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Large-Bore Pipe Decontamination

Topical Report
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By:
M. A. Ebadian

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For
U.S. Department of Energy
Office of Fossil Energy
Federal Energy Technology Center
P.O. Box 880
Morgantown, West Virginia 26507-0880

By
Florida International University
Hemispheric Center for Environmental Technology (HCET)
Center for Engineering & Applied Sciences
10555 West Flagler Street
EAS-2100
Miami, Florida 33174

Disclaimer

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ACRONYMS

D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
DOE-EM	U.S. Department of Energy-Environmental Management
DOE-OST	U.S. Department of Energy-Office of Science and Technology
FIU	Florida International University
FIU-HCET	Florida International University-Hemispheric Center for Environmental Technology
FY97	Fiscal Year 1997
FY98	Fiscal Year 1998
HCET	Hemispheric Center for Environmental Technology
RAPIC	Remedial Action Program Information Center

EXECUTIVE SUMMARY

The decontamination and decommissioning (D&D) of 1200 buildings within the U.S. Department of Energy-Office of Environmental Management (DOE-EM) Complex will require the disposition of miles of pipe. The disposition of large-bore pipe, in particular, presents difficulties in the area of decontamination and characterization. The pipe is potentially contaminated internally as well as externally. This situation requires a system capable of decontaminating and characterizing both the inside and outside of the pipe. Current decontamination and characterization systems are not designed for application to this geometry, making the direct disposal of piping systems necessary in many cases. The pipe often creates voids in the disposal cell, which requires the pipe to be cut in half or filled with a grout material. These methods are labor intensive and costly to perform on large volumes of pipe. Direct disposal does not take advantage of recycling, which could provide monetary dividends. To facilitate the decontamination and characterization of large-bore piping and thereby reduce the volume of piping required for disposal, a detailed analysis will be conducted to document the pipe remediation problem set; determine potential technologies to solve this remediation problem set; design and laboratory test potential decontamination and characterization technologies; fabricate a prototype system; provide a cost-benefit analysis of the proposed system; and transfer the technology to industry.

This report summarizes the activities performed during fiscal year 1997 (FY97) and describes the planned activities for fiscal year 1998 (FY98). Accomplishments for FY97 include the development of the applicable and relevant and appropriate regulations, the screening of decontamination and characterization technologies, and the selection and initial design of the decontamination system.

1.0 INTRODUCTION

The D&D of 1200 buildings in the DOE-EM Complex will require the disposition of miles of pipe. This pipe ranges in size, material type, type of contaminant, and coating. The disposition of large-bore pipe presents difficulties in the areas of decontamination, characterization, and disposition. The pipe is potentially contaminated internally as well as externally. This situation requires a system capable of decontaminating and characterizing the interior and exterior of the pipe. Current decontamination and characterization systems are not designed to do both, necessitating, in many cases, direct disposal of piping systems. The pipe creates voids in the disposal container and in the disposal cell, requiring the pipe to be cut in half or filled with a grout material. These methods are labor intensive and costly to perform on large volumes of pipe. Also, direct disposal does not take advantage of recycling, which would provide monetary dividends during the disposition of large-bore pipe.

1.1 PURPOSE OF THIS INVESTIGATION

The decontamination and characterization of large-bore pipe is difficult because of the various geometries and diameters of pipe and its different material types. A robust decontamination system must be capable of adapting to different pipe diameters (project scope is 6 inches to 24 inches), cleaning surfaces with various surface conditions and material types (i.e., painted, rusted, carbon steel, or stainless steel) and be cost effective to operate and maintain. The characterization system must be capable of handling the different pipe parameters and detecting contamination on the inside and outside surfaces to meet the criteria for unrestricted reuse. It must also operate in a cost-effective manner. Current technology options do not provide a robust system to meet these objectives.

The purpose of this project is to verify the need for this technology through determining quantities of pipe available for decontamination, perform a technology screening process to select technologies for decontamination and characterization, perform treatability studies to collect required performance data, and design and fabricate a prototype system to decontaminate the internal and external surfaces of large-bore pipe. A field mobile system capable of performing decontamination and characterization operations will be the main deliverable for this project.

2.0 PROJECT DESCRIPTION

The following tasks were scheduled for completion during FY97. Throughout this process, remediation service companies have been involved to ensure the large-bore pipe system is commercially viable and that a system will be marketed upon satisfactory testing. The preliminary engineering tasks (Tasks I-VI) were performed during FY97, with the majority of the fabrication and evaluation activities (Task VII) to occur during FY98.

TASK I.	PERFORM A LITERATURE SEARCH AND SURVEY THE D&D COMMUNITY TO DETERMINE THE PIPE REMEDIATION PROBLEM SET
TASK II.	DEVELOP A PROBLEM STATEMENT DETAILING THE PIPE REMEDIATION PROBLEM SET
TASK III.	DETERMINE APPLICABLE REGULATORY POLICIES AND PROCEDURES
TASK IV.	PERFORM A REVIEW OF PIPE DECONTAMINATION AND CHARACTERIZATION SYSTEMS AND DEVELOP SYSTEM DESCRIPTIONS
TASK V.	PERFORM BENCH-SCALE TESTING TO OBTAIN COMPREHENSIVE AND COMPARABLE DATA
TASK VI.	PERFORM LIFE-CYCLE COST ANALYSIS OF VIABLE SYSTEMS (FY97-FY98)
TASK VII.	DEVELOP A LABORATORY-SCALE SYSTEM (FY 97-FY98)

3.0 RESULTS

The seven tasks presented in Section 2 "Project Description" and in the FY97 Project Technical Plan (PTP) are presented below. The italicized text indicates the task description presented in the FY97 PTP. The results of each task and any deviations are presented in the paragraphs that follow.

The planned activities for FY97, with the exception of selecting the characterization technology and the completion of the life-cycle cost assessment, were completed on schedule. The selection of the characterization technology will be completed during December 1997 and January 1998, and the life-cycle cost assessment will not occur until after the initial design of the characterization system is completed. The delay in the life-cycle cost analysis is due to the fact that required cost numbers are not available for these unique systems until well into the design stage. However, preliminary cost numbers will be obtained and reviewed during the first quarter of 1998 to ensure the system will be a cost-effective option. The delay in the selection of the characterization system is due to the fact that gathering the technology screening information for the characterization technologies was a time-consuming task extending beyond its planned duration.

TASK I. PERFORM A LITERATURE SEARCH AND SURVEY THE D&D COMMUNITY TO DETERMINE THE PIPE REMEDIATION PROBLEM SET

To ensure the applicability of the system, a detailed analysis will be conducted to define the pipe remediation problem set. This will include conducting a literature search and contacting the Site Technology Coordination Groups (STCGs) at the DOE sites to define the magnitude and scheduling constraints for pipe remediation. Information related to pipe diameter, material of construction, contaminants of concern, and the availability of the material for D&D will be compiled. This information will be studied to ensure that the system resolves the existing problem set.

The objective of this task was to provide potential commercial partners with quantities and schedule information related to the pipe remediation problem set. Through initial contacts and previous experiences with trying to obtain quantities and other information related to remediation waste quantities from DOE sites, this task was simplified to reviewing sites with known published information related to remediation waste quantities. Through this review, Hanford reported 150,000 m^3, and Fernald reported 6,000 m^3 of piping. If the average pipe diameter is assumed to be 10 in., then 1 ft of pipe is 0.5454 ft^3. Therefore, approximately 10 million linear feet of piping will require disposition. The decontamination system's projected average production rate for 10-in.-diameter pipe is 1 ft per minute; therefore, approximately 168,000 hours of processing will be required. If the unit operates 2,000 hours per year, the system will be run for 84 years to complete the quantities reported by these two remediation sites. Additional sites are currently performing D&D and will generate quantities of pipe requiring disposition; therefore, it is projected that the system would be implemented for an extended period of time if it is proven cost effective and reliable.

