from the TRUEX process for ADA to test its mercury removal technology.

ID-2.1.64 Solid-Liquid Separation Equipment Development and Application

Summary: The removal of undissolved solids from high activity waste (HAW) and dissolved calcine is required to avoid process operational problems in the separation unit operations as well as carryover of radioactivity to the LLW grout processes. The removal of undissolved solids may be accomplished by cross flow filtration or other applicable solid liquid separation technologies. Extensive filtration testing is needed in order to establish suitable operating conditions and performance limitations. Candidate technologies need to be tested with simulated tank wastes in addition to dissolved pilot-plant calcine slurries.

Requirements: TBD

Timing: Data is needed ASAP to support treatment of tank wastes.

Contacts:	INEEL	James Rindfleisch	(208) 526-3114
		Nick Mann	(208) 526-8644

Status: INTEC has been testing separation technologies for some time. They have been evicted from their existing test facility and must build a new one to meet requirements to obtain data for treatment of tank wastes.

Technologies Evaluated:

- **High Shear Rotary Membrane Filtration System; SpinTek-11.** The SpinTek system separates solids from liquids using rotating filters. An increased solids concentration over cross flow filtration can be obtained which reduces the volume of solid waste that must be disposed of. The INTEC PI studying separation technology is very interested in the SpinTek system as a means of separating solids in HLW tank bottoms.

  SpinTek presently has an operating pilot system, which they were willing to ship to INEEL and operate for three months with no cost to INTEC. Unfortunately, INTEC does not at present have a shielded facility large enough to house the SpinTek system. INTEC funding has been cut, so there is no opportunity to investigate SpinTek this fiscal year. ***SpinTek is a candidate for ASTD funding.***

APPENDIX B

INEEL HIGH LEVEL WASTE (HLW) LONG-TERM TECHNOLOGY NEEDS/MATCHES

ID-2.1.27 Blowback Metal Filters for Solids (Calcine) Retrieval

Summary: Calcine currently stored in bins at INTEC will be vacuumed and pneumatically transported to a facility designed to dissolve it. A pre-cleaner is needed to reduce the plugging of HEPA filters.

Requirements: The selected technology should remove 99% of particles larger than 2 microns and 90% of the particles smaller than 2 microns with a pressure drop of less than 20 inches of water. A demo test of 100 hours is required.

Timing: The system should be demonstrated in time for design of the calcine transport system in 2006.

Contacts: INEEL	Scott Herbst	(208) 526-6836
	Diane Croson	(208) 526-3402

Status: This need is being addressed with work on sintered metal filters and is connected with Savannah River work on that technology. These filters are considered to have been successful in earlier tests. While one filter was broken during maintenance (while rodding out a clogged drain line), this was not an operational failure. Funding for this year is minimal and is to be used in preparing a functional requirements document. Emphasis in the HLW program is shifting away from the calcine and toward the tank wastes.

Technologies Evaluated:

- **InnovaTech Boundary layer particulate separation system.** The InnovaTech appears to be a good application. The system has a very low pressure drop, does not plug, and in laboratory tests has demonstrated a capability to remove particulate well below the requirements of this need. The InnovaTech system has been demonstrated in laboratory tests to remove 95% of particulate greater than one micron from a simulated gas stream fed to a HEPA filter. In the next fiscal year, INTEC is considering transferring the calcine from a bin that is not seismically qualified to a bin that meets all requirements.

  The InnovaTech system has been recommended and will be considered if the sintered metal filters do not pan out. INTEC presently has a test facility for evaluating transfer systems, but funding limitations and the shifting emphasis toward tank wastes preclude much work on either technology this Fiscal Year. The InnovaTech system remains a potential ASTD project within the five-year horizon.

APPENDIX C

INEEL MIXED LOW LEVEL WASTE (MLLW) SHORT-TERM TECHNOLOGY NEEDS/MATCHES

ID-3.1.06 Advanced Nuclear Assay for CH-TRU Waste Drums

Summary: The non-destructive assay (NDA) system currently used at the stored waste examination pilot plant (SWEPP) does not have the capability to meet all of the Waste Isolation Pilot Plant (WIPP) requirements on many of the transuranic (TRU) Drums stored at Radioactive Waste Management Complex (RWMC). INEEL is presently meeting their production schedule by setting aside drums that they cannot adequately characterize or that do not pass requirements using the existing system. An improved NDA system is needed.

Requirements: A set of nine detailed requirements are identified, which define the wide variety of wastes that must be examined: the containers, the system should be capable of meeting all WIPP requirements, technicians should be able to operate the system, a minimum speed must be met, and very important, the measurement errors must be significantly less than the current equipment at SWEPP.

Timing: The new equipment is needed between 1999 and 2002, depending upon the speed of the equipment.

Contacts:	INEEL	Don Pound	(208) 526-7684
		Bryant Ford	(208) 526-7684
		Dan Menkhaus	(208) 526-9435

Status: All work to meet this need is being conducted under the direction of the Mixed Waste Focus group. Three systems have been tested to a set of requirements based on needs identified in this ID number and other input. A report has been issued on the test results, and analysis and follow-up action is required.

Technologies Evaluated:

- **The Canberra, LANL, and Bio/Imaging systems** were tested by the Mixed Waste Focus Area. The end user summary report indicates each of the vendors meet most of the requirements in the STCG need, but none of them met all requirements. Discussions with technology personnel at INEEL have varied on the advisability of planning for ASTD testing on these technologies. Some say they are already commercial and can be obtained through normal procurement channels, others contend improvements are needed and ASTD testing should be considered.

  Additional discussions with technology and operations personnel are planned before a final recommendation is made.

ID-3.1.41 WERF Fly Ash Stabilization

Summary: Currently there are no means to stabilize Waste Experimental Reduction Facility (WERF) fly ash. The ash is not water-soluble and must be compacted into a solid that meets Toxicity Characteristics Leaching Procedure (TCLP) and Uniform Toxicity Standards (UTS) for disposal. A phosphate bonded ceramic system developed by Argonne National Laboratory was selected for initial evaluation to meet this need.

Requirements: The process should be capable of stabilizing four 55 gallon-drums per day. Cadmium, chromium, lead, and mercury should be stabilized in the presence of other constituents such as zinc and silica in the fly ash.

Timing: The process should be demonstrated as soon as possible.

Contacts:	INEEL	Robert Shilkett	(208) 526-1332
		Curtis Branter	(208) 526-8540

Status: The phosphate bonded ceramic system has not been able to properly solidify the WERF fly ash.

Technologies Evaluated:

- **Envirotec Phosphate Bonded Technology.** In the prior report it was suggested that Envirotec be contacted to determine if they had any suggestions on means to improve on the negative results obtained at WERF. Since the last report an internal LMITCO report was obtained in which extensive testing on the phosphate bonded technology was conducted. The results indicate the technology will not work and Envirotec technology is no longer considered a potential candidate for ASTD testing.
- **Portland Cement with Pre-conditioning of WERF Fly Ash.** The internal LMITCO report indicated there were preconditioning processes for the WERF fly ash, which permitted production of a grouted fly ash, which met all EPA requirements. WERF personnel plan to do further testing on this method and also to investigate grouting of the incinerator bottoms. Depending on the success of these tests, ***the technology could be an ASTD candidate for next year.***

APPENDIX D

INEEL ENVIRONMENTAL RESTORATION (ER) SHORT-TERM TECHNOLOGY NEEDS/MATCHES

ID-6.1.01 In Situ Debris Characterization for Partial Retrieval

Summary: The Radioactive Waste Management Complex (RWMC) contains an enormous amount of buried TRU, low-level, and mixed wastes located in the Subsurface Disposal Area (SDA) pits and trenches. It may be required to remove and treat some of this waste, which is a mixture of contaminated and uncontaminated, or below contaminated risk-based levels, soils and materials. If this is the case, it would be more cost effective to excavate and process only the contaminated waste. Thus there is a need to better characterize this waste through location of specific, high-risk contaminants of concern in order to reduce the volume to be treated.

Requirements: The technology should be capable of detecting actinides, VOCs, C-14, Tc-99, Sr-90, Cr, Hg, Nitrated and Ni-59 in situ or during the removal stage. It should also be integrated with the waste removal system and able to operate in all environmental conditions at the INEEL on a continuous, 3-shift basis during the 10 to 15 year remediation period.

Timing: A functional, proven device is needed prior to March 2000 for the Pit 9 remedial action plan. The need for this technology has been moved out further.

Contacts:	DOE-ID	Nolan Jensen	(208) 526-0436
	INEEL	Doug Jorgensen	(208) 526-7022

Status: INEEL ER and technology development departments have a proven technology to characterize certain types of contaminants called Dig Face Characterization. However, for the Pit 9 project, a reconfiguration of the Dig face equipment and sensor array would need to be done. If they decide to enhance this technology and find funding to do so, this need may go away.

Technologies Evaluated:

- **Smart Sampling: Sandia National Lab** (TMS #162). This technology is a risk-based process that maximizes the amount of contaminated material removed while minimizing cost using a software visualization system with geostatistical routines. Value is added in the preplanning efforts to realize where to dig and how much soil/water/waste to remove. The INEEL is in contact with Mr. Paul Kaplan, technology PI, and discussions continue.

- **Portable Sensor for Hazardous Waste; Physical Sciences, Inc. (PSI)** Technology Management System (TMS #31). This technology is a portable sensor capable of screening contamination of metals in water and soil based on spark-induced breakdown spectroscopy. GETF supplied additional information upon INEEL request. However, the technology is still in development and PSI is looking for funding to continue the effort. Until the development effort is successfully completed this is not a potential ASTD project.

ID-6.1.03 In Situ Treatment of Mixed Tank Wastes

Summary: There is a need for in situ treatment methods of waste in tanks containing TRU isotopes, uranium, fission products, VOC, SVOCs, PCBs, and toxic metals that will meet RCRA, TSCA, CERCLA, and other applicable regulations.

