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FINAL REPORT

DEACTIVATION AND DECOMMISSIONING (D&D) TECHNOLOGY INTEGRATION

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Prepared for:

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DISCLAIMER

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EXECUTIVE SUMMARY

Technology integration is one of the fundamental areas of technology innovation, which is itself an extremely important field for the Department of Energy (DOE) remediation. Due to the unique challenges presented by radiological contaminated sites, it is not only imperative that innovative technologies be used, but that the technology innovation process is streamlined to reduce deployment time. Florida International University's Hemispheric Center for Environmental Technology (FIU-HCET), in an effort to assist DOE in cleanup efforts, will specifically address the area of technology integration.

The project, which is detailed herein, has two principal components:

1. Design of a stand-alone technology integration module (TIM)
2. Implementation of the TIM using an appropriate concrete decontamination technology and a characterization technology.

The Technology Integration Model essentially outlines the process to be followed to integrate two technologies. FIU-HCET has also implemented the model partially to address a specific DOE technology need—integration of decontamination and characterization technologies.

The "in-process" characterization activities in decontamination currently require cessation of decontamination activities, while the amount of contamination removed and/or remaining is characterized by performing a separate radiological survey.

An integration of decontamination and characterization technologies would allow for continuous decontamination activities coupled with real-time assessments of contamination removed. The result would be a large gain in productivity accompanied by cost and time savings.

Another of the key objectives of this project is to utilize only commercially available technologies in order to allow for an expedient product development and commercialization. The final deliverables are comprehensive lists of decontamination and characterization technologies, corresponding subsets of compatible or integratable technologies, and a Commercialization Study to plan and implement construction of a prototype design and subsequent testing. In an effort to generate "field-usable" results, this project has made recommendations for various possible technology combinations and has concentrated on one concrete removal technology for integration, design, and testing. FIU-HCET has selected and is working closely with one of the vendors in order to achieve this. Preliminary testing of the sensor technology was performed at the FIU-HCET testing facilities during FY98, and subsequent testing and final design will be performed during future projects in FY99.

1.0 INTRODUCTION

As part of the ongoing task of making Deactivation and Decommissioning (D&D) operations more efficient, this subtask has addressed the need to integrate existing characterization technologies with decontamination technologies in order to provide real-time data on the progress of contamination removal. Specifically, technologies associated with concrete decontamination and/or removal have been examined with the goal of integrating existing technologies and commercializing the resulting hybrid.

The Department of Energy (DOE) has estimated that 23 million cubic meters of concrete will require disposition as 1200 buildings undergo the D&D process. All concrete removal to be performed will also necessitate extensive use of characterization techniques. The in-process characterization presents the most potential for improvement and cost-savings as compared to other types. Current methods for in-process characterization usually require cessation of work to allow for radiation surveys to assess the rate of decontamination. Combining together decontamination and characterization technologies would allow for in-process evaluation of decontamination efforts.

Since the present methods do not use in-process evaluations for the progress of decontamination, they may allow for "overremoval" of materials (removal of contaminated along with non-contaminated materials). Overremoval increases the volume of waste and therefore the costs associated with disposal. Integrating technologies would facilitate the removal of only contaminated concrete and reduce the total volume of radioactive waste, which would be disposed of. This would eventually ensure better productivity and time savings.

This project presents a general procedure to integrate the above-mentioned technologies in the form of the Technology Integration Module (TIM) along with combination lists of commercially available decontamination and characterization technologies. The scope of the project has also been expanded by FIU-HCET to evaluate a technology integration—shot blasting technology and an ultrasonic rangefinder, which are decontamination and sensor technology, respectively.

2.0 CONCLUSION

The Technology Integration Module (TIM), which is the first deliverable of this project, serves as a good guideline to engineers who are involved in the integration of technologies. The applicability of this procedure is not only for the environmental technologies, but the module works for the integration of any kind of technology. This module needs more implementation so that further evaluation could refine the procedure for technology integrations. The module will help DOE in developing effective and efficient integrated technology.

The combinations list for technology integration, which is the next important deliverable of this project, gives a good number of technology combinations. These combinations have been generated as a result of extensive research, taking into account the DOE requirements and criteria, and especially the present-day decontamination and characterization technology requirements. The different combinations listed prove to be efficient for specific applications. The implementation of any of these technology combinations is not difficult since the TIM has already been developed that guides one through the whole integration procedure. To justify this fact the technology combination of Shot-Blasting Concrete Removal Technology and the Ultrasonic Sensor Depth measurement characterization technology has been implemented, and preliminary tests have been performed to evaluate the procedure.