TASK II. DEVELOP A PROBLEM STATEMENT DETAILING THE PIPE REMEDIATION PROBLEM SET

A detailed project statement specifying the requirements for the decontamination and characterization system will be developed. This project statement will be used to develop the specifications for the decontamination and characterization system. These specifications will dictate the specific contaminants of concern and the applicable diameters and construction materials the system is capable of processing. This problem statement will be used to develop potential decontamination and characterization systems.

Based on the information found in Task 1 and on the D&D experience of project team members, the problem statement was developed for the decontamination and characterization system. The problem statement is as follows:

> The scope of the project entails delivering a field-ready mobile system to process large-bore pipe creating a near-white metal finish on the internal and external surfaces. The pipe ranges in diameter from 6 in. to 24 in. The maximum length of material to be cleaned by the system is ten feet. All obstructions, valves, and flanges will be removed from the pipe prior to entering the decontamination system. The minimum system requirements include:

- The system must be capable of achieving a near-white metal finish[1] on the interior and exterior of the pipe.
- The system must handle pipes 6 in. to 24 in. in diameter.
- The system must handle pipes up to 10 ft in length.
- The output of the system must produce a surface that is free of moisture and dust.
- The process rate must be 3 to 5 ft per minute for 6-in.-diameter pipe.
- The ventilation system must follow ANSI 509 and 510 standards for nuclear systems.
- The system must have nuclear grade bag-in bag-out HEPA filtration as the final stage of filtration.
- All spent media and waste from the pipe must be collected in standard 55-gal drums.
- All waste must be dry and be considered non-hazardous as contained in 55-gal drums.
- System components must fit inside a nuclear grade strong tight container or containers.
- The system must be completely field mobile.
- All electrical work must meet Occupational Safety and Health Association (OSHA) standards and must be watertight.
- The system must include 15-ft-long entry and exit material handling systems.

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1 "A cleaned, near-white surface, when viewed without magnifications, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint and oxides, corrosion products and other foreign matter, except for staining. Staining shall be limited to no more than five percent of each square inch of the surface area and may consist of light shadows, slight streaks or minor discolorations caused by rust stains, mill scale stains, or previously applied paint stains." (Structural Steel Painting Council, 1991, *Surface Preparation Specifications*, Structural Steel Painting Council, Pittsburgh, PA, pp. 53-56.)

- The system must meet the requirements for unrestricted reuse as defined in DOE Order 5400.5 and Regulatory Guide 1.86.

TASK III. DETERMINE APPLICABLE REGULATORY POLICIES AND PROCEDURES

To ensure the applicability of the system, a complete review will be conducted to determine the relevant regulatory policies and procedures for its development and implementation. Areas of concern include, but are not limited to, transportation of the system, air emissions during operation, acceptance criteria for the release of the decontaminated pipe, and health and safety issues associated with operating the equipment. During the design and fabrication of the system, a complete list of applicable regulations will be compiled along with the details regarding the manner in which the regulations will be met.

Table 1 presents the applicable, relevant, and appropriate regulations (ARARs) to be considered for the design and construction of the decontamination and characterization system. The ARARs have been presented to vendors and subcontractors for use during the completion of various phases of this project.

Table 1.
Applicable and Relevant and Appropriate Regulations (ARARs)

Source	
GENERAL	**Description**
40 CFR 260.10	Definition of remediation waste
40 CFR 261.3	Resource Conservation and Recovery Act (RCRA) hazardous waste determination data
40 CFR 261.3(a)	Definition of hazardous waste
40 CFR 261.6	Requirements for recyclable materials
40 CFR 262.20 through .33, 40 CFR 263.20	RCRA preparing and transporting hazardous waste off-site
40 CFR 265.171 through .174, .176 and .177	RCRA condition of containers
40 CFR 268.2	RCRA definition of hazardous waste debris
40 USC §4901 et seq.	Noise control
40 USC §6903(27)	Definition of solid waste
42 USC §10101 (12), (16), (23)	Nuclear Waste Policy Act
42 USC §2014(2)(ee)	Atomic Energy Act definition of low-level radioactive material
42 USC §7641	Noise Pollution and Abatement Act

Table 1.
Applicable and Relevant and Appropriate Regulations (ARARs) (Continued)

RADIOACTIVE	
10 CFR 1021.2	Provides requirements for complying with National Environmental Protection Act (NEPA) at DOE facilities.
10 CFR 20	Defines the Nuclear Regulatory Commission's (NRC's) standards for protection against radiation hazards. Subpart B provides the protection program. Subparts C and D provide dose limits. Subpart E (proposed) provides radiological criteria for decommissioning. Subpart H provides information on respiration protection and controls to restrict internal exposure in restricted areas. Subpart K provides information on waste disposal.
10 CFR 835	Occupational radiation protection
40 CFR 191.03(b)	Environmental Radiation Protection Standards for Management and disposal of high-level radioactive waste (HLRW), spent nuclear fuel and transuranic (TRU) wastes
40 CFR 191.13 through .15	Environmental radiation protection standards for the management and disposal of HLRW, spent nuclear fuel, and TRU wastes
DOE Order 441.1	Standards for occupational radiation protection of workers at DOE facilities
DOE Order 5400.5	Radiological protection requirements and guidelines for the cleanup of residual radioactive materials and the management of the resulting waste and residues and release of property
DOE Order 6430.1A, 1324-5.3, -6	Low-level radioactive solid waste confinement (general design criteria)
Reg. Guide 1.86	Section four of this document provides surface decontamination limits for release for unrestricted use.
AIR	
40 CFR 264.1030; .1032 through .1034	Permitted status: air emission standards for process vents
40 CFR 60.672 (a), (d), (e)	Standards of performance for nonmetallic mineral processing plants
Clean Air Act	General provision on air pollution control prevention of air pollution nuisance

Table 1.
Applicable and Relevant and Appropriate Regulations (ARARs) (Continued)

HAZARDOUS WASTE MANAGEMENT (TRANSPORTATION)	
10 CFR 71	Provides requirements that must be used in the packaging and transportation of radioactive material
40 CFR 262.20 - 262.33 and 263.20 through 263.31	Generators who transport hazardous waste for off-site treatment, storage, and disposal
49 CFR 171-173, 177, 178	Department of Transportation requirements for the transportation of hazardous materials
49 USC §1801-1812	Hazardous Materials Transportation Act
49 CFR 171	Prescribes requirements governing transportation of hazardous material and the manufacture and packaging of containers
49 CFR 172	Prescribes requirements for shipping papers; package marking, labeling, and placarding; and emergency response and training
49 CFR 173	Includes definitions of hazardous materials, package preparation requirements, and inspection and testing responsibilities
49 CFR 174	Prescribes requirements for the transport of hazardous materials in or on rail cars
49 CFR 175	Prescribes requirements for the transport of hazardous material aboard aircraft
49 CFR 176	Prescribes requirements for the transport of hazardous materials by vessel
49 CFR 177	Prescribes requirements for the transport of hazardous material by motor vehicle
DOE Order 1540.1C	This order establishes the DOE's polices for management of materials transportation.
DOE Order 1540.2	Standardizes the current approval procedures to ensure that DOE packaging designs and transportation operation provide for public health and safety in accordance with regulations of the DOT and in accordance with standards that are equivalent to the standards prescribed by NRC Chapters II through Chapter XII of this Order summarize the actions associated with the review and approval of packaging for the transportation of radioactive and other hazardous materials.
DOE Order 1540.3A	Provides definitions used in transportation and packaging of radioactive materials
DOE Order 5480.3A	Hazardous materials packaging and transportation safety

Table 1.
Applicable and Relevant and Appropriate Regulations (ARARs) (Continued)

Other Requirements	
10 CFR 61	Provides requirements for the land disposal of radioactive waste
29 CFR 1904 and 1910	OSHA worker protection requirements
Clean Water Act	General provision on water pollution control prevention of water pollution nuisance
DOE 5700.6C	Quality assurance
DOE Order 5440.1E	NEPA compliance program
DOE Order 5480.1B	Environmental, safety, and health program for DOE operations
DOE Order 5480.4	Environmental protection, safety, and health protection standards
DOE Order 5483.1A	Occupational safety and health programs for DOE employees at government-owned, contractor-operated facilities
DOE Order 6430.1A	General design criteria

Sources: DOE/EM-0246 U.S. Department of Energy, 1995, *Decommissioning Resource Manual*, U.S. DOE, Germantown, MD, Appendix E.