Requirements: Must minimize personnel exposure and risk of release to the environment. Minimum desired performance is reduction of PCB to less than 5 ppm (parts per million) and other contaminants to TSD acceptance criteria. The major goal is the elimination or reduction of VOCs, SVOCs, and PCBs.

Timing: The need is now.

Contacts:	DOE-ID	Nolan Jensen	(208) 526-0436
	INEEL	Bob James	(208) 526-5020

Status: This need has been removed from the STCG list.

Technologies Evaluated:

- **Treatment of Hazardous Wastes, Surrogated Mixed Wastes and Energetics Using ECO Logic Process,** (TMS #1831). This product uses a Canadian-based ECO Logic technology. It was successfully demonstrated in Australia using bulk solids and high-strength liquid wastes and at the GM site in Ontario, Canada using about 1,000 tons of PCB-contaminated materials. Additional information on this technology is required to make a recommendation to INEEL.

ID-6.1.04 In Situ Treatment of VOC Contaminated Groundwater in Deep Fractured Rock

Summary: An injection well at the Test Area North (TAN) at the INEEL was once used for disposal of organics, inorganics, and radionuclides. Of most concern are trichloroethylene (TCE), dichloroethylene (DCE), and perchloroethylene (PCE). The current planned remediation method is pumping and ex-situ treatment. However, this method may not achieve the desired Maximum Contaminant Levels (MCLs) concentrations at the 100-year completion. This method also creates a hazardous secondary waste stream.

Requirements: The system must treat the groundwater and be functional in fractured basalt at depths of 200 to 400 feet below the surface while minimizing the generation of secondary waste streams. It must reduce the concentrations to the MCLs and require little maintenance between years 2025 and 2095.

Timing: Alternate in situ technologies must be successfully demonstrated in similar geography prior to October 2000.

Contacts:	DOE-ID	Mark Shaw	(208) 526-7245
	INEEL	Doug Kuhns	(208) 526-6852

Status: They would like to try an in situ bioremediation or an in situ chemical oxidation as a field treatability study, but are running into problems with the State of Idaho because it is not a proven technology. The INEEL is currently and successfully deploying an INEEL-developed bioremediation technology to meet this need. Their plan was to field-test this new technology and revert back to pump and treat if it was not successful. So far it has been very successful. In fact, so successful that they have received ASTD funding to test it on contaminated groundwater at two other sites: ORNL and LLNL, as long as it continues to reduce the contamination.

Technologies Evaluated:

- **Dynamic Underground Stripping (DUS); Steam Tech** (TMS #7). DUS is a combination of several technologies previously used separately and adapted to the hydrogeology of typical site contamination in soil and groundwater. These technologies are Steam Injection, Electrical Resistance Tomography (ERT) for underground imaging, and an offgas treatment technology. It is effective above and below the water table and is well suited for sites with interbedded sand and clay, like the INEEL. (See Status section above.) If the bioremediation is not successful, INEEL would consider the DUS technology as an alternative to pump and treat.

ID-6.2.11 In Situ Immobilization of Radionuclides in Groundwater

Summary: An injection well at the Test Area North (TAN) at the INEEL was once used for disposal of organics, inorganics, and radionuclides producing high levels of contaminants. These contaminants pose unacceptable risks to residents in the 100-year plan. There are current ex-situ remediation methods being used to remove the organics, however, the radionuclides remain. Ex-situ treatment of the latter creates a hazardous secondary waste stream. The bottom of the well is 300 feet below the surface through fractured rock.

Requirements: The method used must be in-situ, to treat Cs-137 and Sr-90 contaminated ground water, while minimizing secondary waste streams. It should enable the concentrations to be within the EPA MCLs. The method should also be functional in fractured basalt at depths from 200 to 400 feet below the surface.

Timing: A technology needs to be fully demonstrated by 2000.

Contacts:	DOE-ID	Nolan Jensen	(208) 526-0436
	INEEL	Tom Stoops	(208) 526-4262

Status: Technologies for development of an in situ method that could immobilize the radionuclides in the groundwater is not actively being pursued. The INEEL is currently and successfully deploying an INEEL-developed bioremediation technology to meet this need. Their plan was to field-test this new technology and revert back to pump and treat if it was not successful. So far it has been very successful. In fact, so successful that they have received ASTD funding to test it on contaminated groundwater at two other sites: ORNL and LLNL, as long as it continues to reduce the contamination. This need has been removed from the STCG list.

Technologies Evaluated:

- **In Situ Groundwater MOP-UP Process; Biopraxis, Inc.** (TMS #1743). MOP-UP exploits reagents, derived from or produced by microorganisms that take up heavy metal and radionuclide pollutants in the contaminated medium. The two-step process yields two streams: a high-solids slurry containing the metals, and the purified ground water. Laboratory tests on actual and simulated groundwater samples and electronics manufacturing wastewaters have yielded exceptional results. Simple treatability tests with groundwater samples provided by DOE, DoD, EPA, and private industry show this technology to be capable of taking Hg, Pb, Cd, Cu, Cr, As, U, Ba, Zn, and Al to nondetectable levels, even waters containing high levels of other inorganics and/or organic pollutants. It has been proven to work effectively on a wide range of radionuclides. (See Status section above.) If the bioremediation is not successful, INEEL would consider other technologies as an alternative to pump and treat.

New Need
Long-term Barrier for the Idaho CERCLA Disposal Facility

Summary: A new landfill facility titled the Idaho CERCLA Disposal Facility (ICDF) is being designed to hold INEEL contaminated soils. The physical barriers planned for this facility will be tight clay, lined with a plastic hypolon material. The plastic material has a much shorter active life than the half-lives of some of the radionuclides that will be present in this facility. Thus, the clays must act as a long-term physical barrier to prevent the migration of actinides and radionuclides outside of this facility. The combination of clays or other proven technologies to meet this requirement has not yet been determined. Thus, there is a need for some type of a long-term physical or chemical barrier to bind actinides and radionuclides from migrating outside of the ICDF.

Requirements: The combination of clays or chemistry for the barrier must be capable of containing radionuclides with half-lives greater than 50 years.

Timing: Construction on the new facility is scheduled to begin in 2001, therefore, the barrier technology would have to be proven to work prior to approval of the final design.

Contacts:	DOE-ID	Nolan Jensen	(208) 526-0436
	INEEL	Bob James	(208) 526-5020
		Denny Meyers	(208) 526-3081

Status: The need was withdrawn after refinement of the requirements for the ICDF.

Technologies Evaluated:

- **Phosphate Bonded Ceramic Final Waste Forms, Argonne National Laboratory** (TMS #117). This technology develops waste forms for MLLW streams that cannot be handled by other established methods. It was used at the INEEL for mixed RCRA ash and was not successful, but may work for this need. This technology was used at the INEEL for mixed RCRA ash and was not successful. Therefore, INEEL is not interested in pursuing it further.
- **Waste Stabilization/Grouting; MSE-TA, Inc.** MSE has a waste stabilization technology to grout waste in place. They have experience in deploying in-situ technologies at the INEEL in the Acid Pit and Dover AFB. The GETF POC is currently gathering information on the MSE-TA technologies that could match this need.
- **Envirobond; Rocky Mountain Remediation Services.** This is a method of treating soils/wastes containing various metals, including cesium, thorium, radium, uranium, lead, mercury, etc. It prevents leaching of metal contaminants by creating an impenetrable chemical bond at a cost that is below traditional cement and silicates treatments. This technology has been demonstrated in the EPA SITE program and is readily accepted by many regulatory agencies. The INEEL is interested in this technology and have asked the GETF POC to provide detailed information for evaluation against the facility design and CERCLA criteria.

New Need-
ID-6.1.29 Accurate Location of Underground Utilities and Stainless Steel Piping

Summary: A device to locate below-surface utility, vacuum, and stainless steel waste lines is needed at several areas at the INEEL. To date, technologies such as magnetometers have been used but without the desired accuracy or capability to detect stainless steel or small lines under 10 feet of soil. The soil at the location of the INEEL is composed of clay and basalt rock, which complicates the work of detection sensors. One of the areas needing this technology is on the INTEC high-level waste tank farm. There are eleven 500-gallon tanks with a congested network of stainless piping, vacuum lines, utility lines, and cathodic protection running between them, approximately 10 feet below the surface. There is a need to drill for soil samples around the piping and below the tanks, but there is no certainty about where obstacles are located. Another area that needs underground survey technology is at the Test Area North (TAN). The INEEL will remediate three 10,000-gallon tanks (located about 10 feet below surface) via in situ vitrification (ISV). Prior to performing this process, they need to cut and cap the stainless steel lines running between these tanks. They also need to trench outside of the TAN 607 building (where TMI fuel is stored) and do not want to run into existing piping.

Requirements: The identified technology must be cost effective and capable of locating stainless steel pipes, utility and steam lines, and cathodic protection under 10 feet of soil within one-foot accuracy.

Timing: A technology to meet these challenges is needed now.

Contacts:	DOE-ID	Nolan Jensen	(208) 526-0436
	INEEL	Bob James	(208) 526-5020
		Dennis Schantz	(208) 526-0877

Status: Several survey devices that hold detection sensors have been deployed on these sites, but have not provided the needed information or the desired accuracy. This need was formalized as ID-6.1.29 in November 1999.