The commercialization study evaluates possible testing and commercialization options of technologies and their combinations. The preliminary phases of this study have been performed at FIU-HCET in the form of the evaluation of a technology integration. Also a study has been made on private industry commercialization techniques and presented as a Strategic Alliances report, which reflects a cooperative interest from industry, commercial nuclear utility, university, and national laboratory team members to bring collaborative experience and strength to DOE.

The cross-over technology study is a study that evaluated possible cross-over technologies to determine if other areas of environmental remediation can positively be impacted by technology integration. The resulting report indicates the success that Technology Integration can bring about in environmental remediations.

3.0 ENGINEERING STUDY APPROACH

3.1 STUDY OBJECTIVES

The basic objectives of this study were the following:

- Design of a stand-alone technology integration module (TIM)
- Implementation of the TIM using an appropriate concrete decontamination technology and a characterization technology—utilizing commercially available technologies, which allows an expedient product development and commercialization.

Though the project only called for a technology integration module and technology combination lists, HCET has expanded the scope to include the following tasks:

- Commercialization study to evaluate possible testing and commercialization options
- Cross-over Technology Study

The project has focussed entirely on the integration of technologies. The first steps include generation of the TIM, which can be used for the integration of various other types of technologies, and a thorough investigation of existing decontamination and characterization technologies. After the module was created and the appropriate technologies investigated, lists of compatible technologies have been generated. Specifically, the project has evaluated the integration of characterization technologies with a decontamination technology: concrete removal.

The final phases of the project generated lists of compatible technologies and a commercialization study, which includes design, testing, and deployment of the most promising technology combination. This final phase has been started under the current project and will be finished during subsequent projects.

One additional task performed as part of this project is the evaluation of possible "cross-over" technologies. The term cross-over refers to any remediation technologies that can conceivably be used for non-radiological applications (i.e., characterization of general hazardous waste, decontamination in non-nuclear environments). If additional technologies are found to be feasible, these too will be presented in a report format as a deliverable of this subtask.

The main benefits derived from combining decontamination and characterization technologies, work toward the most basic goals involved in remedial activities performed in radioactive environments, namely:

- Minimize the time required to be present in active or contaminated areas.
- Reduce the amount of non-contaminated waste disposed of with contaminated waste.
- Remove enough radioactive contamination from active areas to reclassify the structures as unrestricted use areas.

As part of the project, FIU-HCET has selected and worked extensively with technology vendors in order to achieve the project goals. The final stages of this project deal with commercialization of an integrated technology with vendor involvement. In this way, FIU-HCET will work toward the ongoing mission to transfer innovative technologies to the public and private sectors and Latin American and Caribbean countries. The final deliverables will also generate lists of potential technology combinations, which will be made available to all sectors of the D & D industry and government.

3.2 PROJECT EXECUTION

The project was carried over according to a task execution plan, which develops the project in increments of subtasks. The step-by-step details of the project subtasks and their development are explained below.

3.2.1 Technology Integration Module (TIM)

Essentially, this document lists an outline that contains the steps in a technology integration process. Following the outline, an explanation of each of the steps is given, so that an engineer or a person interested in integrating two technologies may go directly to the specific section explaining every step.

A thorough search was conducted for an already existing manual on performing technology integrations; however, what was found were only certain pieces of what can be considered the whole module. Several valuable resources were encountered pertaining to the management and innovation of technology; however, existing modules for performance of technology integrations were not found. In this module, the attempt is to put these pieces together with the purpose of having a document that will be of benefit to future projects. The focus of the projects that FIU-HCET currently manages has been primarily on integration of technologies that pertain to the field of D&D; however, the present module was created to apply to technologies from any area. An engineer in any discipline wanting to integrate two technologies may do so by following this document.

The detail of the TIM is presented in Appendix A.

A review of technology integration materials has been performed by FIU-HCET to characterize the success of efforts. Special attention was given to government-related technology integration procedures and DOE procedures with respect to the subject.

After reviewing existing technology integration materials, FIU-HCET utilized the information gleaned, in-house expertise and industry professionals to generate a general outline for the TIM. This outline was used to fully develop the specific module components.