U.S. Department of Energy, Draft 4, 1996, *Preferred Decommissioning Technologies Guide*, U.S. DOE, Germantown, MD.

TASK IV. PERFORM A REVIEW OF PIPE DECONTAMINATION AND CHARACTERIZATION SYSTEMS AND DEVELOP SYSTEM DESCRIPTIONS

Using the problem statement and specifications developed as part of Task II, a review will be conducted of the previous work performed in the area of ex-situ decontamination and characterization for piping systems. System descriptions will then be developed for each viable alternative. The information required for a life-cycle cost analysis will be gathered as part of this review. This information includes capital cost, operations and maintenance cost, system life, disposal costs, and secondary waste management costs. This information will be validated to ensure that the costs are an accurate representation of the actual costs. Information related to end points achieved, health and safety issues, production rates, sensitivity levels for sensors, availability of the equipment, field portability, utility requirements, and training requirements will also be gathered as part of this review.

Established sources and databases were used for categorizing and performing the initial technology screening. These sources and databases included the following:

- DOE/EM-0142P *Decommissioning Handbook*
- ORNL/M-2751 *Oak Ridge National Laboratory Technology Logic Diagram*

- EGG-WTD-11104 *Idaho National Engineering Laboratory Decontamination and Decommissioning Technology Logic Diagram*
- DOE-EM, 1996, Draft-4, *Preferred Decommissioning Technologies Guide*
- UC-706 Hemispheric Center for Environmental Technology, 1995, *Analysis of Potential Surface Blasting Decontamination Technologies for Structural Steel*
- Hemispheric Center for Environmental Technology (HCET), Draft January 1997, *Analysis of Potential Concrete Floor Surface Removal Technologies*
- Remedial Action Program Information Center (RAPIC) database
- Nuclear News Buyers Guide
- Fernald Environmental Restoration Management Corporation (FERMCO), 1993, *Operable Unit 3 Remedial Investigation and Feasibility Study Work Plan Addendum, Final*

Decontamination System

The screening tables for the decontamination system are presented in Appendix A. The tables include technologies that have been eliminated from further review during the initial screening process. After the initial screening, six technologies were retained for further evaluation. The further evaluation consisted of performing a detailed review to determine if the technologies were feasible given the project parameters. The technologies included for further review were the following:

- Automated grinding
- Laser ablation
- Flashlamp
- Ultrasonic cleaning
- Grit blasting
- Shot blasting

After the completion of bench scale testing (Task V), laser ablation and automated grinding were eliminated from future consideration. Flashlamp, ultrasonic cleaning, and shot blasting were eliminated after the completion of a more detailed literature review. The flashlamp technology was eliminated because it was not able to meet the requirements for a near-white metal finish. Ultrasonic cleaning was eliminated because of the requirement to be a field-mobile system and not being able to meet a near-white metal finish without creating a potential mixed waste. Shot blasting was eliminated because of the possibility of trapping the contamination within the peened over metal surfaces causing difficulty in completing the characterization effort.

Based on the initial screening, grit blasting was selected as the decontamination technology for the internal and external surfaces of the pipe. Grit blasting is a proven commercial technology that is aggressive, generates very little secondary waste, can be adjusted to meet a variety of surface finish

requirements (including near-white metal), does not produce an aqueous or hazardous waste, and can be developed into a field-mobile system.

Characterization System

The literature search and screening for possible technology alternatives for pipe characterization systems are presented in Appendix B. The completion of this task was more time consuming than planned. Screening of the alternatives and the development of the required procurement documents have been scheduled for completion during FY98.

Task V. Perform Bench-Scale Testing to Obtain Comprehensive and Comparable Data

If the results of the initial screening indicate a lack of performance data on the decontamination and characterization systems, field and laboratory testing of the decontamination and characterization system will be conducted as required. This development and testing program will ensure that comprehensive and comparable data is available to conduct a thorough review of the systems. Bench-scale testing will be used to validate the end point achieved, production rates, health and safety issues, and operations and maintenance issues.

Carbon steel samples were sent to two laser ablation vendors to obtain an indication of whether laser ablation can achieve a near-white metal finish on a painted carbon steel surface. Both vendors' results were similar, indicating the surface could not be cleaned to a near-white metal surface with the laser systems they used. Based on this review, laser ablation was eliminated from further consideration.

The manufacturer-recommended honing devices for 4-in., 6-in., and 10-in. diameter pipes were obtained from Brush Research Manufacturing Company and evaluated on non-contaminated carbon steel at the HCET test facility. The device was operated inside the test pipe as directed by the manufacturer. The technology was able to achieve a near-white metal finish; however, the honing device showed excessive wear and would not be practical for high volume, high production rate applications.

Based on these bench-scale tests, laser ablation and the honing device were eliminated from further consideration.

Task VI. Perform Life-Cycle Cost Analysis of Viable Systems

A life-cycle cost analysis will be performed using the data on the viable options for the decontamination and characterization of large-bore pipe. As part of the completion of the life-cycle cost analysis, assumptions related to labor rates, disposal costs, and project schedule will be developed. A sensitivity analysis will be conducted to determine the acceptability of the life-cycle cost analysis for the different DOE sites. Based on the results of the life-cycle cost analysis, the decontamination and characterization systems will be selected.

The completion of the initial screening process for the decontamination system produced one viable alternative—grit blasting. Life-cycle cost analysis worksheets were distributed to five different grit blasting vendors requesting the necessary information and backup data to complete a life-cycle cost analysis. The response from the vendors was incomplete and inadequate to

perform a life-cycle cost analysis. Further information was requested from the vendors, but the responses again were inadequate. The decision was made to proceed with the procurement process and obtain the necessary information as part of the requirements of submitting a responsible bid. The information obtained from the bidders was appropriate to perform an initial cost analysis; however, the data could not be used in a life-cycle cost analysis because the data could not be verified. Variables defined during the completion of the initial design would provide the necessary level of detail to perform a life-cycle cost analysis. The initial design of the decontamination system is complete, and the required information to perform a life-cycle cost analysis is available. However, this task will be delayed until the completion of the initial design of the characterization system, which is planned for the first quarter of FY98. Delaying this task will allow a total system life-cycle cost analysis to be developed.

TASK VII. DEVELOP LABORATORY-SCALE SYSTEM

Using the results of the life-cycle cost analysis and the review of issues associated with fabrication, operations, and health and safety issues, a laboratory-scale system will be developed. The laboratory-scale system will be of sufficient scale to ensure that all operations and maintenance issues are reviewed. The laboratory scale system will include a HEPA ventilation system, material handling equipment, a pipe decontamination system, and a pipe characterization system. The testing of this system will include the processing of five tons of pipe. Based on the results of the laboratory testing, a full-scale system design including a field-mobile system capable of characterizing and decontaminating large-bore pipe applicable to the most viable problem set within the DOE Complex will be developed and transferred to industry. It is anticipated that the laboratory-scale system and the full-scale system design will continue through FY98.

A scope of work to design, fabricate, and test the decontamination system was developed and sent to five different grit blasting vendors. The proposals received were all of equal quality; therefore, the vendor with the lowest bid was selected, and a purchase order has been issued to the company. The system consists of three main components: a centrifugal wheel grit blasting machine for performing external decontamination, a lance-type system for internal decontamination, and a ventilation component. The initial design, final design, fabrication, and testing of the decontamination system have been scheduled for completion during FY98. Section 4, "Planned FY98 Activities," outlines the tasks scheduled for completion for the decontamination and characterization systems.

