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for the November 1997 to October 1998 Period

LARGE-BORE PIPE DECONTAMINATION

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Prepared for:

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Office of Science and Technology

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ACRONYMS

D&D	Deactivation 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's 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 deactivation 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 (completed FY97); determine potential technologies to solve this remediation problem set (completed FY97); design and laboratory test potential decontamination and characterization technologies (completed FY97); fabricate a prototype system (FY98 and FY99); provide a cost-benefit analysis of the proposed system (preliminary completed FY98); and deployment of the system (FY99 and beyond).

The Large-Bore Decontamination Process consists of three main systems: the decontamination system, the characterization system, and the material handling system integration system. The decontamination system is further segregated into two modules: the decontamination module and the ventilation module. The development of project tasks and documents follows this general outline to ensure consistency in understanding the project flow.

This report summarizes the activities performed during FY98 and describes the planned activities for FY99. Accomplishments for FY98 include completing the final design of the decontamination module, design and procurement of the ventilation module, the screening of potential characterization technologies, procurement of the characterization system, and the completion of a preliminary cost-benefit analysis.

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 meet the remediation goals for large-bore pipe, 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. 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 (completed FY97), perform a technology screening process to select technologies for decontamination (completed FY97) and characterization (completed FY98), perform treatability studies to collect required performance data (completed FY97), and design and fabricate a prototype system to decontaminate and characterize 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.

A summary of activities completed during FY97 is provided to understand the project development and implementation process. For further information related to the activities completed during FY97, please refer to the Fiscal Year 1997 Year-End Report for the August 1996 to October 1997 Period for LARGE-BORE PIPE DECONTAMINATION.

Literature Search to Determine Pipe Remediation Problem Set

Rough order-of-magnitude quantities were obtained from Hanford and Fernald, including 150,000 m^3 of pipe at Hanford and 5,880 m^3 of pipe at Fernald. Obtaining quantities from other DOE operations offices would require a significant level of effort; therefore, Florida International University's Hemispheric Center for Environmental Technology (FIU-HCET) and the

Deactivation and Decommissioning Focus Area (DDFA) decided that acquiring the additional information would not be cost-effective and concluded that significant volumes of pipe exist to warrant the continuation of the project.

Determine Applicable Regulatory Policies and Procedures

The list of regulations that govern the fabrication and operation of the pipe decontamination and characterization system was compiled. This list was given to the potential technology vendors to aid in proposal development, design, equipment fabrication, and system evaluation.

Review of Decontamination and Characterization Technologies

The review and collection of data for possible decontamination and characterization options for large-bore pipe are complete. Based on the information reviewed, an initial screening method used for pipe decontamination technologies was developed and implemented. The initial criteria include the technology's ability to meet the required clean, near-white metal surface finish[1] on the interior or exterior of a pipe and the system's potential to be developed into a field mobile system. Seventeen decontamination technologies were evaluated as part of the initial screening process. Of the technologies screened, six technologies were selected for further evaluation; these six were then narrowed to one technology: grit blasting.

The literature survey of technologies capable of characterizing the interior and exterior of large-bore pipe is complete, and the resulting list detailing 21 technologies was prepared.

Perform Bench-Scale Testing to Obtain Comprehensive and Comparable Data

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 deployed. 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 FIU-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.

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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 5 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.)

2.0 PROJECT DESCRIPTION

The following tasks were scheduled for completion during FY98. The preliminary engineering was performed in FY97, with the majority of the procurement, fabrication, and system testing activities occurring during FY98 and FY99. The tasks are segregated into three major categories: decontamination system, characterization system, and integration and field implementation of the two systems.

Task 1.0 Decontamination System

Task 1.1 Title I Design

Task 1.2 Title II Design

Task 1.3 Title III Design

Task 1.4 Operations

Task 1.5 Close-Out

Task 2.0 Characterization System

Task 2.1 Screen Potential Characterization Technologies

Task 2.2 Design and Evaluate EIC Technology

Task 2.3 Procurement of Characterization System

Task 2.4 Title I Design

Task 2.5 Title II Design

Task 2.6 Title III Deign

Task 2.7 Operations

Task 2.8 Close-Out

Task 3.0 Integration and Field Implementation

Task 3.1 Integrate Decontamination and Characterization

Task 3.2 Field Implementation at a Selected DOE Site

3.0 RESULTS

The ten tasks presented in Section 2 "Project Description" and in the FY98 Project Technical Plan (PTP) are presented below. The italicized text indicates the task description presented in the FY98 PTP. The results of each task and any deviations are presented in the paragraphs that follow. The project tasks have been grouped into three categories: Decontamination System, Characterization System, and the integration and field implementation of the two systems.