The individual components of the TIM were then compiled into one module format. The module was then analyzed for logical flow and completeness. The module was subjected to in-house peer reviews and then finalized. The result is the final Technology Integration Module. The detailed module is presented in Appendix A. This marks the first milestone of the Technology Integration project.

3.2.2 Technology Integration

3.2.2.1 TIM Implementation Using a Concrete Removal Technology and a Characterization Technology

This task required design of the integration of a concrete removal technology and a characterization technology and was executed as a result of the design task, which comes later in the execution.

3.2.2.2 Decision Factors and Selection Criteria

The minimal criteria used for selection of decontamination and characterization technologies and their possible combinations are listed as follows:

Commercially available technologies or commercial technologies that would need only slight modifications to be integrated with decontamination technologies;

Technologies which when integrated represent a substantial cost and/or time savings to DOE

Decontamination technologies previously used by DOE for the removal of radioactive contamination

- The costs associated with combining technologies not to exceed the savings represented by commercializing the new technology
- Performance parameters (i.e., precision, accuracy, speed) sufficient to make the technology combination feasible.

3.2.2.3 Evaluation of Decontamination Technologies and Selection of a Concrete Removal Technology

The execution of this subtask generated:

- a general list of decontamination technologies viable for integration with characterization technologies and
- selection of one particular concrete removal technology for technology integration.

As a first step FIU-HCET evaluated and generated a list of FIU-HCET-tested decontamination technologies from various resources. Table 3.1 lists decontamination technologies demonstrated at FIU-HCET.

Table 3.1
Decontamination Technologies Demonstrated at FIU-HCET

Demo Date (Surrogate)	Vendor	Technology Name (Model)	Technology Class
Metal Assessments			
5/95 (Metal)	LTC Americas	LTC 1050 PN	Steel Grit Blasting
6/95 (Metal)	A.R.C.	Iceblast	Wet Ice Blasting
6/95 (Metal)	AEA O'Donnell, Inc.	Sponge Jet	Sponge Blasting
6/95 (Metal)	Bartlett	Plasblast	Plastic Media Blasting
6/95 (Metal)	Church & Dwight	Armex	Soda Blasting
6/95 (Metal)	IceSolv	TOMCO	CO_2 Blasting
6/95 (Metal)	IceSolv	10K Hydrolazer	High H_2O
6/95 (Metal)	IceSolv	ADMAC	Ultra High H_2O
6/96 (Metal)	LTC Americas	LTC Power Tool Center (Model PTC-6) LTC Needle Gun Tool	Scarification
6/96 (Metal)	LTC Americas	LTC Power Tool Center (Model PTC-6) LTC Right Angle Roto-Peen Scaler equipped with 3M Heavy-Duty type Roto-Peen Flaps.	Scarification
5/96 (Metal)	Pentek Inc.	Roto-Peen Scaler	Scarification
5/96 (Metal)	Pentek Inc.	Corner-Cutter	Scarification
7/97 (Metal)	Surface Technology Systems	Advanced Recyclable Media System (ARMS)	Sponge Blasting
7/97 (Metal)	EXITECH	Laser Ablation	Laser (Thermal)
3/97 (Metal)	Pegasus International, Inc.	Pegasus Coating Removal System Model PCRS-7	Coating Remover (Chemical)
3/97 (Metal)	Pegasus International, Inc.	NELCO Porta Shot Blast Model JHJ-2000	Steel Abrasive Blasting
Concrete Assessments			
96 (Concrete floor)	3M	CPM 4E	Scarification
96 (Concrete floor)	3M	CPU-10-18KE	Scarification
96 (Concrete floor)	Unique Systems	Peena Cleaner	Scarification
96 (Concrete floor)	LTC Americas	LTC 1073	Grit Blasting
96 (Concrete floor)	P.W. Stevens Environmental Co.	UHP Flow International	Ultra High Pressure H_2O
96 (Concrete floor)	Concrete Cleaning, Inc.	Centrifugal Shot Blasting	Steel Abrasive Blasting
96 (Concrete floor)	Pentek	Corner Cutter	Scabbling
96 (Concrete floor)	Pentek	Moose	Scabbling
96 (Concrete floor)	Pentek	Squirrel I	Scabbling
96 (Concrete floor)	Pentek	Squirrel III	Scabbling
97 (Concrete floor)	J&B Diversified Services	Wheel Abrator Blastrac Model 1-15 D	Steel Abrasive Blasting
97 (Concrete floor)	Custom Coating	Nelco Porta Shot Blast Model GPX-10-18 HO Rider	Steel Abrasive Blasting