Figure 1 shows the general layout of the system and its different modules.

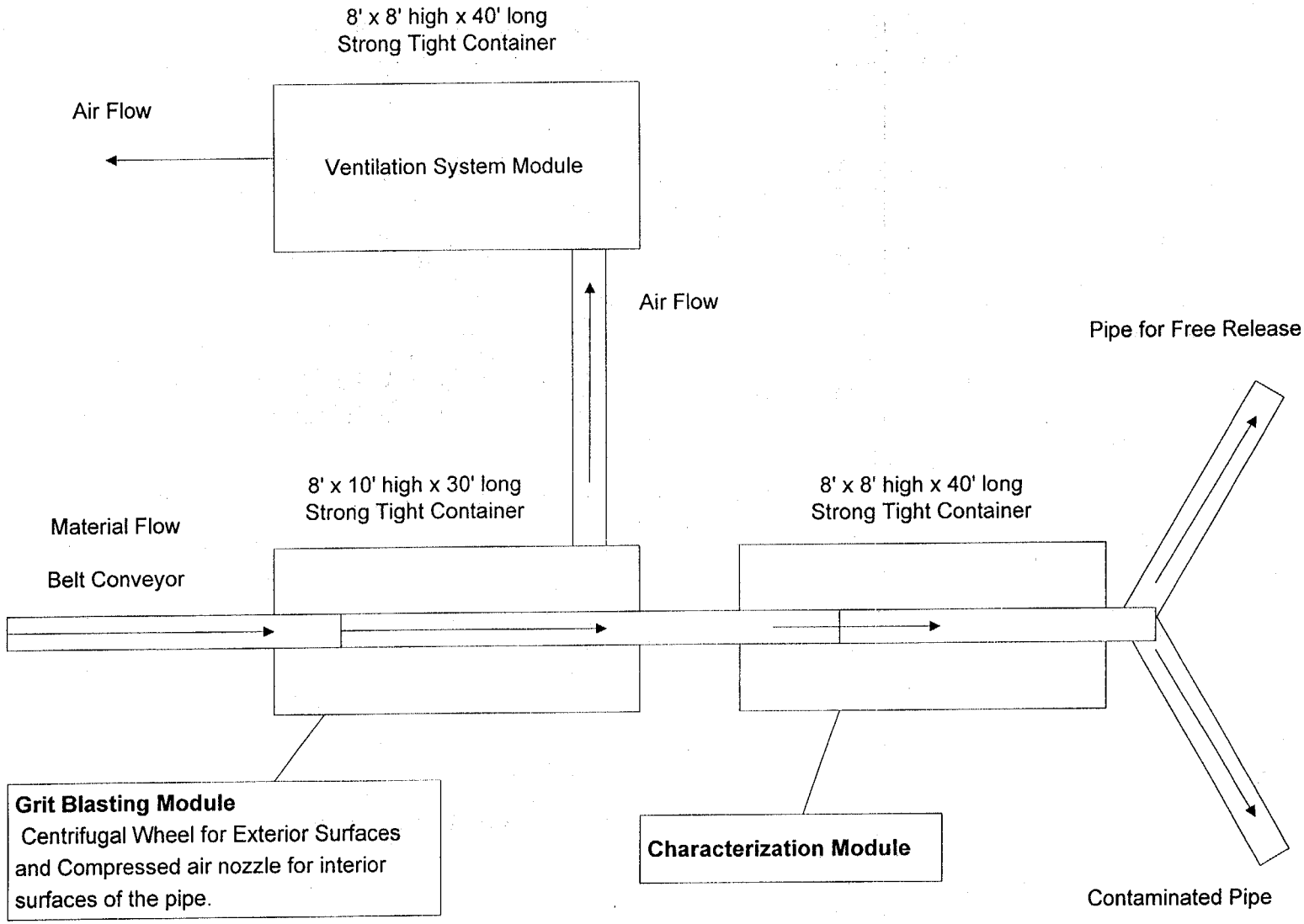

Figure 1. Product Flow Diagram

4.0 ACTIVITIES PLANNED FOR FY98

The following tasks are scheduled for completion during FY98. The project tasks have been grouped into three categories: decontamination system, characterization system, and integration of the two systems.

4.1 PROJECT TASKS

Decontamination System

TASK 1. TITLE I DESIGN

An initial design of the system and a review of the estimated costs for its completion will be performed. Florida International University-HCET (FIU-HCET) will review and approve 20% completion of design drawings. FIU-HCET will also approve the expenditure for long lead-time procurement items. (Completed 11/97)

TASK 2. TITLE II DESIGN

FIU-HCET will review and approve the final design of the large-bore pipe cleaning system and review the estimated costs for its completion.

TASK 3. TITLE III DESIGN

FIU-HCET will monitor the fabrication of the system to ensure that the specifications and design drawings are being followed.

TASK 4. OPERATIONS

FIU-HCET will witness the cleaning of five tons of pipe ranging from 6 in. to 24 in. in diameter. The vendor will develop a detailed operations and maintenance manual. Remediation service companies will be invited to the system testing to offer input and to help determine potential technology transfer partners.

TASK 5. CLOSE-OUT

Upon successful field-testing, the system will be transported to FIU-HCET, and five people will be trained on the operation and maintenance of the system.

Characterization System

TASK 1. SCREEN POTENTIAL CHARACTERIZATION TECHNOLOGIES

A detailed review will be performed on the preliminary list of characterization technologies to determine the viable technology options. This assessment may involve laboratory testing of technologies in which detailed performance data is required to ensure the viability of the system. The technologies that pass the screening process will be part of the bidders list for the request for proposal.

TASK 2. DESIGN AND EVALUATE EIC TECHNOLOGY

The EIC technology will be further developed for application to characterizing the internals of pipe. This includes reviewing the system from a fluid mechanics view point, evaluating the system at different flow rates, and evaluating different radioactive sources and dimensions of pipe. Equipment parameters will be reviewed to ensure the system has the appropriate limits of detection and production rates along with other performance factors.

TASK 3. PROCUREMENT OF CHARACTERIZATION SYSTEM

Detailed performance specifications will be developed, and a request for proposal will be developed and sent to the potential vendors. At a minimum, the specifications will detail minimum detection limits, contaminants of concern, production rates, and deployment requirements. Based on the bid responses, the vendor that presents the least cost option that meets the performance specifications will be selected to design, fabricate, and test the characterization system under the oversight of HCET.

TASK 4. TITLE I DESIGN

Title I design will require the development of initial design drawings and the approval of long-term procurement items.

TASK 5. TITLE II DESIGN

FIU-HCET will review and approve the final design of the characterization system and review estimated costs for completion.

TASK 6. TITLE III DESIGN

FIU-HCET will monitor the fabrication of the system to ensure the specifications and design drawings are being followed.

TASK 7. OPERATIONS

FIU-HCET will witness the characterization of five tons of pipe ranging from 6 in. to 24 in. in diameter. A detailed operations and maintenance manual will be developed by the vendor for the calibration and operation of the characterization system. Remediation service companies will be invited to the system testing to offer input and to help determine potential technology transfer partners.

TASK 8. CLOSE-OUT

Upon successful field-testing, the system will be transported to FIU-HCET, and five people will be trained on the operation and maintenance of the characterization system.

TASK 9. INTEGRATE DECONTAMINATION AND CHARACTERIZATION SYSTEMS

The decontamination and characterization system will be integrated during all steps of the design and fabrication of the two main systems. Prior to field implementation at a DOE site, the systems will be tested to ensure all material handling, power, and layout issues are resolved so the system

will operate as an integrated system. The system will be operated at the HCET test facility to complete this task.

TASK 10. FIELD IMPLEMENTATION AT A SELECTED DOE SITE.

With the help of the D&D Focus Area manager, a DOE remediation project will be selected to operate the system on a minimum of ten tons of pipe. Remediation service companies will be invited to the system testing to offer input and to help finalize potential technology transfer partners.