3.1 PROJECT TASKS

Task 1.0 Decontamination System

Task 1.1 Title I Design

An initial design of system and a review of estimated costs for completion will be performed. FIU-HCET will also approve the expenditure of long lead-time procurement items.

The initial design for the decontamination system was completed on November 20, 1997. The design consists of an initial layout of the decontamination system confirming the system will conform to the requirement of fitting within transportable strong tight containers. Overall dimensions for the blast cabinet, conveyors, and material conveyance systems were specified. The initial design also indicated material flow paths and the preliminary ventilation requirements. The overall safety requirements and interlocks were also defined. The overall configuration of the decontamination system is shown in Figure 1.

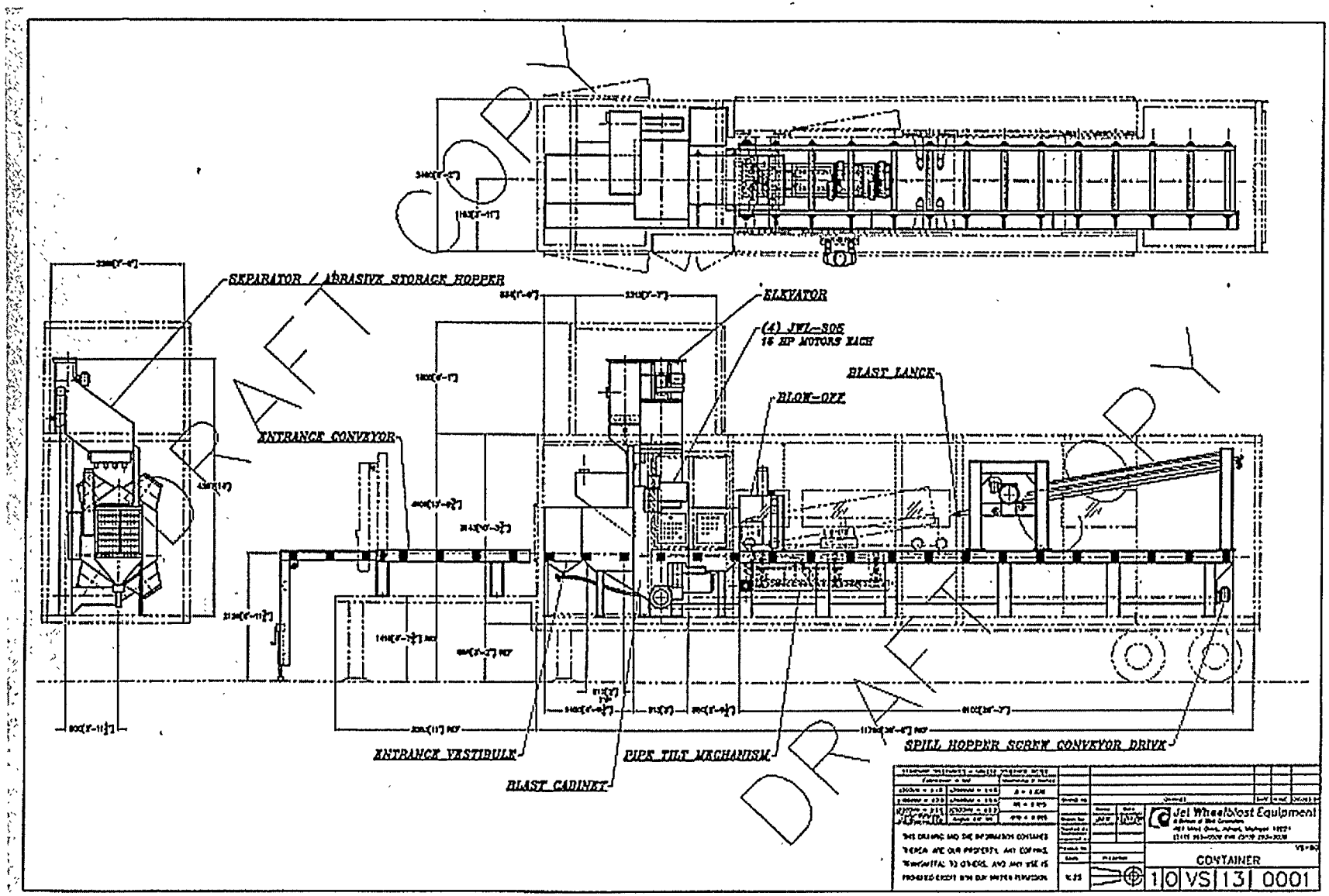

Figure 1. Overall configuration of decon module.

Task 1.2 Title II Design

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

The final design for the decontamination system was completed on June 15, 1998. The detailed design consisted of a narrative and a set of design prints. The final design submittals indicate the requirements set forth in the performance specifications will be met or exceeded. These performance specifications require the following:

- System must handle 6 inch in diameter through 24-inch diameter pipe.
- System must handle four-foot to ten-foot length pipe.