Table 3.1
Decontamination Technologies Demonstrated at FIU-HCET (Continued)

Demo Date (Surrogate)	Vendor	Technology Name (Model)	Technology Class
97 (Concrete floor)	Textron Systems Corporation	Electro-Hydralic Scabbling System	Scarification
97 (Concrete floor)	Pegasus International, Inc.	Pegasus Coating Removal System Model PCRS-5	Coating Remover (Chemical)
97 (Concrete floor)	Pegasus International, Inc.	NELCO Porta Shot Blast Model EC-7-2	Steel Abrasive Blasting
Walls/Ceilings Assessments			
7/97 (wall/Ceiling)	Surface technology System	Advanced Recyclable Media System (ARMS)	Sponge Blasting
7/97 (Wall/Ceiling)	Pegasus International, Inc.	Pegasus Coating Removal System Model PCRS-5	Coating Remover (Chemical)
7/97 (Walls)	LTC Americas	LTC Power Tool Center (Model PTC-6) LTC Needle Gun Tool	Scarification
7/97 (Walls)	LTC Americas	LTC Power Tool Center (Model PTC-6) LTC Roto-Peen Scaler equipped with Start Cutting Wheels.	Scarification
7/97 (Walls)	LTC Americas	LTC Power Tool Center (Model PTC-6) Scaler Hammer	Scarification
8/97 (Walls)	Pegasus International, Inc.	NELCO Porta Shot Blast Model JHJ-2000	Steel Abrasive Blasting
6/97 (Walls)	Pentek, Inc.	Wall Walker ™	Scarification
Strippable Coating Assessments			
97	Bartlett Services, Inc.	Stripcoat TLC	Strippable Coating
97	Bartlett Services, Inc.	Stripcoat TLC Free	Strippable Coating
97	Frham Safety Products, Inc.	JDL #GP-RDM	Strippable Coating
97	Pentek, Inc.	Pentek 604	Strippable Coating
	Pentek, Inc.	Pentek 603 & Pentek 603 Pretreatment	Strippable Coating
97	Technical Solutions & Systems, Inc.	Tech Sol 8001 with Reinforced Mesh	Strippable Coating
97	Technical Solutions & Systems, Inc.	Tech Sol 8002	Strippable Coating
97	Technical Solutions & Systems, Inc.	Tech Sol 8830	Strippable Coating
97	Williams Power Corp.	Alara 1146	Strippable Coating

Table 3.1
Decontamination Technologies Demonstrated at FIU-HCET (Continued)

Metal/Masonry Assessments			
Demo Date (Surrogate)	**Vendor**	**Technology Name (Model)**	**Technology Class**
12/97 (concrete floor)	Pegasus International	EBE 350 Floor Shot Blaster	Steel Abrasive Blasting
2/98 (concrete floor)	Oceaneering	ROVCO2	CO2 Blasting
4/98 (concrete floor)	Pegasus International	Marcrist DTF 25	Diamond Floor Shaver
5/98 (concrete floor)	Pentek, Inc.	Squirrel III	Scabbling
6/98 (walls, concrete floor)	Surface Technology Services	ARMS™	Sponge Blasting
8/98 (walls)	Pentek, Inc.	3-D Wall Walker™	Scabbling

Secondly, FIU-HCET has also made a list of non-FIU-HCET tested decontamination technologies. This list had been integrated with the FIU-HCET-tested decontamination technologies list and is given below.