5.0 CONCLUSIONS

The project tasks for FY97 have been completed within budget and on schedule with the exception of the selection of the characterization system and the completion of the life-cycle cost analysis. These activities will be completed during FY98 with no change in the project completion date of October 1998. Through the selection and initial design of the decontamination technology, the project shows the promise of producing a cost-effective alternative to the direct disposal of piping systems.

6.0 REFERENCES

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APPENDIX A

Table 1.
Initial Screening for Pipe Decontamination
Technologies that have been eliminated from consideration

Technology Type	Applicable Geometry		Description	Comments
	Internal	External		
Ultra-High-Pressure Water	X	X	An internal combustion engine or electric motor drives a pump that generates up to 60,000 psig of water pressure. The ultra-high-pressure pump supplies water to a system of rotating nozzles that sprays the water stream onto the surface. The coating or substrate is removed by the kinetic impact of the water stream. The contamination and the coating are flushed away from the surface. Water systems can access and flush convoluted surfaces. A standard water supply is required to operate the system. For the treatment of secondary waste, a system is needed to collect and separate the debris from the water. Both would need to be treated.	Based on the testing performed by HCET, the technology fails to meet the required end point of a near-white metal finish.
Carbon Dioxide Blasting		X	This technology has a refrigerated liquid CO_2 supply and a system for converting the liquid to a solid media that is used for coating removal. Compressed liquid is allowed to expand in a pressure-controlled chamber in which the temperature drops, causing a mixture of CO_2 vapor and solid CO_2 snow to form. The snow is collected, compressed, and extruded through a die to produce pellets of a selected size and hardness as needed for decontamination. The CO_2 pellets remove the coating and perform decontamination by a combination of impact, embrittlement, thermal contraction, and gas expansion. The frozen pellets provide thermal shock and cause cracking.	Based on the testing performed by HCET, the technology fails to meet the required end point of a near-white metal finish.

Table 1.
Initial Screening for Pipe Decontamination
Technologies that have been eliminated from consideration (Continued)

Technology Type	Applicable Geometry		Description	Comments
	Internal	External		
Ice Blasting		X	Compressed air carries the media to a nozzle, which accelerates the media and impinges the surface. The media scrape the coating, rust, and contamination from the surface. A vacuum system which surrounds the nozzle removes the media and the surface removed. The vacuum system separates the usable media from the remaining debris, and the media is reused in the system. Compressed air or electricity may power the vacuum system. Many systems can operate a single nozzle or multiple nozzles, increasing production rates. Various grades and types of media are available to customize the media to the surface conditions. Media type and the surface being removed can significantly affect the amount of secondary waste to be managed.	Based on the testing performed by HCET, the technology fails to meet the required end point of a near-white metal finish.
Plastic Pellet Blasting		X	This process uses compressed air or centrifugal wheels to project plastic media at the surface. The sharp-faceted particles fracture on impact, leaving new sharp edges to allow their continued use for stripping. In general, the plastic media are selected to be harder than the coating. In typical applications, the air pressure measures in the range from 10 to 60 psig. Higher pressures remove coating faster but also are more likely to induce substrate damage. A vacuum system is used to collect the media and removed surfaces.	Based on the testing performed by HCET, the technology fails to meet the required end point of a near-white metal finish.
Automated Brushing/ Milling	X	X	This technique involves abrading the targeted surface using course brushes or media that are propelled against the surface using centrifugal force.	The technology fails to meet the required end point of a near-white metal finish.
Chemical Foams	X	X	A series of aqueous chemical cleaning solutions are applied to the surface for a given period of time and then either vacuumed or wiped off. The surfaces are then rinsed off. Foam is reapplied if the decontamination levels are not met.	The technology fails to meet the required end point of a near-white metal finish.

Table 1.
Initial Screening for Pipe Decontamination
Technologies that have been eliminated from consideration (Continued)

Technology Type	Applicable Geometry		Description	Comments
	Internal	External		
Sponge Blasting		X	This technique consists of an open blasting system with various grades of media. The sponge media is made of a water-based urethane matrix. During surface contact, the media expands and contracts, exposing the embedded abrasive and creating a scrubbing effect. The sponge then recoils and collapses around the contaminant, trapping it.	The technology fails to meet the required end point of a near-white metal finish.
Strippable Coating	X	X	Strippable coatings involve the application of a polymer mixture to a contaminated surface. As the polymer reacts, the contaminants are stabilized and become entrained in the polymer. The contaminated layer is pulled off, or it falls off.	The technology fails to meet the required end point of a near-white metal finish.
Vibratory Finishing	X	X	Objects are placed in a basket filled with abrasive media that are vibrated at a high frequency in a cleaning solution. The vibrating media produces a scouring action that removes contamination.	System is designed for small parts. It is not applicable to large-bore pipe decontamination.
Soda Blasting		X	Compressed air advances the sodium bicarbonate medium from a pressure pot to a nozzle, where the medium combines for stripping with a stream of water. The blast medium and water mixture impacts the surface, removing the coating and contamination. The water helps control the dust produced when the media impacts on the coating and prohibits heat buildup.	Based on the testing performed by HCET, the technology fails to meet the required end point of a near-white metal finish.
Acid Etching	X	X	This process uses a series of chemical baths to etch and neutralize the coatings and contamination on the surface. The dwell time for the material depends on the type of material, the type of contaminant, and the method by which part became contaminated.	Process is not designed to be a mobile system. Delete from consideration.

Table 2.
Pipe Decontamination Technologies

Technology Type	Applicable Geometry		Description	Comments
	Internal	External		
Automated Grinding	X		The system employs a series of cutting stones which spin (using centrifugal force) and hone the inside of the pipe. The system spins at a speed that induces the stones to be self-centering and to exhibit a uniform force on the pipe interiors.	Consider for further review. A Flex-hone system has been developed and tested to decontaminate the interior of piping system. System is able to achieve a near-white metal finish.
Laser Ablation	X	X	Laser systems have been employed to perform paint removal from airplanes and to remove graffiti. Systems are built to specification. Work is currently underway to develop systems for use in the decontamination field. Laser light impacts the surface causing the coating, rust, and subsurface material to be abraded.	Consider for further review. System is able to achieve a near-white metal finish.
Flashlamp		X	The system works by pulsing an electric current into a xenon gas filled quartz lamp, producing an effect similar to a photo camera flash. With the aid of a reflector housed in the system's head, the emitted light is concentrated and projected onto coated surfaces. The intense light breaks the chemical bond holding the material. The resulting fine ash and gases are sucked into a drum and fine scrubbed by a vacuum.	Consider for further review. System may be able to achieve a near-white metal finish.
Ultrasonic Cleaning	X	X	The contaminated component is placed in a bath of cleaning solution. A vigorous scrubbing action is produced by means of ultrasonic vibration to clean the component surfaces.	Consider for further review. System is able to achieve a near-white metal finish.

Table 2.
Pipe Decontamination Technologies (Continued)

Technology Type	Applicable Geometry		Description	Comments
	Internal	External		
Grit Blasting	X	X	Compressed air carries the media to a nozzle, which accelerates the media and impinges the surface. The media scrapes the coating, rust, and contamination from the surface. A vacuum system that surrounds the nozzle collects the media and removed surface. The vacuum system separates the usable media from the remaining debris, and the media is reused in the system. The system can operate a single nozzle or multiple nozzles, increasing production rates. Various grades and types of media are available to customize the media to the surface conditions. Media type and surface being removed can significantly affect the amount of secondary waste to be managed.	Consider for further review. System is able to achieve a near-white metal finish.
Shot Blasting		X	The primary unit consists of a blast head and a vacuum system. Hardened steel shot is propelled at a high rate of speed from the blast head to abrade the surface. The materials removed and part of the steel shot are collected by the vacuum system and separated. The removed material is collected in a drum, while the shot is separated for recycling by the unit. The end condition of the surface is determined by the rate of speed of the machine and the volume of shot fired into the blast chamber.	Consider for further review. System is able to achieve a near-white metal finish.