Technologies Evaluated:

- **Electromagnetic Radiography (EMR); Mission Research Corporation and Detection Sciences, Inc.** EMR is an outgrowth of advanced, high-performance ground-penetrating radar (GPR). The technology is an antenna (size of a lawn mower) that can be deployed manually or remotely, to detect high-level ionic chemical contamination in the ground. It takes a footprint measuring five feet wide to a depth of 50 feet (even in clay). This technology may eliminate the need to bore characterization holes; however, soil samples are needed to calibrate and confirm the data. A demonstration on the EMR technology was performed earlier this year, and it was unsuccessful.
- **Smart Sampling; Sandia National Lab** (TMS #162). This technology is a risk-based process to optimize the amount of contaminated material that must be removed while minimizing cost using a software visualization system with

geostatistical routines. Value is added in the preplanning efforts to realize where to dig and how much soil/water/waste to remove. It will not detect the piping, however, it may assist in providing a cost-effective method on where to survey. The INEEL is in contact with Mr. Paul Kaplan, technology PI, and discussions continue.

New Need
Disposition of ARA-16 Tank Waste

Summary: There is a need to disposition an underground 1000-gallon tank at the Auxiliary Reactor Area (ARA) that contains about 100 gallons of alpha contaminated liquid and sediment. It is a listed mixed waste with PCBs at about 70 nanocuries/gram. The waste could more easily and quickly be disposed of if there was a technology to remove the PCBs from the liquid without generating a significant secondary waste stream. This would remove it from the TSCA (Toxic Substance Control Act) regulation. Currently, there is not a licensed facility that could take the waste, nor is there a technology that is cost effective.

Requirements: The technology must not generate additional RCRA or TSCA regulated secondary waste streams. It must also be cost effective for treating this small volume of waste. It would be desirable to have the application be both in situ and a proven technology.

Timing: The technology must be identified prior to August 1999.

Contacts:	DOE-ID	Katie Hain	(208) 526-4392
	INEEL	Frank Webber	(208) 526-8507

Status: The RI/FS process proposes three alternatives: 1) remove the tank and contents and send the waste to the Advanced Mixed Waste Facility (when completed) for treatment, 2) perform in situ vitrification in the tank, and 3) pump out the waste and send it to the TAN V tanks for in situ vitrification.

Technologies Evaluated:

- **Treatment of Hazardous Wastes, Surrogated Mixed Wastes and Energetics Using ECO Logic Process** (TMS # 1831). This product used a Canadian-based ECO Logic technology. It was successfully demonstrated in Australia using bulk solids and high-strength liquid wastes and at the GM site in Ontario, Canada using about 1,000 tons of PCB-contaminated materials. Since there is such a small amount of waste in this tank, the INEEL has selected alternative #1 as it does not impose an immediate threat to the environment.

APPENDIX E

INEEL ENVIRONMENTAL RESTORATION (ER) LONG-TERM TECHNOLOGY NEEDS/MATCHES

ID-6.1.02 Real-time Field Instrumentation for Characterization and Monitoring Soils and Groundwater

Summary: Rapid and accurate characterization and monitoring instrumentation is needed to identify groundwater and soil contamination while determining the extent of contamination, to verify soil contaminant concentration levels, and to ensure that retrieved soils meet the regulatory limits for disposal. They are currently using hand-held sodium-iodide crystals, but the samples must be sent off for analysis, which has too long of a turn-around time.

Requirements: Devices that are real-time or provide more timely results, and yet not excessively costly, are needed to perform this work. They will also have to be field useable, capable of quantifying metals at TCLP levels, and reliably quantify (within 1 pCi/g) Cs-137 at 16 pCi/g, Sr-90 at 60 pCi/g, Co-60 at 1.8E+5 pCi/g, and Eu-152 at 140 pCi/g.

Timing: Remediation efforts began in 1997 and will continue for five to ten years. The Record of Decision (ROD) will allow the introduction of new technologies that will improve performance in support of this effort.

Contacts:	DOE-ID	Nolan Jensen	(208) 526-0436
	INEEL	Bob James	(208) 526-5020
		Lee Davidson	(208) 526-3770

Status: A technology to meet this challenge is needed as soon as possible. Since this is a monitoring not remediating task, the technology does not necessarily have to be previously deployed and proven to work at the INEEL or other like geological areas prior to deployment for this task.

Technologies Evaluated:

- **Smart Sampling: Sandia National Lab** (TMS # 162). This technology is a risk-based process that minimizes the amount of contaminated material removed while minimizing cost using a software visualization system with geostatistical routines. Value is added in the preplanning efforts to realize where to dig and how much soil/water/waste to remove. INEEL has already investigated this process for use in sampling the vadose zone. The INEEL is in contact with Mr. Paul Kaplan, technology PI, and discussions continue.

- **Portable Sensor for Hazardous Waste; Physical Sciences, Inc. (PSI)** Technology Management System (TMS # 31). This technology is a portable sensor capable of screening contamination of metals in water and soil based on spark-induced breakdown spectroscopy (SIBS). GETF supplied additional information at INEEL request. However, the technology is still in development and PSI is looking for funding to continue the effort.

ID-6.1.23 In Situ Stabilization of Contaminated Waste

Summary: The Radioactive Waste Management Complex (RWMC) contains an enormous amount of buried transuranic (TRU), low-level, and mixed wastes located in the Subsurface Disposal Area (SDA) pits and trenches. An alternative to excavating and ex-situ treatment of the waste, which is costly, time-consuming, and creates large volumes of secondary waste, is needed. It is desired to have an in situ technology effective in treating heterogeneous waste and debris.

Requirements: The technology must be able to remove or destroy organic substances and immobilize other contaminant risk drivers, operate in a landfill setting, and address the monitoring requirements to demonstrate waste stabilization and cost-effective remediation.

Timing: Buried waste remediation is to begin by 2003 and continue for 5-10 years.

Contacts:	DOE-ID	Alan Jines	(208) 526-7524
	INEEL	Doug Jorgensen	(208) 526-7022

Status: There are three treatability studies taking place at the INEEL in FY-1999 to test in situ stabilization technologies: in-situ vitrification, in-situ thermal desorption, and in-situ grouting. The procurement packages for the deployment of these technologies will go out in early FY-2000. The award, deployment, and analysis will feed a Record of Decision, due in FY-2003. This need was removed from the STCG list.

Technologies Evaluated:

- **Phosphate Bonded Ceramic Final Waste Forms, Argonne National Laboratory** (TMS #17). This technology develops waste forms for MLLW streams that cannot be handled by other established methods. This technology was used at the INEEL for mixed RCRA ash and was not successful. Therefore, INEEL is not interested in pursuing it further.
- **Envirobond; Rocky Mountain Remediation Services.** This is a method of treating soils/wastes containing various metals, including cesium, thorium, radium, uranium, lead, mercury, etc. It prevents leaching of metal contaminants by creating an impenetrable chemical bond at a cost that is below traditional cement and silicates treatments. This technology has been demonstrated in the EPA Superfund Innovative Technology Evaluation (SITE) program and is readily accepted by many regulatory agencies. This technology is not appropriate to meet this need since it is best suited for soils, clays, and sludges and not solid wastes.
- **In-Situ Waste Grouting, MSE-TA, Inc.** MSE has a waste stabilization technology to grout waste in place. They have experience in deploying in-situ technologies at the INEEL in the Acid Pit and Dover AFB. They will most likely bid on the In-situ Grouting procurement.

New Need
Characterization of Surrounding Soil, Bunker, and Tank Content for SFE-20

Summary: There is a proposed plan to remove a tank SFE-20 (Spent Fuel External) at INTEC and treat the waste on site. SFE-20 is a 640-gallon tank that contains liquid and sludge and is located in a three-foot by three-foot bunker approximately 20 feet below the surface. In order to generate a remediation plan, there is a need to characterize the soils surrounding the bunker for levels of contamination, the crawl space within the bunker for leaks and radiation levels, and the exact amount and contents within the tank. It is not possible to send personnel into this crawl space.

Requirements: The system must be able to accurately characterize the amount and content of the liquid and sludge within the tank.

Timing: It is anticipated that the ROD will be approved by the summer of 1999. The INEEL is hoping that characterization will be completed by FY-2003 or -2004 for remediation to begin.

Contacts:	DOE-ID	Nolan Jensen	(208) 526-0436
	INEEL	Bob James	(208) 526-5020
		Susan Evans	(208) 526-1493

Status: Currently, there has not been an effort to look for technologies to satisfy this need. Provided a Westinghouse Idaho Nuclear Company, Inc. (WINCO) document that was obtained from the INEEL Technical Library on the results of an early 1980s manual characterization of the SFE-20 tank, vault, and supporting facilities. This document provided radiation levels, chemical analysis, and detailed pictures of the condition of the SFE-20 system at that time. Also provided the name of the INTEC Robotic and Remote Inspection POC to discuss inspection tools that are already used to inspect other tanks on site that could meet this need.

Technologies Evaluated:

- **ROVVER and SPOT Series Robotic Crawlers; Visual Inspection Technologies, Inc.** These mobile, remote devices vary in size, maneuvering capabilities, and on-board sensors, but they are all small enough to enter the opening in the vault. All have on-board charged coupled device (CCD) cameras and lighting and need to be modified with a radiation detector to meet this need. The INEEL Robotics and Remote Systems organization has one of these units to perform remote characterization.
- **SCARAB I, II, or III; Remote Operated Vehicle Technologies, Inc.** The basic unit is a remote, mobile, radiation-tolerant vehicle with three cameras (one on a pan and tilt), lighting, and a radiation detector. Modifications to this unit include tracks to negotiate objects as tall as 7" (II) or 13" (IIA), and a telescoping manipulator capable of inspecting over 8' objects. Any of these would be ideal for inspecting the tank vault (depending on its configuration), but the overall size of the vehicles may not fit into the vault opening (currently checking this). This company provides robots and

remote service to the nuclear industry. They have recently teamed with the R. Brooks Company to enhance inspection and retrieval technologies for hazardous environments. INEEL will likely use less expensive remote systems.