Table 3.2
Comprehensive List of Decontamination Technologies

Chemical Decontamination Technologies:
Multi-phase treatment: Alkaline Permanganate
Foam decontamination
Chemical gels
PCRS-7 by Pegasus
Fluobric Treatment
Chelation treatment
Chemical foams
Inorganic acid treatments
Detergents cleaning
REDOX treatments
Biological
Catalytic extraction process
Electromigration

Table 3.2
Comprehensive List of Decontamination Technologies (Continued)

Mechanical Decontamination Technologies:
Water flushing
Ultra-high pressure water
Super-heated water
Steam cleaning
Wet abrasive cleaning
Solvent washing to remove radiological
Solvent washing to remove organics
Vacuum, low pressure
Automated brushing
Hand grinding, honing, scraping, brushing
Explosive
Dusting/Vacuuming/Wiping/Scrubbing
Fixative/Stabilizer coatings
Turbulator
Metal-based paint removal
Strippable coatings
Grinding
Scarifiers
Milling
Drill and spall
Paving breaker and chipping hammer
Expansive grout
Asbestos removal
Blasting Decontamination Methods:
Sponge blasting
Centrifuge Cryogenic CO_2 pellet blasting
Super critical CO_2 blasting
Wet Ice blasting
Hydroblasting
Shot blasting – centrifugal
Grit blasting – steel grit
Plastic blasting
Sodium bicarbonate blasting

Table 3.2
Comprehensive List of Decontamination Technologies (Continued)

Scabbling Technologies:
Moose
Squirrel I
Squirrel II
Corner Cutter
Elect. Hydraulic Scabbling (EHS)
Thermal Decontamination Technologies:
Microwave scabbling
Plasma torch
Laser heating
Light ablation/Laser Etching and Ablation
Flashlamp cleaning
Other Technologies:
Electropolishing
Ultrasonic cleaning
Vibratory cleaning
Emerging Technologies:
Flaming
Flame scarifying
Electrical resistance
Microbial degradation
Flashlamp
Electro-hydraulic scabbling
$ROVCO_2$ pellet system
Liquid Nitrogen with solid particulates

Using the selection criteria one suitable technology was selected from the above comprehensive list of decontamination technologies, for integration—the shot blasting concrete removal technology. The related equipment is the Centrifugal shot blast unit for floor decontamination.

Justification for the selection of the shot blasting technology: To comply with the requirements delineated at the onset of the project, a floor decontamination technology was selected. The reasoning was first simplicity in its approach as compared with the wall decontamination units. Floor decontamination systems are able to produce higher production rates than the vertical technologies.

Also, mechanical abrasion was chosen as the removal method due to its efficiency in containing waste materials and its ability to remove substantial amounts of concrete (typically up to ¼") as opposed to only removing coatings or top layers. Other types of decontamination units were eliminated from the selection process due to their method of removal. Laser removal methods were not chosen due to their limitation of only removing superficial layers and with questionable success.

Other types of technologies were also eliminated from the selection process due to their uncontrolled generation of air-borne contaminants. For example, ice and water blasting was not chosen since they both generate large amounts of air-borne particulate or water vapor contaminants. Any such technology will have a limited application at DOE facilities and is therefore not applicable for this project, which has a primary goal of commercializing new technologies.

Conclusion: Centrifugal shot-blast technology was selected for its high production rates, portability, contaminant containment, and integration potential. The units are small enough to be portable and big enough to allow incorporation of new components. The resulting technology integration will produce a very useable technology with real-time assessments of radiation.

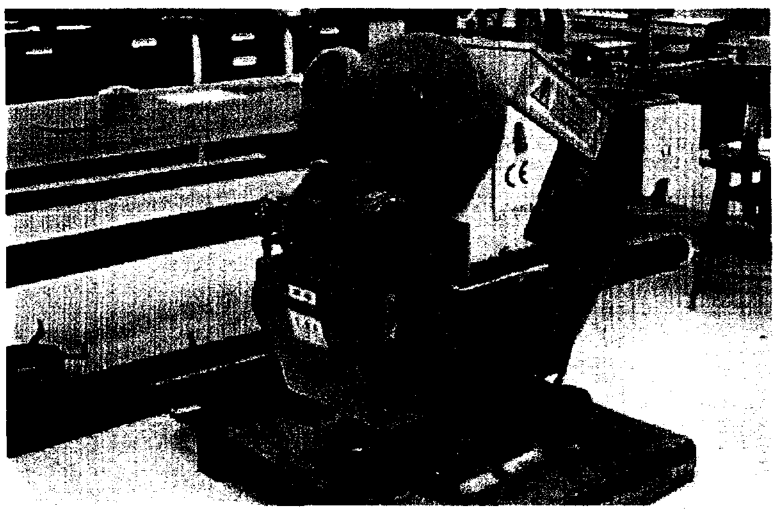

Figure 1. Centrifugal Shot Blasting Unit.