APPENDIX B

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Science and Engineering Associates, Inc.**
	Address	6100 Uptown
		Albuquerque, NM 87110

Contact	Name	David Cremer
	Phone	(505) 884-2300
	Fax	(505) 884-2991

Technology	Name	**Pipe Explorer**
	Description	
	Detector type	NaI, C_sI, ZnS, BC-408
	Spectrometric capabilities	
	Special features	
	Utilities required	

Demonstration	Site	ANL, ITRI
	Results	

Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	500 feet
	Diameter	2" to 40"

Applicable to radiation	Alpha and detection range	< 6 dpm/100cm^2
	Beta and detection range	< 1000 dpm/100cm^2
	Gamma and detection range	< 1000 dpm/100cm^2

Scan rate	Feet per minute	Depends on MDA- 0.1 to 30

Limitations related to	Contamination	None, Can measure all types
	Pipe geometry	Calibration required for each geometry
	Pipe bends	Up to 8
	Other	Can circumvent > 50 % obstruction.

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**AIL Systems, Inc.**
	Address	455 Commack Rd.
		Deer Park, NY 11729-4591
Contact	Name	Al Hennerborn
	Phone	(516) 595-6669
	Fax	(516) 595-5582
Technology	Name	**GammaCam™**
	Description	Gamma Ray Imaging System - Portable instrument that produces accurate 2-D images of gamma ray emitting objects. The system provides real time pseudo-color gamma ray imagery superimposed on a black and white video picture to quickly locate and measure radiation sources from a safe distance. System can operate in both low and high background environments.
	Detector type	High density terbium-activated scintillating glass
	Spectrometric capabilities	< 80 keV to >1.3 MeV
	Special features	
	Utilities required	
Demonstration	Site	Argonne National Lab, IL, D&D Technology Demo at CP-5 12/96
	Results	Successfully imaged areas in reactor building during D&D Tech Demo
	Site	Millstone Nuclear Power Plant, CT 7/97
	Results	Successfully imaged pipes containing gamma radiation
Applicable to pipe	External surface	Yes
	Internal surface	Yes, system can locate internal gamma source in pipe by imaging through pipe wall (obtaining image dependent upon interior source strength and pipe wall thickness).
	Length	Dependent upon external distance of sensor head to pipe (FOV = 50°)
	Diameter	Dependent upon external distance of sensor head to pipe (FOV = 50°)
Applicable to radiation	Alpha and detection range	Cannot detect
	Beta and detection range	Cannot detect
	Gamma and detection range	Sensor head requires 1-2 mR integrated dose in low background environments

Scan rate	Feet per minute	N/A. System captures a still image of scene. Sensor head requires repositioning to capture another area image.
Limitations related to	Contamination	Sealed enclosure required for operation in air contaminated areas
	Pipe geometry	No
	Pipe bends	No
	Other	System not designed to be pipe crawler. Max. field system has operated in was 70 R/hr. The GammaCam™ will not meet DOE surface-release criteria for alpha and beta radiations.

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Quantrad Sensor, Inc.**
	Address	2360 Owen Street
		Santa Clara, CA 95054

Contact	Name	Ed Browning
	Phone	(408) 727-7826 or (408) 727-7827
	Fax	(408) 727-7828

Technology	Name	**Scout MCA**
	Description	Portable Multichannel Analyser
	Detector type	Various sensor types
	Spectrometric capabilities	Alpha, Beta, Gamma, Neutrons
	Special features	
	Utilities required	

Demonstration	Site	
	Results	

Applicable to pipe	External surface	Yes
	Internal surface	Most
	Length	Any
	Diameter	> = 1/2"

Applicable to radiation	Alpha and detection range	up to 10 MeV
	Beta and detection range	up to 500 keV
	Gamma and detection range	30 keV to 2.5 Mev

Scan rate	Feet per minute	Any

Limitations related to	Contamination	No problems/cleanable surface
	Pipe geometry	Any
	Pipe bends	3" x 1/2" gamma sensors
	Other	

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Ordela, Inc.**
	Address	1009 Alvin Weinberg Dr. Oak Ridge, TN 37830

Contact	Name	Wayne Graves / Danny Kopp
	Phone	(423) 483-8675
	Fax	(423) 483-8404

Technology	Name	**Bore-Hole Frisch-Grid**
	Description	Large-area, ionization chamber for rapid alpha spectometry
	Detector type	Gridded Ionization Chamber
	Spectrometric capabilities	Yes, resolution < 60 keV FWHM at 5 MeV alpha energy
	Special features	Insensitive to beta and gamma radiation, alpha counting efficiency > 45% for surface source on inside bore-hole wall
	Utilities required	A source of Ar-CH4 (P-10) gas at < 200 kPa absolute pressure

Demonstration	Site	LITCO
	Results	Good

Applicable to pipe	External surface	N/A
	Internal surface	Yes
	Length	Any
	Diameter	> = 6"

Applicable to radiation	Alpha and detection range	Yes, < 60 keV FWHM for alpha
	Beta and detection range	No
	Gamma and detection range	No

Scan rate	Feet per minute	N/A

Limitations related to	Contamination	Yes
	Pipe geometry	Yes. Unit won't fit in pipes or boreholes less than 5" dia
	Pipe bends	Yes, not suitable for bends
	Other	

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Los Alamos National Laboratory**
	Address	MS J561, Group NIS-6
		Los Alamos, NM 87545

Contact	Name	Jim Koster
	Phone	(505) 667-3346
	Fax	(505) 665-9277

Technology	Name	**Long Range Alpha Detection**
	Description	Pipe Monitor
	Detector type	LRAD
	Spectrometric capabilities	None, measures gross Ionization only
	Special features	Based on measurement of ions produced by alpha radiation
	Utilities required	Flowing air to transfer ions to the sensitive volume

Demonstration	Site	LANL
	Results	Good, detects 200 dpm or more

Applicable to pipe	External surface	Any
	Internal surface	Any
	Length	Any
	Diameter	Any

Applicable to radiation	Alpha and detection range	High sensitivity, whole pipe
	Beta and detection range	Low sensitivity
	Gamma and detection range	Very low sensitivity

Scan rate	Feet per minute	Whole pipe/2 min.

Limitations related to	Contamination	Not very good for beta and gamma detection
	Pipe geometry	Must allow air flow through pipe
	Pipe bends	Not a problem
	Other	

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**INEL/DTD Robotics**
	Address	P.O. Box 1625
		Idaho Falls, ID 83415-2220

Contact	Name	David Willis
	Phone	(208) 526-8613
	Fax	(208) 526-7688

Technology	Name	**Small Pipe Characterization System**
	Description	Internal pipe crawler
	Detector type	Marlin - Gerin
	Spectrometric capabilities	Never tested
	Special features	The computer controlled crawler moves inside the pipe
	Utilities required	

Demonstration	Site	No work for demonstrations
	Results	Performed using radiation detector

Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Approximately 15 feet
	Diameter	2 to 3 inches

Applicable to radiation	Alpha and detection range	N/A
	Beta and detection range	Unknown
	Gamma and detection range	Unknown

Scan rate	Feet per minute	Unknown

Limitations related to	Contamination	Yes
	Pipe geometry	System never field for radiation measurement
	Pipe bends	Not designed for bends
	Other	

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Canberra Industries**
	Address	800 Research Parkway
		Meriden CT, 06457

Contact	Name	Frazier Bronson
	Phone	(203) 639-2345
	Fax	(203) 235-1347

Technology	Name	**ISOCS (In-Situ Object Counting System)**
	Description	Integrated system to do quantitative nuclide-specific assay of many different types of objects, including pipes. Product includes mathematical calibration software for field calibration of nearly all pipe sizes and source distribution geometries
	Detector type	High resolution Germanium
	Spectrometric capabilities	Yes
	Special features	Activity for each individual nuclide is determined, without significant interference from other nuclides present in the sample or in the background, also useful for drums, boxes, walls, floors, ceilings, etc.
	Utilities required	