- **MicroTrac Pipe Inspection System; RoboProbe.** This remote system can fit within 4" pipes, can maneuver around 90-degree bends, and has an onboard camera and lighting to be able to inspect the inside of the tank. It would need to be modified with a sampling device in order to meet this need. The INEEL is considering this system, but needs to establish funding. Information was transferred to their technical file.
- **Circumspector; Inuktun.** This remote system can fit within 4" pipes, can maneuver around 90-degree bends, and has an onboard camera and lighting to be able to access and inspect the inside of the tank. It would need to be modified with a sampling device in order to meet this need. The INEEL is considering this system, but needs to establish funding. Information was transferred to their technical file.
- **Scissors; Inuktun.** This remotely operated mobile device maneuvers on treads, holds a pan and tilt camera and lighting, and raises from 15 3/8" to 65" to view over objects, or, in this case, the top of the tank in the vault. It would need to be modified with a radiation detector to meet this need. The INEEL already has a remote vehicle that telescopes up to view over objects (a Remotec system), however, they took the information for their technical file.
- **Foreign Object Search and Retrieval (FOSAR); R. Brooks Company.** This device was built for inspecting steam generators, tanks, and other vessels and retrieving foreign objects. The retrieval tool may work as a sampling device. There was little desire for this device as the INEEL has developed devices like this in-house. Each task has different needs and they have found each inspection/sampling device must be modified to meet these specific needs.
  - **Electromagnetic Radiography (EMR); Mission Research Corporation and Detection Sciences, Inc.** EMR is an outgrowth of advanced, high-performance ground-penetrating radar (GPR). The technology is an antenna (size of a lawn mower), that can be deployed manually or remotely, to detect high-level ionic chemical contamination in the ground. It takes a footprint measuring five feet wide to a depth of 50 feet (even in clay). This technology may eliminate the need to bore characterization holes; however, soil samples are needed to calibrate and confirm the data. A demonstration on the EMR technology was performed earlier this year, and it was unsuccessful.

APPENDIX F

INEEL DECONTAMINATION AND DECOMMISSIONING (D&D) SHORT-TERM TECHNOLOGY NEEDS/MATCHES

ID-7.2.03 Concrete Decontamination

Summary: In contaminated facilities, much of the concrete is contaminated only on the surface or to a relatively shallow depth (typically less than one inch). Historically, such material has been handled by mechanically removing the surface layers of concrete through a scabbling operation. This is slow and costly and directly exposes the workers to radiation fields. Dust control is also a problem. In addition to plane surface contamination, concrete often contains seams or cracks where contamination has penetrated deeper. It is desired that new or significantly improved techniques be developed to decontaminate these concrete structures. INEEL facilities are typical of this problem in that leaks and spills from nuclear operations have resulted in large amounts of contaminated concrete. These areas were often covered with paint to "fix" and contain the contamination. These areas such as sumps and some reactor or fuel processing areas, which experienced repeated contamination incidents over a period of time, are contaminated to much greater depths.

Requirements: The new technology(s) must be capable of handling the many forms, geometries and types of concrete requiring decontamination at the INEEL, including seams and cracks up to ten inches deep. It must be able to remove 1/8 inch to ¼ inch of concrete in a safe and economical manner, with the ability to remove up to two inches with multiple passes. The technology(s) must decontaminate the structure so that the remaining concrete can be released for unrestricted use.

Timing: The need is now, but will continue with the decommissioning of each facility at the INEEL.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: This is a high priority need because contaminated concrete is found in each facility on the D&D list. INEEL has tried several innovative technologies, such as the Pentek scabblers, the Bartlett Wall Walker (remote scabbling), and INEEL-developed biotechnology. However, each of these technologies is more expensive than the baseline manual method. They plan to use an existing robotic system to deploy a concrete scabbler this fiscal year.

Technologies Evaluated:

- **Advanced Recyclable Media System (ARMS); Surface Technology Systems (STS).** This technology removes and absorbs low-level radioactive contaminants and hazardous materials, such as oil, grease, paint, rust, and heavy metals from almost any surface. A high-powered stream of soft, absorbent fiber material is blasted from a nozzle onto the contaminated surface. This soft fiber media can be recycled and reused rather than disposed of as a secondary waste stream. STS is a service company that charges approximately $10K/week for three service technicians to operate; alternatively, the equipment can be purchased for approximately $20K. The INEEL is

not interested in this technology at this time (see status). The information on the capability and cost of the ARMS has been transferred to their technology file.

- **SP-400 Superabsorption; WaterWorks America.** This is a high technology polymer capable of near instant absorption of liquids, allowing a user to essentially freeze problem liquids in place while trapping any dissolved solids. This material could be used to absorb the liquid used in the conventional water-jet decontamination process. The approximate costs are based on the quantity of pallets purchased-1925 lbs/pallet; $5.95/lb for 1 to 9 pallets; $5.49/lb for 10 to 19 pallets; $4.99/lb for >20 pallets. The INEEL D&D Operations organization is already using a superabsorption product titled Spingo.
- **Corpex Nuclear Decontamination Process, Corpex-935; Corpex Technologies, Inc.** (TMS # 87). This product is specifically designed to remove contamination that has penetrated or chemically bonded with concrete to a depth of 1-3 mm. It is a - nontoxic, biodegradable decontamination process that uses a molecular chelant to remove a wide range of radioactive contaminants and scales from concrete surfaces. The process does not create mixed waste and minimizes solid waste. Approximate costs range from $18.50-19.50/gal, depending on the quantity purchased. The INEEL is interested in this product to be used on concrete surfaces where the scabbler cannot reach, such as inside corners, nooks and crannies, and high ceilings. The GETF POC has obtained more data on the chemical constituents from the manufacturer and supplied them to INEEL for RCRA records. INEEL personnel now have all the information they have requested and are evaluating the technology. ***Pending the results of this evaluation, the Corpex process may be a candidate for ASTD funding.***

ID-7.2.06 Remote Characterization

Summary: Opportunity to develop several technology improvements in the area of remote characterization and surveying, including improved means to remotely obtain samples from difficult to access places, such as underground tanks and piping systems, and in areas of high radiation. A method is needed to trace the exact spatial location of underground piping. Currently, workers do most facility characterization in a hands-on mode. This causes personnel to be in very high radiation areas and or results in not being able to collect adequate characterization data. In the case of buried piping, current technology does not provide for the accurate location data.

Requirements: Characterization technologies must be able to enter openings having diameters as small as six inches and extend as much as 40 feet into the regions to be characterized. Real time video images of the area being characterized should be provided. The capability to collect both solid and liquid samples (from a few cubic centimeters to a few hundred cubic centimeters) is required. Radiation surveys must also be performed remotely, measuring from one mr/h (milli rem per hour) to a few thousand R/h. Isotopes encountered will be standard fission products, Co, Cs, Sr, etc., and also isotopes of uranium and plutonium.

Timing: This capability would be useful immediately but will become extremely important by the time large structures such as the Engineering Test Reactor (ETR), the Materials Test Reactor (MTR), and the Power Burst Facility (PBF) reactor are scheduled for decommissioning between FY-1999 and 2005. The decontamination of the ETR and MTR will probably be much further out, but PBF will be within this timeframe. However, the environmental documentation on the proposed D&D processes on ETR and MTR will be done within the next few years. Thus, characterization needs to be done to assist this process.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: This is a medium priority because characterization can be done manually. However, there are hot cells within the ETR and MTR facilities where the radiation levels are too high for human entry. They will be decommissioned last. (See Timing.) Also, the INEEL already has a number of remote characterization systems. This need was driven to find a unique, reasonably-priced system that has not been demonstrated at other DOE sites in order to obtain funding from the Large Scale D&D Focus Area.

Technologies Evaluated:

- **ROVVER and SPOT Series Robotic Crawlers; Visual Inspection Technologies, Inc.** These mobile, remote devices vary in size, maneuvering capabilities, and on-board sensors, but they are all small enough to enter the opening in the vault. All have on-board CCD cameras and lighting and need to be modified with a radiation detector

to meet this need. The INEEL Robotics and Remote Systems organization has one of units to perform remote characterization.

- **SCARAB I, II, or III; Remote Operated Vehicle Technologies, Inc.** The basic unit is a remote, mobile, radiation-tolerant vehicle with three cameras (one on a pan and tilt), lighting, and a radiation detector. Modifications to this unit include tracks to negotiate objects as tall as 7" (II) or 13" (IIA), and a telescoping manipulator capable of inspecting over 8' objects. Any of these would be ideal for inspecting the tank vault (depending on its configuration), but the overall size of the vehicles may not fit into the vault opening (currently checking this). This company provides robots and remote service to the nuclear industry. They have recently teamed with the R. Brooks Company to enhance inspection and retrieval technologies for hazardous environments. INEEL will likely use less expensive remote systems.
- **MicroTrac Pipe Inspection System; RoboProbe.** This remote system can fit within 4" pipes, can maneuver around 90 degree bends, and has an onboard camera and lighting to be able to inspect the inside of the tank. It would need to be modified with a sampling device in order to meet this need. The INEEL already has an in-house pipe inspection system, however, they took the information for their technical file.
- **Circumspector; Inuktun.** This remote system can fit within 4" pipes, can maneuver around 90 degree bends, and has an onboard camera and lighting to be able to access and inspect the inside of the tank. It would need to be modified with a sampling device in order to meet this need. The INEEL already has an in-house pipe inspection system, however, they took the information for their technical file.
- **Scissors; Inuktun.** This remotely operated mobile device maneuvers on treads, holds a pan and tilt camera and lighting, and raises from 15 3/8" to 65" to view over objects, or, in this case, the top of the tank in the vault. It would need to be modified with a radiation detector to meet this need. Approximate costs are $36,000. The INEEL already has a remote vehicle that telescopes up to view over objects; however, they took the information for their technical file.
- **Architect 3-D Modeling (ARCHITECT); UK Robotics.** This technology captures data on structures, objects, and environments and converts three-dimensional point data into full three-dimensional computer aided design (CAD) models. These can be seamlessly exported into a variety of CAD systems. In hazardous environments, ARCHITECT offers the user the potential to achieve remote scanning, either aboard a vehicle or by other means. The INEEL is very interested in this technology to provide the 3-D model in real time instead of doing it manually as a "front end" to their Optimization Planning System to characterize the ETR and PBF reactor buildings. The GETF POC transmitted documentation from the manufacturer to INEEL, which is currently in the process of procuring the technology.