3.2.2.4 Evaluation of Commercially-available Characterization Technologies

The initial subtask here was to delineate the target categories for characterization technologies. Internal FIU-HCET resources as well as external resources were used to gather information on characterization technologies in the target categories obtained as a result of the previous subtask.

The resulting list of target categories and related information is as follows:

- **Depth measurement**. Instruments such as laser designators to measure the amount of material removed during decontamination processes. The objectives are to locate technologies, which are portable enough to be integrated with a decontamination technology and have a resolution of at least 1/8".
- **Radiation detection**. Radiation detectors for alpha, beta, and gamma should be evaluated with the end goal of integrating them with a decontamination technology. These detectors can be used in a dynamic fashion (moving over surfaces and scanning) or in a static manner. They should be commercially available and relatively sturdy to withstand field applications.

- **Geographic Positioning Systems (GPS)**. At a minimum, these systems should be capable of computing their position relative to a fixed point within close distance and should be portable enough for integration. They may also include satellite linkages and/or RF modem transmitters.
- **Airborne particulate**. These sensors shall be portable enough to integrate with a decontamination technology and will be used to measure the amount of airborne particulate. This will enable comparisons of particulate generated from different operations.
- **Velocity meters**. These meters shall be portable enough for integration with a decontamination technology and will output the operational velocity of the decontamination unit.
- **Substrate assessors**. Portable units will be investigated with the purpose of assessing exactly what type of substrate the decontamination unit is dealing with (i.e., concrete, wood, etc.).
- **Data loggers**. For incorporation with electronic and radiation detection equipment. This technology already has ample vendors and well-developed technologies.
- **Data transmission devices**. For transmission of data in radioactive environments. Examples are RF modems, ultrasonic pulse systems, cellular modems, hard-line modems, etc.
- **Data acquisition**. For real-time acquisition of data produced during field operations. Typical applications involve laboratory settings where several transducer devices must be monitored and data stored.

Some resources used for this purpose were literature resources, previous studies, vendor information, industry professionals (DOE and private) and FIU-HCET in-house expertise. Special attention was given to DOE and industry input in an effort to yield efficient and user-friendly technologies that address existing needs. Internal cross-referencing of previous projects and studies was performed, and other technology databases were utilized (i.e., other technology transfer centers) whenever possible.

3.2.2.5 Technical Review of the Generated List of Characterization Technologies

This task involved a technical review of the characterization technologies presented in the list generated in the previous task, as preparation for integration design. Some of the aspects considered are ease of integration, performance parameters, hardware configuration, calibration requirements, and integration cost. The personnel involved in this task were required to contact a few vendors regarding the subject.

At this stage all the material required for the Decontamination and Characterization technology integration was available and the milestone of integrating them required only the design of such a system, which was achieved later in the project.

3.2.2.6 Generation of Potential Technology Combination Lists

After the characterization and decontamination technology combinations were selected and evaluated, a set of comprehensive lists was generated that detail the recommended technology combinations.

The following lists were required to be compiled:

1. Decontamination technologies suitable for technology integration
2. Characterization technologies suitable for technology integration
3. Viable decontamination/characterization technology combinations
4. Viable technology integrations with the chosen concrete removal technology

To reduce the redundancy and repetition, the above lists have been combined as follows:

- Lists 1 and 2 have been combined as a comprehensive list of Decontamination and Characterization technologies. Certain vendor details have been provided.
- A list composed of possible combinations of specifically Radiation detection technologies and Decontamination technologies
- Lists 3 and 4 list viable technology combinations of Decontamination technologies and Characterization technologies in general. In other words, list 4 is a part of list 3.

These lists are the next important deliverables of this project after the TIM. The above-mentioned detailed lists are presented in Appendix B.

3.2.2.7 Integration Design

The technologies selected for integration and implementation are the shot blasting technology, which is a Decontamination technology, and the Ultrasonic range-finder/sensor, which belongs to the Depth Measurement category of the Characterization technologies.

A general conceptual integration design was visualized with general performance parameters for this selection. The shot blasting unit and the appropriate ultrasonic sensor have been procured for preliminary testing and evaluation. The preliminary conceptual design is depicted in the CAD drawing provided in Appendix C and shows the outline and plausibility of the integration. The integration design has not been finalized, due to the requirement of carrying out more tests on the technologies, which evaluate the real-time performance required in the combination.