- System must be capable of achieving a near white metal finish on structural steel.
- System must handle a minimum dimension of 2 inches through 24 inches structural steel shapes.
- System must handle ten-foot length structural steel.
- The output of the system must produce a surface that is free of moisture and dust.
- Process rate must be 3 to 5 feet per minute for 6-inch 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 waste drums.
- All waste must be dry and be considered non-hazardous.
- System components must fit inside a nuclear grade container or containers.
- The system must be field mobile.

Figure 1 illustrates the overall configuration of the decontamination module, and Figure 2 is a representation of the ventilation module configuration. The design drawings were reviewed by FIU-HCET and comments were incorporated prior to starting Title III design.

Title II also included the development of the layout of the strong tight containers for the decontamination module and the ventilation module. The layout of each of these containers was completed during FY98. The procurement of the ventilation module strong tight container was completed during FY98 with the detailed design and fabrication to occur during the first quarter of FY99. The detailed design and fabrication for the decontamination system strong tight container will be completed during the first quarter of FY99.

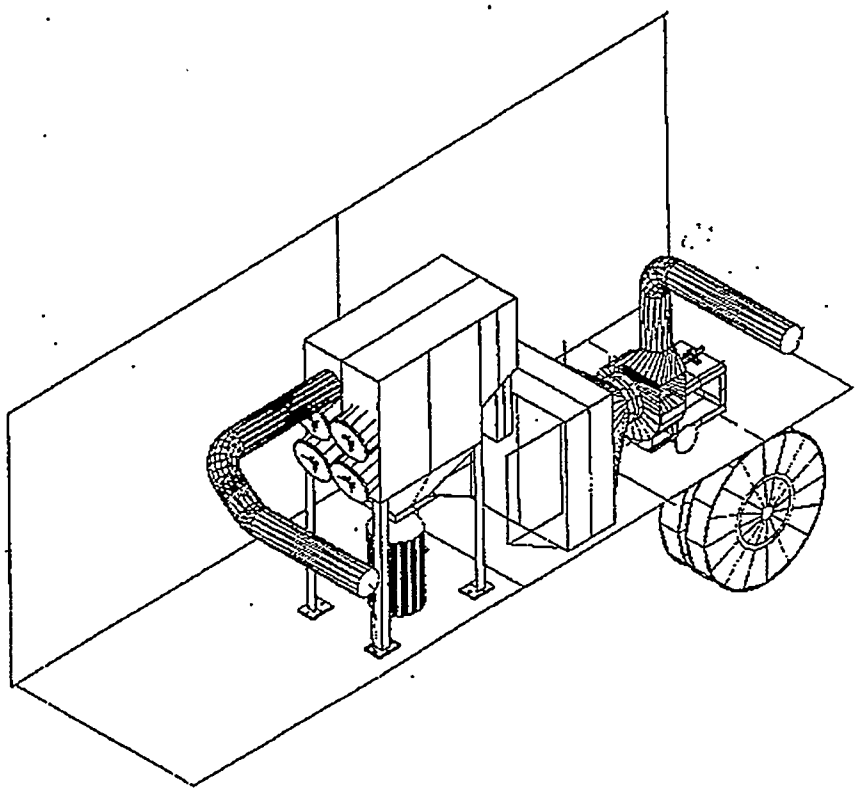

Figure 2. Ventilation module arrangement.