ID-7.2.08 Robotics for D & D

Summary: Robotic technology capable of utilizing multiple tools to perform universal work tasks in high radiation areas is required. These devices will be used for inspection, characterization, and demolition activities on INEEL D&D projects. Light duty robots will be used to photograph, probe, collect samples, perform radiation and other surveys, and move light objects. Another robotic device of a much more robust construction and capable of handling much heavier tools and lifting load is also needed. The first facility needing their use is the TAN-616 Liquid Waste Treatment Facility. They will also be used at the Materials Test Reactor (MTR), Engineering Test Reactor (ETR), and other INEEL facilities as they are decommissioned.

Requirements: The light duty robotic devices must be relatively small, mobile, and capable of performing tasks with tools having a maximum weight of 50 pounds that extend 20 feet from the base unit. The base unit itself can be either stationary or mobile. If it is stationary it should be easy to relocate using other robotic equipment. If a tethered design is used, arrangements must be provided for ease in decontaminating the tethering cables and to reduce self-entanglement during operation. The tools should interchange easily. The entire unit must be constructed for ease of decontamination following its use in contaminated areas. It should be capable of operating continuously in radiation fields of up to 1000 R/h and at temperatures of up to 100oF. Other tools of up to 1000 pounds will be used with the heavier duty robot and it must be capable of lifting weights of up to 4000 pounds. Reach, radiation, temperature environments, tether, and decontamination requirements are similar to those of the light duty robotic device.

Timing: This capability would be useful immediately, but is needed throughout the D&D lifecycle at the INEEL.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: INEEL is currently deploying some robotic devices, but they need off-the-shelf, proven, and more cost effective machines. This is a high priority need because manually operated equipment cannot perform all of the required tasks. The INEEL already has a number of remote and robotic systems. This need was driven to find a unique, reasonably priced system that has not been demonstrated at other DOE sites in order to obtain funding from the Large Scale D&D Focus Area.

Technologies Evaluated:

- **SCARAB III; Remote Operated Vehicle Technologies, Inc.** This unit is a remote, mobile, radiation-tolerant vehicle with three cameras (one on a pan and tilt), lighting, a radiation detector, tracks to negotiate objects as tall as 13", and a telescoping manipulator capable of inspecting over 8' objects. The manipulator has elbow and wrist action, and a gripper. The system also comes with optional jet-spray attachment, vacuum heads, a power brush, plow/squeegee attachment, a U.T. probe, orbital

welding equipment, and other decontamination tools. This company provides robots and remote service to the nuclear industry. They have recently teamed with the R. Brooks Company to enhance inspection and retrieval technologies for hazardous environments. INEEL will likely use less expensive remote systems.

- **MiniManip; Inuktun.** The MiniManip is a compact remote gripper that can be mounted to small remotely operated vehicles, transporters, or extendable boom poles. The INEEL is interested in this gripper to attach to their existing vehicles.
- **Rosie; RedZone Robotics, Inc.** (TMS # 1799) Rosie is a stand-alone robotic delivery platform with various attachments, such as manipulators, scabblers, and camera systems to perform D&D tasks. It has a rugged mobile platform with a long-reach arm that has the strength to dismantle entire structures. It has been successfully demonstrated at ANL. RedZone has a clean unit in their facility; therefore, a clean Rosie can be used for training, and a contaminated system can perform actual remote tasks. Rosie and the dual-arm platform that was demonstrated at Argonne National Laboratory is currently being pursued by the Oak Ridge ETTP K-25 site to assist in the decommissioning of building K-1420. This activity is scheduled to begin in January 2000 and run for 9 months to one year. The cost to refurbish the unit, ship it to Oak Ridge, and modify the control system is estimated at $350K. The money has been found and Rosie will be deployed in Oak Ridge during FY 2000. The INEEL D&D Operations manager and Technology Development manager are currently investigating the best fit for Rosie, which will probably be the Power Burst Facility (PBF) reactor. INEEL and Oak Ridge will continue to communicate about their status, the support of INEEL Robotics personnel, and the transfer of Rosie to the INEEL after it is finished in Oak Ridge. ***Rosie is a potential candidate for a large scale D&D demonstration.***

ID-7.2.09 Develop a Rapid Wood Radiological Contamination Monitor

Summary: There exists a need at the INEEL to develop technology that can quickly determine the level and type of radioactive contamination in cracks and crevices on large pieces of wood so that uncontaminated pieces can be separated and not require disposal in a LLW disposal facility.

Requirements: The new technologies and/or processes must be able to analyze structural wood in facilities ready for decommissioning to determine the level of contamination to a level of less than one mr/hr. It is desired that the technology will permit the recycle or reuse of at least 70% of the wastes generated by typical D&D projects.

Timing: This technology is needed in FY-1999, but will continue to be needed throughout the D&D lifecycle at the INEEL.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: Currently, INEEL personnel survey wood elements, such as beams, studs, and plywood sheets taken out of facilities with a pancake radiation probe. The wood that is found contaminated or having cracks or knots is cut up and sent to a burial facility or WERF to be incinerated.

Technologies Evaluated:

- **Passive Alpha Track Detector & Electric Anionization Characterization; Rad Elec, Inc.** This device uses an electric ion chamber as a passive integrating ionization monitor. It assists in the characterization of alpha contaminated surfaces, but can be used for beta emitters as well. If statistical and not total characterization can be utilized this unit can meet this need very economically.

ID-7.2.11 Asbestos Wrapped/Insulated Pipe Removal and Packaging

Summary: Asbestos is an Occupational Safety & Health Administration (OSHA) carcinogenic material and must be controlled in accordance with regulatory requirements. Asbestos must be encapsulated to prevent release prior to disposal. Present methods for the removal of this piping are costly, cumbersome, time consuming, and hazardous to D&D workers. An improved materials handling technology of encapsulating, cutting, and removal of piping wrapped/insulated with asbestos (all types; amosite, chrysotile, tremolite, actinolite, anthophyllite, and crocidolite) is needed. Asbestos insulated pipes typically range in size from 1/2 inch to 8 inches in diameter.

Requirements: The materials handling technology should preclude the time-consuming cumbersome process of glove box bagging addressed in the baseline. The method should fix the asbestos to the insulated material, allowing sizing (cutting) to facilitate handling without the use of glove bags. Sizing should be required for waste to fit in 2 ft x 4 ft x 8 ft or a 3 ft x 4 ft x 8 ft waste boxes.

Timing: This technology is needed in FY-1999, but will continue to be needed throughout the D&D lifecycle at the INEEL. Demonstration is dependent on identification of an INEEL facility undergoing asbestos covered pipe removal.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: Most of the asbestos is covering pipe runs that are very congested and of various configurations. The INEEL has investigated technologies for remote asbestos removal, but these devices only work on straight pipe runs that have several inches of clearance around them. This need is high priority because the majority of INEEL facilities have asbestos-wrapped piping. Current regulations require that facilities be sprayed with water prior to removing asbestos to reduce the airborne fibers. This leaves a secondary waste stream.

Technologies Evaluated:

- **Encapsulation Technologies; Capture Coating.** The Capture Coating technology is a room fogging and coating process to dramatically reduce airborne radioactive contamination levels. It has been used to fix contaminants to surfaces for safer and more cost effective D&D activities. There is a potential use for this technology to assist in the manual asbestos activities to reduce dust and airborne contamination that severely affects the safety and performance of workers, D&D equipment, and instrumentation. The cost per application is approximately $15K. Breakdown is a one-time readiness fee is approximately $3500; equipment is approximately $1200/day; materials are approximately $65-75/gal x 10 gal/room; an engineer is approximately $624/day and an operator is approximately $464/day for about a two-day operation, plus travel, per diem, and freight. The INEEL is interested in using this technology to reduce airborne asbestos during D&D operations, but need to wait until the regulations are changed.

ID-7.2.12 Cutting Equipment For Above Ground, Underground, and Underwater Structures

Summary: During the dismantlement of equipment structures and buildings for the D&D program, various sizes of potentially contaminated and contaminated items are encountered. These items must be sized to facilitate handling and packaging for disposal. Current methods of sizing result in residues that must be controlled, handled, and disposed. Technology development is needed in the area of materials sizing equipment that reduces or eliminates the cutting residue. This equipment may be used in reactor/fuel storage pools as well as in contaminated or clean spaces, such as the TRA-660 canal described in ID-7.1.10. The reactors, including an upper and lower grid assembly, is an approximate 46 x 46 x 46 inch cube and is estimated to weigh no more than 5,000 lbs. after all the control rods and safety rod drive motors have been removed. Limiting underground structures are typically tunnels that range from 3 ft high and 2 ft-wide and larger with a curved ceiling. Above ground areas typically have sufficient clearance for most equipment that will fit in the tunnel to be operated.

Requirements: This technology should be able to size materials to facilitate handling and disposal, including solid metals to 12 inches thick, structural steel, piping to 14 in. diameter, concrete to 24 in. thick, and fibrous material to 24 in. thick. Equipment may use multiple attachments for sizing operations. The equipment should function in above ground structures as well as underwater environments, be easily decontaminated, able to be suspended from a crane, and stable when cutting force is applied (i.e., does not twist). The water clarity should not be impaired when cutting underwater as with arc saws and plasma arc and acetylene torches. The system should be capable of operating with minimal clearance and in tight spaces. The processed product should be able to be packaged into 55-galllon drums and/or metal boxes that are 3 ft x 4 ft x 8 ft long.