This task also achieves the pending milestone of the implementation of the Technology Integration Module using the shot-blasting technology for concrete removal and ultrasonic sensor technology for characterization. The evaluation and performance details of the ultrasonic sensor technology as required for the integration are presented in Appendix C in the form of a feasibility report.

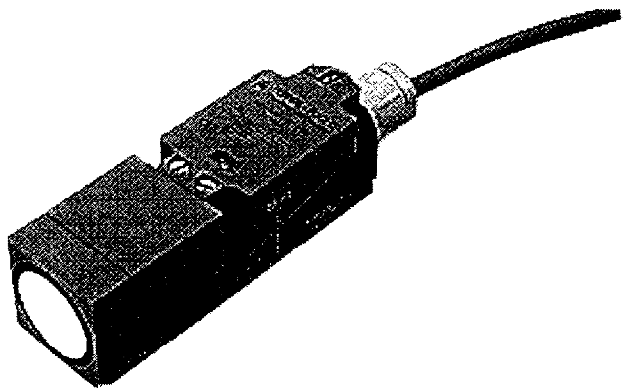

Figure 2. Ultrasonic Sensor or Ultrasonic Rangefinder.

3.2.3 Commercialization Study

Once the final integration design for the concrete removal technology was achieved, a Commercialization Study was performed to evaluate possible testing and commercialization options. Testing options may include one or more rounds of preliminary testing at the FIU-HCET testing facilities, followed by testing at a DOE facility. Commercialization involves extensive work with the vendors involved and DOE in order to yield commercially viable units. The initial stages of the commercialization process have been performed. The required tests for the configuration selected for implementation and testing – shot blasting and ultrasonic sensor integration—have been determined and preliminary tests undertaken. The test observations on the implemented integrated technologies are briefed in Appendix D. The remaining phases will be performed under following projects.

As a part of the commercialization study, the industry commercialization techniques were also studied and the results are summarized as Strategic Alliances in Appendix E. The Strategic Alliance approach to technology qualification and deployment provides DOE, through the Cooperative Agreement, with a new way of bringing industry principals to technology research and development activities. These principals will be directed to test those solutions against the major technological problems prevalent within the DOE complex. The Strategic Alliance created by DOE EM reflects a cooperative interest from industry, commercial nuclear utility, university and national laboratory team members to bring collaborative experience and strength to DOE.

A study on Technology Transfer has also been made; most of this work was an exhaustive search for technology transfer centers, mainly the research alliances between industry, government departments and universities or other educational/research institutions. Results are presented in the References section, and the material generated has been compiled by FIU-HCET as a binder.

3.2.4 Cross-Over Technology Study

As part of FIU-HCET's commitment to encourage or create innovative technology, possible cross-over technologies were evaluated to determine if other areas of environmental remediation can be positively impacted by technology integration. A good number of remediation technologies with characterization technologies were cross-referenced to find possible combinations, and the results are presented as follows:

3.2.4.1 Environmental Technologies with Radiation Characterization Technology

- Downhole samples and analyzers
- Data transmission devices
- Data logging devices
- Geographic positioning systems
- Inflatable containment berm for high-pressure water cleaning operations: waste containment
- Remotely operated tank scanner: integrates with ultrasonic tank inspectors; Visual Inspection Technologies, N.J.
- Remote Sensing Liquid Level detection in tanks: HMT-2000 is a multi-tank level measuring device; measures up to 2,500 feet away; has alarms, temperature shift adjust, intrinsically safe, eight channels, and programmable.
- Geoprobe: direct push technology; ideal for sands or non-hard compacted soils.

3.2.4.2 Applications of the Combinations of Environmental Technologies with Radiation Characterization Technology

The following applications have been found:

- Drop downhole rad sensors, with long wire connections, connect to data-logger/transmitter
- Solar/Remote Monitoring Stations
- Radioactives/Metal extraction in GW
- Cone Penetrometer Applications: SRS
- Robotic Applications: Red zone
- Underwater Applications
- Waterproof sensors
- NRC UWP-100 AND UWP-030: remote sensing of gamma fields
- Computerized Monitoring Systems
- NRC RADACS System: comprehensive software program for real-time monitoring of radiological data; can be attached to remote sensors with RF modems and/or phone lines.