Task 1.3 Title III Design

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

During FY98 the majority of the fabrication work was completed for the decontamination and the ventilation modules. The remainder of the Title III design work will be completed during the first quarter of FY99. A total of four trips were made to the manufacturing facilities to ensure the design drawing and performance specifications are met. All fabrication activities meet or exceed the design drawings and performance specifications.

Task 1.4 Operations

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

The delay in the completion of the Title III design for the decontamination system postponed the execution of this task until FY99.

Task 1.5 Close-Out

Upon successful field testing, the system will be transported to FIU-HCET, and five people will be trained to operate and maintain the system.

The delay in the completion of the Title III design for the decontamination system postponed the execution of this task until FY99.

Task 2.0 Characterization System

Task 2.1 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.

Based on the review performed by FIU-HCET and an independent consultant, a total of five companies passed the screening of the 21 technologies identified during the review of possible characterization technologies. The screening criteria included the following:

- System must be capable of characterizing pipe and structural steel meeting DOE Order 5400.5 Reg. Guide 1.86 for alpha, beta, and gamma emitters.
- System must characterize 6 inch in diameter through 24-inch diameter pipe made of different materials excluding aluminum.
- System must characterize two-foot to ten-foot length sections of pipe.
- System must characterize structural steel shapes with width dimensions from 2 inches to 24 inches.
- System must characterize two-foot to ten-foot length sections of structural steel.
- The operation of the system must not result in contamination of personnel, equipment, or create airborne radioactive contamination.
- The system must be field mobile.
- The system must be able to be calibrated in the field.

The five technologies, which potentially meet the initial criteria, were provided performance specifications and a request for proposal as identified in Task 3 of the Characterization System Section.

Task 2.2 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 viewpoint, 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 such as case of operation, and flow control.

The design and evaluation of the EIC is prepared and presented in a separate final report.

Task 2.3 Procurement of Characterization System

Detailed performance specifications and a request for proposal will be developed and sent to the potential vendors. The specifications will detail minimal detection limits, contaminants of concern, production rates, and deployment requirements. The bid responses that meet the performance specifications with the lowest costs will be selected to design, fabricate, and test the characterization system overseen by HCET.

Detailed performance specifications were developed and included in an invitation to bid that was sent to the five technology vendors identified in the initial screening and to seven additional vendors requesting the invitation to bid. Of the twelve invitations to bid sent out, one response was received. The bid was reviewed and found to be technically complete. Funding issues required the delay in the award of the contract for a total of four months. The kick-off meeting for the characterization system development was held during August 1997. The delay in the award of the contract requires the adjustment in the schedule for the completion of the design, fabrication, integration, and field implementation activities.

Task 2.4 Title I Design

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

Title I design submittal was made during the final week of FY98. The review of the Title I submittal will occur during the first quarter of FY99. Figure 3 is a conceptual view of the overall arrangement of the characterization system.