Timing: TRA Filter Pits and TAN 616 are scheduled for D&D in this fiscal year. However, this need will continue throughout the lifecycle of the INEEL D&D efforts.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: INEEL has tested several cutting technologies, but they have either left residues in the water, are too expensive, and/or are difficult to deploy.

Technologies Evaluated:

- **PCI Energy Services.** PCI provides cutting equipment for radiation, contaminated and/or hazardous environments. All equipment has been adapted for remote applications. Cutting technologies include plasma arc, oxy-fuel, electric discharge machining (EDM), metal disintegration machining (MDM), abrasive water-jet cutting, abrasive sawing, and other conventional cutting methods. This company and its technologies are currently being investigated for solving this need. The INEEL is interested in the EDM and MDM cutting technologies of this company and are

planning to submit these to the Large Scale D&D Focus Area for cutting up one of the reactors in the TRA-660 facility. See ID-7.2.21. Cutting needs generalized in ID-7.2.12 would apply to other short-term D&D activities, including the Power Burst Facility and Engineering Test Reactor. Following characterization, the INEEL may decide to go out for commercial bids to allow an experienced commercial company, like PCI, to remotely disassemble the reactors. ***The technology is a candidate for ASTD funding.***

ID-7.2.13 Penetrations in Concrete Floor and Demolition of Concrete Roof

Summary: Floor penetrations are needed to facilitate sampling under the floor and drainage/percolation of runoff water. Also, a method to rubblize the roof to facilitate percolation and ease of returning area to a natural condition is needed. The floor of the TRA-660 facility needs to be penetrated to allow sampling of the soils beneath the floor. In addition, the floor of the IET Control Room needs to be penetrated to allow water percolation through the floor when the roof is demolished. The roof of the IET Control Room needs to be demolished in place and allowed to collapse on the floor thus reducing the cost of dismantlement of the facility. The TRA-620 IET Control Room is a massive underground, shielded, heavily reinforced 16,600 square foot concrete structure, once used for the Aircraft Nuclear Engine tests. The roof is concrete approximately 7 ft thick reinforced with #7 to #14 rebar and covered with approximately 15 ft of overburden. The floor is approximately 2 ft. thick reinforced with #7 to #14 rebar.

Requirements: The technology to be used is to penetrate or fracture the floor of these two facilities to allow sampling of the soils and percolation of the natural snowmelt into the unsaturated aquifer below the building. The roof demolition should be accomplished in such a way so that the natural rainfall/snow melt will be allowed to percolate through the rubble and the fractured floor into the unsaturated aquifer. The side and interior walls may be left standing or demolished. The indentation in the surface caused by the roof demolition should eventually be backfilled with clean soil that allow the area to be returned to a more natural state.

Timing: Planning, characterization, documentation development, and asbestos removal for the IET control room started in 1998. Most of the dismantlement work is to be completed during 1999 - 2000.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: INEEL's baseline for dismantling the concrete roof will be time consuming using conventional devices this fiscal year. A faster, more cost effective method is needed.

Technologies Evaluated:

- **Rosie; RedZone Robotics, Inc.** Rosie is a stand-alone robotic delivery platform with various attachments, such as manipulators, scabblers, and camera systems to perform D&D tasks. It has a rugged mobile platform with a long-reach arm that has the strength to dismantle entire structures. It has been successfully demonstrated at ANL. RedZone has a clean unit in their facility; therefore, a clean Rosie can be used for training, and a contaminated system can perform actual remote tasks. See ID-7.2.08 for the status on this technology. Since this facility is not very contaminated, it will probably be demolished using manually operated heavy equipment.

ID-7.2.14 Decontaminating Radionuclide Contaminated Lead To Allow Free-Release

Summary: Lead, in the form of shot (typically 1/16 inch pellets), bricks (typically 3 x 4 x 8 in.), plates (typically 2 to 3 in. thick), irregular shapes, and sheets (1/8 to 3/4 in thick) has been used at many INEEL facilities for shielding to reduce the dose rates from gamma emitting sources. In some cases, the lead has become surface contaminated by radionuclides; principally Cs-137, Co-60, Sr-90, U-234, U-235, U-238, Pu-238, Pu-239, PU-240, and Am-241. Levels of surface contamination are suspected from greater than 200 dpm (disintegrations per minute) for alpha emitting nuclides (uranium, plutonium, and americium) and 5,000 dpm for beta/gamma emitters (cobalt, cesium, and strontium). The Radiological Controls Manual governs free release criteria for lead. These limits are: less than 1,000 dpm for Co-60 and Cs-137, less than 200 dpm Sr-90, less than 1,000 dpm for U-234, U-235, and U-238 and less than 20 dpm for Pu-238, Pu-239, Pu-240, and Am-241. This lead must be transported, stored, and managed as mixed waste or held for reuse. The costs of handling mixed waste is considerably more than the cost associated with recycling or reusing the lead if it is not contaminated with radionuclides. A cost-effective technology is needed for decontaminating lead so that it may be free-released for recycling or reuse.

Requirements: The new technological method should be cost effective, relatively portable, and not generate large quantities of secondary waste. The secondary waste generated should be readily treatable/disposable to meet 40 CFR 268 land disposal requirements.

Timing: This is a continuous need as lead forms are found in most facilities being decommissioned at the INEEL.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: Radiologically contaminated lead forms are now being stored awaiting the finalization of the Advanced Mixed Waste Storage Facility for disposal. The current burial facility can no longer accept lead.

Technologies Evaluated:

Corpex Nuclear Decontamination Process, Corpex-982; Corpex Technologies, Inc. (TMS # 87). This is a chemical decontamination process that uses a molecular chelant to remove a wide range of radioactive contaminants from surfaces, such as uranium, technetium, plutonium oxides, and heavy radioisotope oxides. The process does not create mixed waste and minimizes solid waste. Costs range from approximately $45-95/gal, depending on the quantity purchased. The INEEL is interested in this product for decontaminating lead bricks as an alternative to storage or treatment. The GETF POC has obtained more data on the chemical constituents from the manufacturer and supplied

them to the INEEL for RCRA records. INEEL personnel now have all the information they have requested and are evaluating the technology. ***Pending the results of this evaluation, Corpex could be a candidate for ASTD funding.***

ID-7.2.16 Field Screening of Lead (shot, bricks, sheeting) for Radionuclide Contamination.

Summary: There is approximately nine million pounds of shielding lead in INEEL buildings, emergency shielding reserve storage, mixed waste storage, and in the operation surge storage. Approximately one million pounds has been identified as radiologically contaminated and placed into storage. Approximately eight million pounds of shielding lead still remains in both operational and deactivated buildings or facilities awaiting decommissioning. The lead forms are sheet plate, shot wool, bricks, irregular shapes, and others. Because of the self-shielding attributes of lead, traditional contamination survey techniques are not effective in surveying the internal volume of lead forms. Lead forms can become volume contaminated as a result of being formed from surface contaminated lead, or as a result of activation in shielding conditions. Current cost to sample lead brick using the physical sample collection and laboratory analysis technique is $300 per sample. Current cost to volume survey a lead brick is $29 using the Volumetric Radioassay sodium iodide detection technology. Therefore an opportunity exists to deploy an accelerated, real-time, volumetric radioassay of lead forms at the INEEL to make a cost effective determination that the lead does not contain radioisotopes to allow free release for recycling lead to the scrap metal industry.

Requirements: The improved system should have adequate sensitivity to detect volumetric contamination with Cs-137 at a level of one picocurie per gram (pCi/g) in a 30-second count. The expected sensitivity to potential gamma-ray emitters other than Cs-137 should be in the one pCi/g range. Surface contamination at allowable levels may be measured as an unacceptable level of volumetric contamination.

Timing: This need is continuous because lead is found in most facilities being decommissioned at the INEEL.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: Volumetric radioassay is being demonstrated in the Large Scale Demonstration at Los Alamos National Laboratory (LANL) this year. If successful, this may be a technology worth pursuing for the INEEL need.

Technologies Evaluated:

- **Portable Sensor for Hazardous Waste; Physical Sciences, Inc. (PSI)** (TMS # 31). This technology is a portable sensor capable of screening site contamination of metals in water and soil, based on spark-induced breakdown spectroscopy. It is a robust, portable, analytical tool to facilitate rapid analysis and decision-making.

ID-7.2.17 Field Screening of Samples/Equipment Surfaces to Identify PCB Contamination

Summary: The capability to rapidly determine, in the field, the concentration of polychlorinated biphenyl (PCB) contamination on equipment surfaces (including tank interior surfaces) needs to be developed. After an area of PCB contamination has been remediated, Toxic Substances Control Act (TSCA) requires that the equipment used in the remediation is rinsed three times with diesel, a swipe survey conducted, and the swipes then analyzed for PCBs. This analysis can take seven to twenty-one days. The equipment used in the remediation must be held until the analysis is reported before it can be released for other use. Similarly, when an area is discovered that is suspected of being contaminated with PCBs, it must be sampled, and the sample then sent to a laboratory for analysis. The analysis can add a minimum of seven days to the schedule and cost approximately $125 per sample.

Requirements: The technological method and associated equipment should be portable, compatible with use in the field, capable of detecting equivalent to less than 10 mg/100 cm2 for a swipe and less than 5 mg/kg for all other media. It should reduce or eliminate the handling of samples. The results should be available within half an hour.

Timing: Planning, characterization, and documentation development started in 1998. The majority of the decontamination and dismantlement work is scheduled to be completed by the end of 2000.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: INEEL is demonstrating, as part of their Large Scale Demonstration this fiscal year, a paint analyzer by Niton that will detect chlorine in paint. If this device is successful, this need will disappear. The Niton device works very well for this need.