Demonstration	Site	USDOE, US Nuclear Power Plant, US Research Institute, German Decommissioning Project, German Regulatory Agency
	Results	Very good

Applicable to pipe	External surface	Not as standard, but can be done as special
	Internal surface	Yes. Applicable to various thickness and composition. Also includes uniform radial distribution, and/or bottom distribution.
	Length	Up to 100 meters
	Diameter	Up to 25 meters

Applicable to radiation	Alpha and detection range	Detection via X-ray and/or gamma decay chain (most alpha emitters also emit photons)
	Beta and detection range	Detection via X-ray and/or gamma decay chain accompanying a beta decay

	Gamma and detection range	Depends on detector separation, and counting time, suitable for free release for most nuclides
Scan rate	Feet per minute	5' to 10' in 5 -15 minutes
Limitations related to	Contamination	Can be protected using a plastic cover
	Pipe geometry	Straight cylindrical shapes (Rectangular or curved shapes as special), diameter depends on detector assembly
	Pipe bends	Not standard, but as special geometry
	Other	

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Eberline Instruments**
	Address	P.O. Box 2108
		Santa Fe, NM 87504

Contact	Name	Jeff Sawyer
	Phone	(505) 471-3232 ext: 237
	Fax	(505) 475-9221

Technology	Name	**IPM**
	Description	Internal Pipe Monitor
	Detector type	Gas Flow Proportional
	Spectrometric capabilities	None
	Special features	
	Utilities required	

Demonstration	Site	None
	Results	

Applicable to pipe	External surface	No, different system
	Internal surface	Yes
	Length	< 10 meters
	Diameter	Various detectors available

Applicable to radiation	Alpha and detection range	Yes, dependent of count times
	Beta and detection range	Yes, dependent of count times
	Gamma and detection range	Yes, dependent of count times

Scan rate	Feet per minute	Manual system

Limitations related to	Contamination	Yes
	Pipe geometry	Right cylinder detector
	Pipe bends	Straight pipe only
	Other	Well known detector technology

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**BNFL Instruments, Limited**
	Address	Pelham House
		Calderbridge, Cumbria CA20 IDB, UK

Contact	Name	Paul Read / Norman Gardner
	Phone	44-19467-85015/85036
	Fax	44-19467-85019/85001

Technology	Name	**IonSens**
	Description	Detect ionization in air from alpha emission
	Detector type	Parallel plate electrometer
	Spectrometric capabilities	None, measures gross Ionization only
	Special features	Based on measurement of ions produced by alpha radiation
	Utilities required	Flowing air to transfer ions to the sensitive volume

Demonstration	Site	BNFL, Sellafield, Seascale, Cumbria CA20 1PG
	Results	Detection limit few tens of bequerels

Applicable to pipe	External surface	Yes
	Internal surface	Yes
	Length	20 feet
	Diameter	6" (development to maximum 24" dia in hand)

Applicable to radiation	Alpha and detection range	Yes
	Beta and detection range	No
	Gamma and detection range	No

Scan rate	Feet per minute	For 20 feet long, 6 inch dia, 3 minutes

Limitations related to	Contamination	Loose contamination can lead to detector contamination requiring subsequent cleaning
	Pipe geometry	No
	Pipe bends	No
	Other	

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830

Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297

Technology	Name	**Large Diameter Pipe Survey Rig**
	Description	Expandable rig with 1-4 attached gas flow proportional detectors for surveying 10" to 24" diameter piping or cylinders
	Detector type	Gas Flow Proportional
	Spectrometric capabilities	Total alpha, beta-gamma
	Special features	
	Utilities required	

Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning
	Results	Performed characterization and final surveys of equipment storage wells and large gas cylinders

Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Up to 12'
	Diameter	10" to 24"

Applicable to radiation	Alpha and detection range	500 to 1,000,000 dpm/100cm^2 (scanning mode), 100 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	2,500 to 1,000,000 dpm/100cm^2 (scanning mode), 500 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma, but not calibrated for quantification

Scan rate	Feet per minute	10 feet/min.

Limitations related to	Contamination	Yes
	Pipe geometry	Straight pipe 10" to 24" in diameter
	Pipe bends	No
	Other	Hand operated with attached pole, useful for beta energies > 50 keV

TECHNOLOGY SURVEY FOR DECONTAMINATION

OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830
Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297
Technology	Name	**SP-175-3M**
	Description	Expandable (motor-controlled) survey assembly consisting of three 1.75" diameter GM detectors. Assembly detection area 46.5 cm^2
	Detector type	Geiger Muller (GM)
	Spectrometric capabilities	Total alpha and beta-gamma
	Special features	
	Utilities required	
Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning
	Results	Performed characterization and final surveys of plant system piping from 5" to 12" diameter
Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Up to 12 feet
	Diameter	5 to 12 inches
Applicable to radiation	Alpha and detection range	3,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	3,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma, but not calibrated for quantification
Scan rate	Feet per minute	5
Limitations related to	Contamination	Yes
	Pipe geometry	Straight pipe 5" to 12" diameter
	Pipe bends	No
	Other	Useful for beta energies > 50 keV, hand operated with attached pole

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830
Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297
Technology	Name	**SP-113-3M**
	Description	Expandable (motor controller) survey assembly consisting of three 1.13" diameter GM detectors. Assembly detection area 19.4 cm^2
	Detector type	Geiger Muller (GM)
	Spectrometric capabilities	Total alpha and beta
	Special features	
	Utilities required	
Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning
	Results	Performed characterization and final surveys of plant system piping from 4" to 6" diameter
Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Up to 12 feet
	Diameter	4 to 6 inches
Applicable to radiation	Alpha and detection range	5,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	5,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma, but not calibrated for quantification
Scan rate	Feet per minute	5
Limitations related to	Contamination	Yes
	Pipe geometry	Straight pipe 4" to 6" diameter.
	Pipe bends	No
	Other	Useful for beta energies > 50 keV, hand operated with attached pole.

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830

Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297

Technology	Name	**SP-113-3T**
	Description	Expandable (motor controller) survey assembly consisting of three 1.13" diameter GM detectors. Assembly detection area 19.4 cm^2
	Detector type	Geiger Muller (GM).
	Spectrometric capabilities	Total alpha and beta-gamma
	Special features	
	Utilities required	

Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning
	Results	Performed characterization and final survey of plant system piping (including piping with bends) from 4" to 6" diameter

Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Up to 50 feet
	Diameter	4 to 6 inches

Applicable to radiation	Alpha and detection range	5,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	5,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma but not calibrated for quantification

Scan rate	Feet per minute	5

Limitations related to	Contamination	Yes
	Pipe geometry	4" to 6" diameter piping (including piping with bends)
	Pipe bends	Yes
	Other	Pulled through piping with attached cables, useful for beta energies > 50 keV

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830
Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297
Technology	Name	**SN-113-3C**
	Description	Flexible detector assembly consisting of three 1.13" diameter GM detectors attached to wheeled carriers. Assembly detection area 19.4 cm^2
	Detector type	Geiger Muller (GM)
	Spectrometric capabilities	Total alpha and beta-gamma
	Special features	
	Utilities required	
Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning
	Results	Performed characterization and final surveys of plant system (including piping with bends) from 2" to 3" diameter
Applicable to pipe	External surface	No
	Internal surface	yes
	Length	Up to 50 feet
	Diameter	2 to 3 inches
Applicable to radiation	Alpha and detection range	5,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	5,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma, but not calibrated for quantification.
Scan rate	Feet per minute	5
Limitations related to	Contamination	Yes
	Pipe geometry	2" to 3" diameter piping (including piping with bends).
	Pipe bends	Yes
	Other	Pulled through piping with attached cables, useful for beta energies > 50 keV

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830

Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297

Technology	Name	**SN-050-6K**
	Description	Flexible detector assembly consisting of six 0.5" diameter GM detectors enclosed in "ball" housings. Assembly detection area 7.6 cm^2
	Detector type	Geiger Muller (GM)
	Spectrometric capabilities	Total alpha and total beta-gamma
	Special features	
	Utilities required	