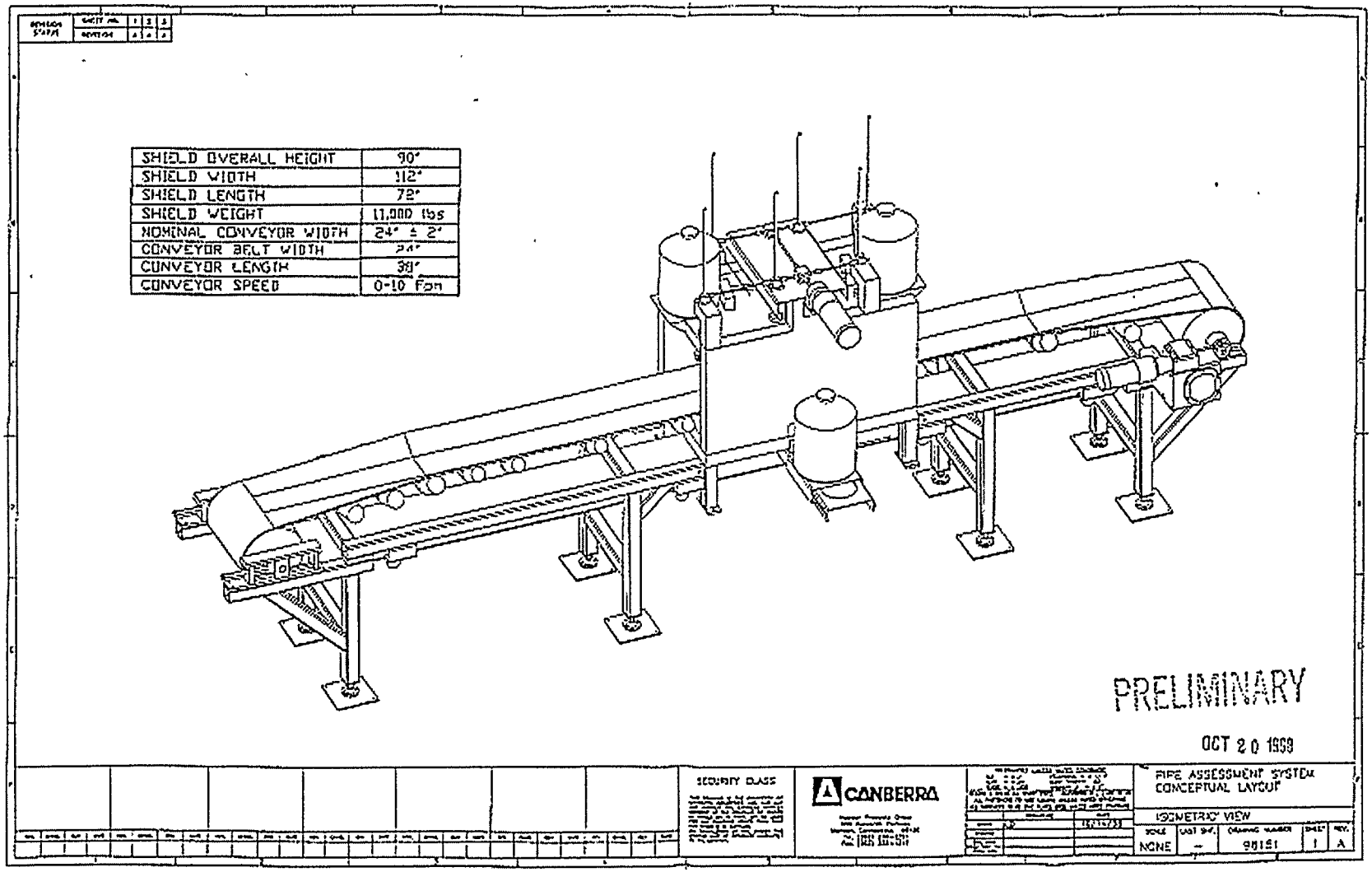

Figure 3. Conceptual view of the characterization system.

Task 2.5 Title II Design

FIU-HCET will review and approve the final design of the Characterization System and review estimated costs to complete it.

The delay in the award of the contract for the characterization system has postponed the execution of this task until FY99.

Task 2.6 Title III Design

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

The delay in the award of the contract for the characterization system has postponed the execution of this task until FY99.

Task 2.7 Operations

FIU-HCET will witness the characterization of five tons of pipe ranging in diameter from 6 to 24 inches. A detailed operations and maintenance manual will be written by the vendor describing the calibration and operation process of the characterization system. Remediation service companies will be invited when the system is tested to solicit input and determine potential technology transfer partners.

The delay in the award of the contract for the characterization system has postponed the execution of this task until FY99.

Task 2.8 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.

The delay in the award of the contract for the characterization system has postponed the execution of this task until FY99.

Task 3.0 Integration and Field Implementation

Task 3.1 Integrate Decontamination and Characterization Systems

The decontamination and characterization systems will be integrated during all steps of their design and fabrication. Prior to field implementation at a DOE site, the systems will be tested to ensure all material handling, power, and system layout issues are resolved to ensure that the system operates as an integrated system. The system will be operated at the FIU-HCET test facility to complete this task.

The delay in the award of the contract for the characterization system has postponed the execution of this task until FY99. Figure 4 illustrates the overall system layout and process flow.

Task 3.2 Field Implementation at a Selected DOE Site.

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

The delay in the award of the contract for the characterization system has postponed the execution of this task until FY99.