Technologies Evaluated:

- **Portable Sensor for Hazardous Waste; Physical Sciences, Inc. (PSI)** (TMS # 31). This technology is a portable sensor capable of screening site contamination of metals in water and soil, based on spark-induced breakdown spectroscopy. It is a robust, portable, analytical tool to facilitate rapid analysis and decision-making. According to the manufacturer, this device will not detect PCBs.

ID-7.2.20 Underwater Radionuclide Characterization of Structures, Equipment, and Containment Pool Walls

Summary: Many of the DOE facilities have used water filled storage pools to store spent fuel and/or research reactors. A better definition of the contamination and activation of the structural components, equipment, and pool liners is needed to more accurately determine the location of hot spots and to calculate the curie content of the items for handling and disposal. There are two research reactors located in a pool that is 8 x 18 x 28 ft in building TRA-660. The center 8 x 4-foot section of this pool is 23 feet deep. There is a container of bolts in this section that measures 90 rem on contact. The reactors and the pool need to be surveyed in detail in order to properly plan the removal of the reactors, cleaning and dewatering the pool, and the ultimate dismantlement of the pool and building. There are other facilities within the INEEL complex in which reactors, spent fuel, and other highly radioactive items are stored. A technology capable of surveying and planning for the ultimate decontamination and dismantlement of these facilities is needed. Visual logging along with radiological logging is needed as well.

Requirements: This technological system should function in an underwater environment, be mobile, able to produce visual and radiological detailed logging, and capable of taking radiation measurements that range from a few mrem/hr to several rem/hr. The radiation detection system should be capable of directional and general area measurements. The visual presentation should be sufficiently detailed so that the physical features are distinguishable and support future planning. The system should relay back to the operator its location in an X-Y coordinate plane. It is desirable for the system to have a manipulator that allows objects to be moved or held for more precise measurements.

Timing: This need is immediate; however, it is also continuous as the D&D of underwater equipment will proceed over the next several years.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: INEEL modified and demonstrated an underwater robot developed by Inuktun Services, Ltd. last fiscal year. It provided the characterization information, but they still need the remote capability to pick up small fasteners and tools.

Technologies Evaluated:

- **ROV #1; Remote Operated Vehicles Technologies, Inc**. This is a submersible remotely operated vehicle that has vertical and horizontal thrusters, cameras, lighting, and depth readout sensors. It is tethered with a 125-ft. cable and comes with a complete control system. A remote controlled gripper arm comes as one of the accessories. Since the INEEL already has a submersible vehicle, this device is not needed.

- **SCALLOP Submersible Monitoring System; Inuktun.** This device is a remotely operated submersible vehicle with a color charged coupled device (CCD), lighting and thruster motors to provide positioning in the water. It is 8 lbs. with a dimension of 14" by 9" by 8.5" and operated, via umbilical cable, by joystick controls. The INEEL currently has one of these vehicles, but it does not have an arm. Inuktun now has an arm that can be attached to the vehicle for a cost of approximately $3,500. The INEEL has purchased the Inuktun arm.

ID-7.2.21 Removal of Two Reactors as Single Units

Summary: Test Reactor Area building TRA-660 contains two, defueled, research reactors in a pool: the Advanced Reactivity Measurement Facility, and the Coupled Fast Reactivity Measurement Facility. It is desirable to remove these reactors, one-at-a-time, as single units in separate lifts. The reactors need to be removed and disposed of in order to complete the decontamination and dismantlement of building TRA-660. The canal is 8 ft. wide, 18 ft deep, and 28 ft long with a 4 by 8 ft storage pit at the center that is an additional 5 ft deep. A 15-ton bridge crane, with a total lift of 36 ft (from floor level to a maximum of 19 ft. and to a minimum of 17 ft below floor level), spans most of the floor and canal area of the building. Each reactor, including an upper and lower grid assembly, is an approximate 46 x 46 x 46 in. cube and is estimated to weigh no more than 5000 lbs. after the control rods and safety rod drive motors have been removed. The reactors - without the upper and lower grid assemblies are approximately 24 x 24 x 46 in. each. A recent survey of the reactors showed the highest radiation levels to be approximately 5 R/hr.

Requirements: The technological system should be capable of being attached to each reactor in 14 to 18 ft of water, moving them to appropriately shielded containers, and placing the containers on a truck for transport and disposal. Radiation levels in the vicinity of facilities where personnel are working should not exceed 5 mrem/hr during the handling process. Disposal and shipping should comply with the requirements in the INEEL Reusable Property, Recyclable Material, and Waste Acceptance Criteria, DOE/ID 10629, and U.S. Department of Transportation Regulations, Title 49 Code of Federal Regulations, part 171 to 179.

Timing: Planning, characterization, and documentation development started in 1998. The majority of the decontamination and dismantlement work is scheduled for completion by the end of 2000.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: INEEL plans to cut the reactor supports, pull the reactors out of the water to a work area, and cut them up remotely, using the Brokk remote manipulator to deploy a cutting tool. The Environmental Assessment on this activity is currently being reviewed. They would like to consider demonstrating an underwater cutting technology on one reactor and still deploy the Brokk on the other.

Technologies Evaluated:

- **PCI Energy Services.** PCI is a world leader in providing cutting equipment for radiation, contaminated, and/or hazardous environments. All equipment has been adapted for remote applications. Cutting technologies include plasma arc, oxy-fuel, electric discharge machining, metal disintegration machining, abrasive water-jet cutting, abrasive sawing, and other conventional cutting methods. This company and

its technologies are currently being investigated for solving this need. ***If a decision is made to disassemble one or both reactors underwater, PCI's cutting technologies will be considered for a Large Scale D&D project.*** (See the status of this technology in ID-7.2.12.)

APPENDIX G

INEEL DECONTAMINATION AND DECOMMISSIONING (D&D) LONG-TERM TECHNOLOGY NEEDS

ID-7.2.04 Metal Decontamination

Summary: Opportunity to develop new or significantly improved decontamination techniques for stainless steel, iron, various types of structural steel, and galvanized siding. Steel or other metals are often encountered in a variety of shapes and sizes in contaminated nuclear facilities. Huge amounts of contaminated metal piping will eventually be generated during the decommissioning of such facilities as the Engineering Test Reactor (ETR), Materials Test Reactor (MTR), Power Burst Facility (PBF) Reactor, and various other large INEEL nuclear facilities. Not only does the generation of large volumes of these materials have a negative impact on the Radioactive Waste Management Complex, but also it is a potential waste of a natural resource. If this metal can be effectively decontaminated and reused it will reduce the impact on the landfill. Note: In late November 1999, this opportunity was separated into, and superceded by, three new ones: ID-7.2.24 (Decontamination of Metal Debris), ID-7.2.25 (Decontamination of Metal Pipes), and ID-7.2.26 (Decontamination of Metal Walls, Floors, Ceilings, and Corners). The discussion here applies to each of the new opportunities.

Requirements: Decontamination technology should be cost effective, safe, and should not generate large volumes of a secondary waste that is difficult or expensive to dispose of.

Timing: This technology is needed to accomplish the planning for D&D of the ETR, MTR, and PBF reactors within the next five years. The PBF reactor and its facilities will be done first. Planning for the other reactors will be done within the next few years, but D&D efforts will most likely be extended beyond FY-2004.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: INEEL has tested chemical extracts, CO2 pellet, and grit blasting, but they were not cost effective. One option is to use a commercially available pipe decontamination system using grit blasting being tested at the Florida International University this fiscal year.

Technologies Evaluated:

- **Advanced Recyclable Media System (ARMS); Surface Technology Systems (STS).** This technology removes and absorbs low-level radioactive contaminants and hazardous materials, such as oil, grease, paint, rust, and heavy metals from almost any surface. A high-powered stream of soft, absorbent fiber material is blasted from a nozzle onto the contaminated surface. The resulting soft fiber media can be recycled and reused rather than disposed of as a secondary waste stream. STS is a service company that charges approximately $10,000/week for three service technicians to operate; alternatively, the equipment can be purchased for

approximately $20,000. The INEEL is not interested in this technology at this time. The information on the capability and cost of the ARMS was transferred to their technology file.

- **SP-400 Superabsorption; WaterWorks America.** This is a high technology polymer capable of near instant absorption of liquids, allowing a user to essentially freeze problem liquids in place while trapping any dissolved solids. This material could be used to absorb the liquid used in the conventional water-jet decontamination process. Approximate costs are based on the quantity of pallets purchased. 1925 lbs/pallet; $5.95/lb for 1 to 9 pallets; $5.49/lb for 10 to 19 pallets; $4.99/lb for >20 pallets. INEEL D&D Operations organization is already using a superabsorption product titled Spingo.
- **Corpex Nuclear Decontamination Process, Corpex-921; Corpex Technologies, Inc.** (TMS # 87). This is a chemical decontamination process that uses a molecular chelant to remove a wide range of radioactive contaminants from a variety of surfaces, mostly metals, rust, and corrosion. The process does not create mixed waste and minimizes solid waste. Approximate costs range from $45-95/gal, depending on the quantity purchased. The INEEL is interested in this product to be used on metal surfaces where the metal can be considered for reuse. Otherwise, it is cheaper and less time consuming to package the metals in waste boxes and dispose in a landfill. The GETF POC has obtained more data on the chemical constituents from the manufacturer and supplied them to INEEL for RCRA records. INEEL personnel now have all the information they have requested and are evaluating the technology. ***Pending the results of the evaluation, Corpex could be a candidate for ASTD funding.***

ID-7.2.07 Remote Demolition

Summary: Currently most facility demolition is done either by hands-on cutting techniques or by using heavy equipment for rubblizing the structures. This is not only slow and expensive, but requires workers to be in close contact with the contaminated materials. A technology is needed which will allow the fast and efficient disassembly of metal structures, piping, machinery, and concrete while allowing minimal exposure to workers and at the same time protecting the environment. Metal structures include sheet metal with supporting "I" beams in sizes of up to 10 inches. Machinery of all sizes is typically encountered, but materials similar to the 10 inch "I" beams would satisfy most of this work. Piping sizes range from fractions of an inch in diameter to about two feet with wall thicknesses of up to four inches. Concrete structures normally have six-inch walls, but these can range up to several feet in thickness. Note: In late November 1999, this opportunity was separated into, and superceded by, four new ones: ID-7.2.28 through ID-7.2.31 (titled Remote Demolition of, respectively, Concrete Structures, Machinery, Metal Structures, and Piping). The discussion here applies to each of the new opportunities.