Demonstration	Site	Fort St. Vrain Nuclea Facility Decommissioning.
	Results	Performed characterization and final surveys of 1" diameter plant system piping with bends (up to 90° elbows)

Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Up to 50 feet
	Diameter	1 inch

Applicable to radiation	Alpha and detection range	1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma, but not calibrated for quantification

Scan rate	Feet per minute	N/A

Limitations related to	Contamination	Yes
	Pipe geometry	1" diameter piping with bends (including elbows)
	Pipe bends	Yes
	Other	Pulled through piping with attached cables, limited scanning ability due to small detection area (more applicable for incremented fixed point measurements in piping), useful for beta energies > 50 keV

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830
Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297
Technology	Name	**SN-050-8K**
	Description	Flexible detector assembly consisting of eight 0.5" diameter GM detectors enclosed in "ball" housings. Assembly detection area 10.1 cm^2
	Detector type	Geiger Muller (GM)
	Spectrometric capabilities	Total alpha and beta-gamma
	Special features	
	Utilities required	
Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning.
	Results	Performed characterization and final surveys of 1" diameter plant system piping with bends (up to 90° bends)
Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Up to 50 feet
	Diameter	1 inch
Applicable to radiation	Alpha and detection range	1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma, but not calibrated for quantification
Scan rate	Feet per minute	N/A
Limitations related to	Contamination	Yes
	Pipe geometry	1" diameter piping with bend (including elbows)
	Pipe bends	Yes
	Other	Pulled through piping with attached cables, limited scanning ability due to small detection area (more applicable for incremented fixed point measurements in piping), useful for beta energies > 50 keV

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830
Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297
Technology	Name	**Ludlum Measurements, Inc. (LMI), 43-94**
	Description	LMI developed 0.5" diameter cylindrical gas flow detector used with SEG developed procedures/methods and apparatus (background shields, centering collars, calibration jigs)
	Detector type	Gas Flow Proportional
	Spectrometric capabilities	Total alpha or total beta-gamma
	Special features	
	Utilities required	
Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning
	Results	Performed characterization and final surveys of plant system piping from 0.75" to 1.5" diameter
Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Up to 25 feet
	Diameter	0.75 to 1.5 inches
Applicable to radiation	Alpha and detection range	3,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	3,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma, but not calibrated for quantification.
Scan rate	Feet per minute	10
Limitations related to	Contamination	Yes
	Pipe geometry	0.75" to 1.5" diameter
	Pipe bends	No
	Other	Pushed/pulled through piping with attached cables, useful for beta energies > 50 keV

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830

Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297

Technology	Name	**Ludlum Measurements, Inc. (LMI) 43-98**
	Description	LMI developed 1.5" diameter cylindrical gas flow detector used with SEG developed procedures/methods and apparatus (background shields, centering collars, calibration jigs)
	Detector type	Gas Flow Proportional
	Spectrometric capabilities	Total alpha or total beta-gamma
	Special features	
	Utilities required	

Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning
	Results	Performed characterization and final surveys of plant system piping form 2" to 3" diameter

Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Up to 25 feet
	Diameter	2 to 3 inches

Applicable to radiation	Alpha and detection range	3,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Beta and detection range	3,000 to 1,000,000 dpm/100cm^2 (scanning mode), 1,000 to 1,000,000 dpm/100cm^2 (fixed-measurement mode)
	Gamma and detection range	Responds to gamma, but not calibrated for quantification

Scan rate	Feet per minute	10

Limitations related to	Contamination	Yes
	Pipe geometry	2" to 3" diameter piping
	Pipe bends	No
	Other	Pushed/Pulled through piping with attached cables, useful for beta energies > 50 keV

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Scientific Ecology Group, Inc.**
	Address	1560 Bear Creek Road
		P.O. Box. 230
		Oak Ridge, TN 37830

Contact	Name	Don Neely
	Phone	(423) 376-8237
	Fax	(423) 376-8297

Technology	Name	**TLD Strings**
	Description	TLDs attached to cables using specialized procedures/ methods to assess contamination in 1" to 2" diameter piping with bends
	Detector type	TLD
	Spectrometric capabilities	Total beta-gamma
	Special features	
	Utilities required	

Demonstration	Site	Fort St. Vrain Nuclear Facility Decommissioning
	Results	Performed characterization and final surveys of 1" to 2" diameter concrete embedded piping with bends (up to 90° elbows)

Applicable to pipe	External surface	No
	Internal surface	Yes
	Length	Previously used up to 100 feet (greater lengths feasible, provided installation is possible)
	Diameter	1 to 2 inches

Applicable to radiation	Alpha and detection range	N/A
	Beta and detection range	>3,000 dpm/100 cm^2
	Gamma and detection range	Respond to gamma, but not calibrated for quantification

Scan rate	Feet per minute	N/A

Limitations related to	Contamination	Yes
	Pipe geometry	1" to 2" diameter piping with bends (including elbows)
	Pipe bends	Yes
	Other	Pulled into piping with attached cables (cannot scan), after waiting determined exposure periods, TLDs are removed for processing. Long exposure periods required for low sensitivity. Useful for beta energies > 50 keV

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Rad Elec Inc.**
	Address	5714-C Industry Lane
		Frederick, MD 21704

Contact	Name	Paul Kotrappa
	Phone	(301) 694-0011
	Fax	(301) 694-0013

Technology	Name	**E-PERM®**
	Description	Electrect Ion Chamber
	Detector type	Passive Integrating Ionization Chambers using Electrects as detectors
	Spectrometric capabilities	No spectrometric capabilities
	Special features	
	Utilities required	

Demonstration	Site	Oak Ridge National Laboratory.
	Results	Capable of detecting levels of < 2.2 dpm/cm^2 of alpha activity on surfaces and in pipe interiors

Applicable to pipe	External surface	Yes
	Internal surface	Yes
	Length	Up to 10 feet
	Diameter	Any

Applicable to radiation	Alpha and detection range	2.2 dpm/cm^2 of alpha activity
	Beta and detection range	Depends upon energy example. Tritium pipe contamination of 2200 dpm/cm^2
	Gamma and detection range	N/A

Scan rate	Feet per minute	N/A. Passive detector

Limitations related to	Contamination	Cannot distinguish Fixed or Removable
	Pipe geometry	Could cause efficiency loss if not straight pipe
	Pipe bends	Could cause efficiency loss, need calibration
	Other	

TECHNOLOGY SURVEY FOR DECONTAMINATION OF INTERNAL AND EXTERNAL SURFACES OF PIPES

Vendor	Name	**Rad Elec Inc.**
	Address	5714-C Industry Lane
		Frederick, MD 21704
Contact	Name	Paul Kotrappa
	Phone	(301) 694-0011
	Fax	(301) 694-0013
Technology	Name	**Ion Transfer Electrect Ion Chamber**
	Description	Passive Integrating Electrect Ion Chamber
	Detector type	Electrect Ion Chamber
	Spectrometric capabilities	No
	Special features	Based on measurement of ions produced by alpha radiation
	Utilities required	Flowing air to transfer ions to the sensitive volume
Demonstration performed	Site	Oak Ridge National Laboratory
	Results	Calibrated and validated with test results
Applicable to pipe	External surface	Yes
	Internal surface	Yes
	Length	Up to 10 feet
	Diameter	6" to 24" diameter
Applicable to radiation	Alpha and detection range	< 2.2 dpm/cm^2 of alpha activity
	Beta and detection range	2200 dpm/cm^2 for tritium betas < 2200 dpm/cm^2 for other beta emitters
	Gamma and detection range	N/A
Scan rate	Feet per minute	Entire pipe in 15 minutes at release rate
Limitations related to	Contamination	Only detects alpha and beta contamination
	Pipe geometry	None
	Pipe bends	May need different calibration with reference source
	Other	Calibration or calibration validation required using a reference source of the type of contamination being measured