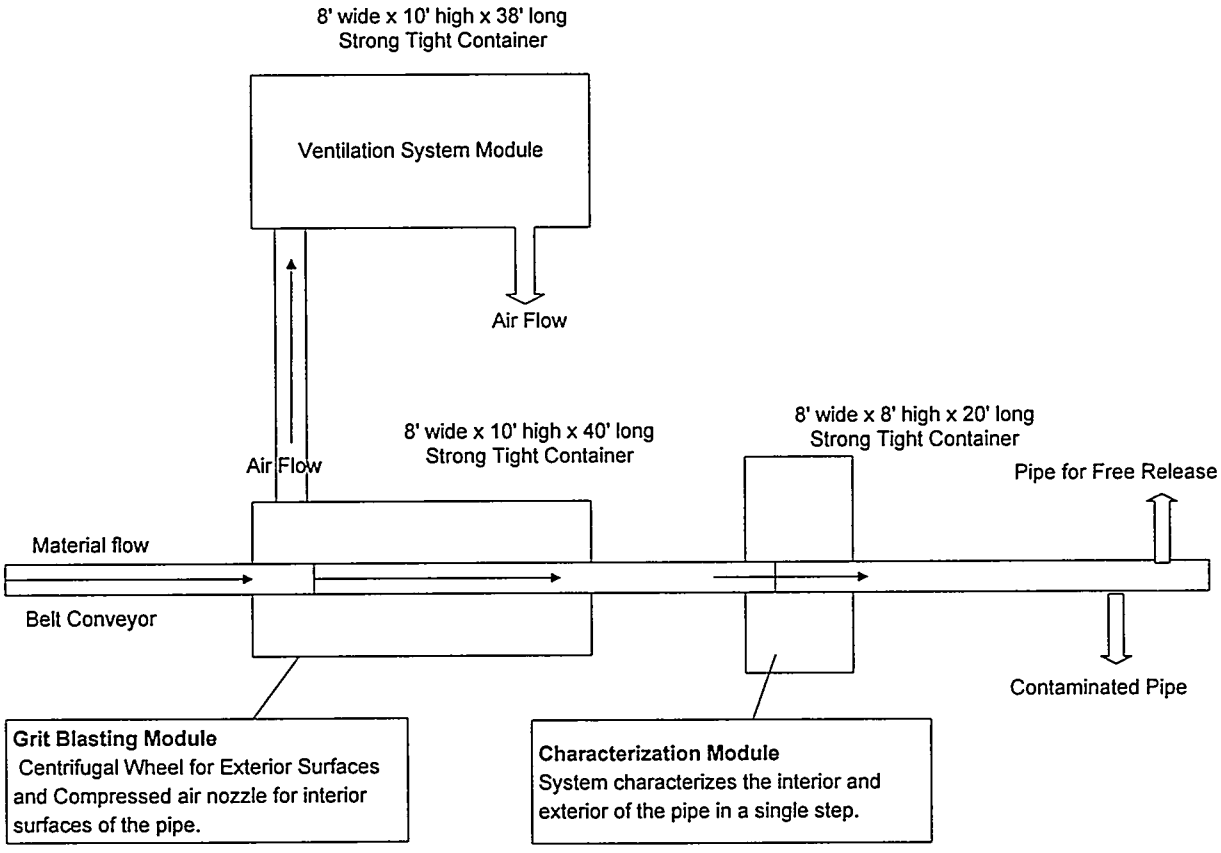

Figure 4. Product Flow Diagram.

4.0 ACTIVITIES PLANNED FOR FY99

The following tasks are scheduled for completion during FY99. The project tasks have been grouped into three categories: decontamination system, characterization system, and integration of the two systems.

4.1 PROJECT TASKS

Task 1.0 Decontamination System

Task 1.1 Title III Design

FIU-HCET will monitor the fabrication of the decontamination and ventilation modules and the installation of the equipment into the transportation containers. Periodic design reviews will be held to ensure the fabrication is on schedule and meets the performance specifications. Operation and maintenance procedures will be developed for each major component.

Task 1.2 Procurement of the Transportation Containers

Strong tight transportation containers will be procured, designed, and fabricated for the decontamination module and designed and fabricated for the ventilation module. The decontamination and ventilation equipment will be permanently housed in these containers. The containers will meet the requirements of 49 CFR for the transport of low-level radioactive waste. The containers will be equipped with penetrations and access ports and doors to facilitate operations and routine maintenance.