Requirements: New technologies are needed which permit these dismantling tasks to be performed safely, remotely, or at least with less physical contact, and with greater speed to reduce the cost and radiation exposures to workers. They must be capable of handling the materials described above. It is desired that these technologies and processes permit the recycle or reuse of at least 70% of the wastes generated by typical D&D projects.

Timing: This capability would be useful immediately but will become extremely important by the time large structures such as Power Burst Facility (PBF), Engineering Test Reactor (ETR), and Materials Test Reactor (MTR) facilities are decommissioned over the next five years. The PBF reactor and its support buildings will be decommissioned prior to the ETR and MTR. However, the environmental documentation and planning on the proposed D&D processes for the other facilities will be done within the next few years.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: This is a high priority within the INEEL as they do not currently have methods to solve this problem for the extremely high radiation zones that cannot be entered manually. The D&D of these areas have been delayed in hopes of finding innovative technologies to solve this need.

Technologies Evaluated:

- **Rosie; RedZone Robotics, Inc.** (TMS # 1799) Rosie is a stand-alone robotic delivery platform with various attachments, such as manipulators, scabblers, and camera systems to perform D&D tasks. It has a rugged mobile platform with a long-reach arm that has the strength to dismantle entire structures. It has been successfully

demonstrated at ANL. RedZone has a clean unit in their facility, therefore, a clean Rosie can be used for training, and a contaminated system can perform actual remote tasks. Rosie and the dual-arm platform that was demonstrated at Argonne National Laboratory is currently being pursued by the Oak Ridge ETTP K-25 site to assist in the decommissioning of building K-1420. This activity is scheduled to begin in January 2000 and run for 9 months to one year. The cost to refurbish the unit, ship it to Oak Ridge, and modify the control system is estimated at $350K. The money has been found and Rosie will be deployed in Oak Ridge during FY 2000. The INEEL D&D Operations manager and Technology Development manager are currently investigating the best fit for Rosie, which will probably be the PBF reactor. INEEL and Oak Ridge will continue to communicate about their status, the support of INEEL Robotics personnel, and the transfer of Rosie to the INEEL after it is finished in Oak Ridge. ***Rosie is a candidate for future ASTD funding.***

ID-7.2.18 General Use Remote Tools for Handling Small Items (Pliers, Cutters, etc.)

Summary: Most remote tools used at the INEEL are specially designed for a specific application. There is a need for general-purpose tools that can pick up small objects (similar to a pair of pliers), and can be used to attach rigging to larger pieces of equipment. One application is in the reactor canals on site that are scheduled for decommissioning. Another is to support the decontamination and dismantlement of the TRA-660 building.

Requirements: The remote, general-use tools should function to pick up small objects at a depth of 24 ft, attach to a rigging, function as pliers, wrenches, screwdrivers, etc. or be capable of effectively manipulating such small tools. These tools should also be able to function underwater.

Timing: Planning, characterization, and documentation development started in 1998. The majority of the decontamination and dismantlement work is scheduled to be completed by the end of 2004. The timing on this need will most likely extend much further with all of the facilities that need to be decontaminated and decommissioned.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: Some remote/robotic devices are being used and demonstrated at INEEL; however, they are mainly task-specific. More generic, off-the-shelf tools are needed for the life cycle of D&D activities.

Technologies Evaluated:

- **SCARAB III; Remote Operated Vehicle Technologies, Inc.** This unit is a remote, mobile, radiation-tolerant vehicle with three cameras (one on a pan and tilt), lighting, a radiation detector, tracks to negotiate objects as tall as 13", and a telescoping manipulator capable of inspecting over 8' objects. The manipulator has elbow and wrist action, and a gripper. The system also comes with optional jet-spray attachment, vacuum heads, a power brush, plow/squeegee attachment, a U.T. probe, orbital welding equipment, and other decontamination tools. This company provides robots and remote service to the nuclear industry. They have recently teamed with the R. Brooks Company to enhance inspection and retrieval technologies for hazardous environments. INEEL will likely use less expensive remote systems.
- **MiniManip; Inuktun**. The MiniManip is a compact remote gripper that can be mounted to small remotely operated vehicles, transporters, or extendable boom poles. The INEEL is interested in this gripper to attach to their existing vehicles, but need funding. ***This is a candidate for ASTD funding.***

ID-7.2.19 Remote/Robotic Technologies for Access and Deployment of Characterization and Sampling Tools

Summary: Remote/robotic technology is needed for access and deployment of characterization and sampling in a small tunnel in the TRA-filter pit area. Characterization includes video imaging, radiation measurements (general area, hot spot, loose and fixed surface), asbestos, radiochemical, and chemical sampling and analysis. This area is not accessible to personnel. Sampling will be performed for concrete, solids/sludge, and liquid. Determination of the nature and extent of obstructions, radionuclide and non-radionuclide contamination, is required to support the evaluation of methods and alternatives for the decontamination and dismantlement. The tunnel is approximately 215 ft. long and 3 ft. high (2 ft. 4in. curved top on a 12 in. high cement trough). The tunnel floor is flat, containing several piping runs, one 8-inch ventilation pipe, one 3-inch ventilation pipe, one 1/2-inch pipe, and two 1-inch pipes. The pipes are supported from the floor of the tunnel every 12 feet. Some or all of these pipes may be insulated with asbestos.

Requirements: Remote technologies should be integrated with characterization and sampling tools to accomplish the requirements described above. The remote technologies should function in an environment with radiation levels of 100 rem/hr, radionuclide contamination to tens of thousands pCi/100 cm2, process chemicals, acids, and caustic solutions. Deployment distances vary from relatively short runs (50 ft) to long runs (1000 ft) and are required in galleries, tunnels, drainpipes, and highly congested areas. The employed system should be similar to a "pipe crawler" but will be deployed external to the pipes. The system should have the capability of a pan and tilt video camera system, and be able to take and analyze air samples, radiation measurements, and positional information.

Timing: A technology(s) for this need would be useful for the planning and characterization of the D&D of these filter pits, which is scheduled for decommissioning around FY-2002. However, it will be crucial later on in the decommissioning of ETR and MTR in later years. The Power Burst Facility is now scheduled to be decontaminated and decommissioned first. The schedule to D&D the ETR and its facilities, which includes the filter pits, was impacted due to a fatality associated with the ETR facility one year ago.

Contacts:	INEEL	Brad Frazee	(208) 526-3775
		Dick Meservey	(208) 526-1834
	DOE-ID	Andy Mikkola	(208) 526-0725

Status: INEEL will continue performing these tasks manually until cost effective remote technology is found and funded. The INEEL already has a number of remote and robotic systems. This need was driven to find a unique, reasonably-priced system that has not been demonstrated at other DOE sites in order to obtain funding from the Large Scale D&D Focus Area. The INEEL Remote and Robotics organization is now on-board with

the D&D Operations and Technology Development organizations to assist them in finding unique remote systems to demonstrate and use for these tasks.

Technologies Evaluated:

- **ROVVER and SPOT Series Robotic Crawlers; Visual Inspection Technologies, Inc.** These mobile, remote devices vary in size, maneuvering capabilities, and on-board sensors, but they are all small enough to enter the opening in the vault. All have on-board CCD cameras and lighting and need to be modified with a radiation detector to meet this need. The INEEL Robotics and Remote Systems organization has one of these units to perform remote characterization.
- **SCARAB I, II, or III; Remote Operated Vehicle Technologies, Inc.** The basic unit is a remote, mobile, radiation-tolerant vehicle with three cameras (one on a pan and tilt), lighting, and a radiation detector. Modifications to this unit include tracks to negotiate objects as tall as 7" (II) or 13" (IIA), and a telescoping manipulator capable of inspecting over 8' objects. Any of these would be ideal for inspecting the tank vault (depending on its configuration), but the overall size of the vehicles may not fit into the vault opening (currently checking this). This company provides robots and remote service to the nuclear industry. They have recently teamed with R. Brooks to enhance inspection and retrieval technologies for hazardous environments. The INEEL already has a remote vehicle that telescopes up to view over objects; however, they took the information for their technical file.
- **MicroTrac Pipe Inspection System; RoboProbe.** This remote system can fit within 4" pipes, can maneuver around 90 degree bends, and has an onboard camera and lighting to be able to inspect the inside of the tank. It would need to be modified with a sampling device in order to meet this need. The INEEL is considering this system, but needs to establish funding. Product information was transferred to their technical file.
- **Circumspector; Inuktun.** This remote system can fit within 4" pipes, can maneuver around 90 degree bends, and has an onboard camera and lighting to be able to access and inspect the inside of the tank. It would need to be modified with a sampling device in order to meet this need. Approximate cost = $19,780. The INEEL is considering this system, but needs to establish funding. Product information was transferred to their technical file.
- **Scissors; Inuktun.** This remotely operated mobile device maneuvers on treads, holds a pan and tilt camera and lighting, and raises from 15 3/8" to 65" to view over objects, or, in this case, the top of the tank in the vault. It would need to be modified with a radiation detector to meet this need. Approximate costs are = $36,000.00. The INEEL already has a remote vehicle that telescopes up to view over objects (a Remotec system); however, they took the information for their technical file.