Task 1.3 Procurement of Transportation Trailers

A total of five transportation trailers will be required to move the Ex-Situ Large-Bore Pipe Characterization and Decontamination System to different project locations. Two double-drop trailers are required one each for the decontamination system and the ventilation system. Three standard height trailers are required one for the characterization system and three for the material handling system. These five transportation trailers will be procured, and the individual systems will be installed on each trailer.

Task 1.4 Field Evaluation

FIU-HCET will witness the cleaning of five tons of pipe ranging in diameter from 6 to 24 inches. Remediation service companies and Department of Energy representatives will be invited to solicit input and to gain an understanding of the capabilities of the system.

Task 1.5 Close-out

Upon successful field testing, the system will be transported to FIU-HCET, and five people will be trained on the procedure to operate and maintain the system.

Task 1.6 Exploration of Deployment Opportunities for Decontamination System

The field-ready decontamination system is scheduled for completion four months prior to the completion of the characterization module. This time period provides an opportunity to implement the decontamination system independently of the characterization system. Opportunities will be reviewed, and contracts will be placed for the implementation of the decontamination system.

Task 2.0 Characterization System

Task 2.1 Title I Design

Title I design will require producing initial design specifications and drawings, a software specification document, and obtaining the approval of long-term procurement items. FIU-HCET will review and approve the Title I design prior to implementing Title II design.

Task 2.2 Title II Design

FIU-HCET will review and approve the final design of the Characterization System and review estimated costs to complete the characterization system. FIU-HCET will review and approve the Title II design prior to implementing Title III design.

Task 2.3 Title III Design

FIU-HCET will monitor the fabrication of the system to ensure the specifications and design drawings are being followed. Fabrication also includes hardware integration and software coding. Periodic design reviews will be held to ensure the fabrication is on schedule and meets the performance specifications. An operation and maintenance procedure will be developed for the characterization system.

Task 2.4 Field Evaluation

FIU-HCET will witness the characterization of five tons of pipe ranging in diameter from 6 to 24 inches and different types of contaminants. Remediation service companies and Department of Energy representatives will be invited when the system is tested to solicit input and to gain an understanding of the capabilities of the system.

Task 2.5 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 characterization system.

Task 3.0 Integration and Field Implementation

Task 3.1 Integrate Decontamination and Characterization Systems

The decontamination and characterization systems will be integrated during all steps of their design and fabrication. Prior to field implementation at a DOE site, the systems will be tested to ensure all material handling, power, and system layout issues are resolved to ensure that the system operates as an integrated system. The system will be operated at the FIU-HCET test facility to complete this task.

Task 3.2 Field Implementation at a Selected DOE Site.

With the help of the D&D Focus Area manager, a DOE remediation project will be initiated on a minimum of ten tons of pipe to operate the system at a selected site. Remediation service companies and Department of Energy representatives will be invited when the system is tested to solicit input and to gain an understanding of the capabilities of the system.

5.0 CONCLUSIONS

Through the selection and initial design of the ex-situ large-bore pipe decontamination and characterization system, the project shows the promise of producing a cost-effective alternative to the direct disposal of piping systems. A cost-benefit analysis has been completed for the decontamination and characterization systems. Broad assumptions were made related to the characterization system because the design and operations costs are not known at this time. The cost-benefit analysis shows a significant savings in the operation of this system over the option of direct disposal. The schedule set forth for the design, procurement, and fabrication of the characterization and decontamination system has been delayed from the baseline schedule established in FY97. These delays were primarily due to an increased amount of design time required to ensure the project meets the overall project objective and the lack of fundamental technologies to select from during the technology selection and procurement process.

6.0 REFERENCES

U.S. Department of Energy, 1990, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, Office of Environment, Safety and Health, Washington, D.C.

U.S. Department of Energy, 1996, *Decontamination and Decommissioning Focus Area Results of the National Needs Assessment*, U.S. Department of Energy-Office of Environmental Management, Washington, D.C.

U.S. Department of Energy, 1996, *Decontamination and Decommissioning Focus Area Technology Summary*, DOE/RL-93-0, U.S. Department of Energy-Office of Environmental Management, Washington, D.C.

U.S. Nuclear Regulatory Commission, 1982, *Regulatory Guide, Termination of Operating Licenses for Nuclear Reactors*, Regulatory Guide 1.86, Washington, D.C.