4.0 REFERENCES

United States Department of Energy (DOE) and the Environmental Protection Agency, 1994, *Decommissioning Benchmarking Study, Final Report*; January 15, 1997; pages III-23f and IV-3, U.S. Department of Energy and the Environmental Protection Agency.

Ebadian, M.A., Lagos, L.E., August 1997, *Analysis of Potential Surface Blasting Decontamination Technologies for Structural Steel, Final Report,* Hemispheric Center for Environmental Technology (HCET), Florida International University, Miami, FL.

Ebadian, M.A., Lagos, L.E., November 1997, *Evaluation of Coating Removal anf Aggressive Surface Removal Technologies Applied to Concrete Walls, Brick Walls, and Concrete Ceilings, Final Report,* Hemispheric Center for Environmental Technology (HCET), Florida International University, Miami, FL.

Ebadian, M.A., Lagos, L.E., November 1997, *Analysis of Potential Concrete Floor Decontamination Technologies, Final Report,* Hemispheric Center for Environmental Technology (HCET), Florida International University, Miami, FL.

TECHNOLOGY TRANSFER REFERENCES

This is an exhaustive list of web sites related to Technology Transfer with an abundance of good information on the related topics. Since all cannot be listed, here's a short list of topic categories and a description of what each is about.

Corporate Technology Transfer Links

This is a list of sites detailing the Technology Transfer concepts and activities of many corporations.

International Technology Transfer Links

This is a list of web sites relating to International Organizations that are actively involved in Technology Transfer. The information from these sites gives a clear understanding of the concept of Technology Transfer and much about technology activities.

Government Technology Transfer Links

This is a list of web sites for government technology centers that are actively participating in Technology Transfer programs. Most of these are links to technology centers of the Department of Defense—Air Force/Navy, Department of Energy, NASA, etc. The information from these links concentrates mainly on the principles/concepts of Technology Transfer and also the technology transfer activities in which the technology centers are involved with other organizations.

University Technology Transfer Links

This is a long list of University Technology Centers from all over the United States that details their technology activities.

APPENDIX A

TECHNOLOGY INTEGRATION MODULE

TECHNOLOGY INTEGRATION MODULE

ABSTRACT

There are currently two on-going projects at FIU-HCET, which require a general procedure or methodology for integration of existing technologies. These projects are not unique in that most projects follow certain steps to achieve the desired end goal. In many cases, projects do not record the steps taken or the procedures followed to arrive at their desired end. The technology integration module here presented will attempt to capture the steps that are followed in the processes of technology integration, which are being carried out at FIU-HCET. Since the integration of technologies is a process performed on a regular basis, but seldom documented thoroughly, this module was created to provide a structured format to follow while carrying out design work. The format of the module is general enough, so that it may be used on other integration projects, but also contains specific examples taken from current FIU-HCET projects. The idea of making an integration module is justifiable since making out such plan of action can save much time in future projects

Prior to creating the enclosed TIM, a thorough search was conducted for an already existing manual on performing technology integrations; however, what was found were only certain pieces of what can be considered the whole module. Several valuable resources were encountered pertaining to the management and innovation of technology; however, existing modules for performance of technology integrations were not found. In this module, the attempt is to put these pieces together with the purpose of having a document that will be of benefit to future projects. The focus of the projects FIU-HCET currently manages has been primarily on integration of technologies that pertain to the field of D&D. The present module was created to apply to technologies from any area. Any engineer who wants to integrate two technologies may do so by following the following document.

The general assumption of this module is that there is an existing technology performing a certain task in the field. This technology lacks many factors that are desirable for the type of application. These may include speed, accuracy, or feedback on the activity that is being performed. In such instances, the integration of the existing technology with another technology may produce a product covers many of the things that the base technology alone may not.

The following document outlines the essential steps in the technology integration process. Following the outline, an explanation of each of the steps is given, so that an engineer or a person interested in integrating two technologies may go directly to the specific section explaining every step. It is recommended that each step be followed, since there is interdependence within the steps. At the end of the document, an appendix presents information cited within the text.

1.0 NEEDS ASSESSMENT

At the start of every project, several steps must be taken to ensure that the project at hand is headed in the right direction. These steps are essential but are sometimes overlooked, costing the engineer and the client large amounts of money and time. It is important for every project to have a clear understanding of the problem to be solved. It is also essential to know the specific requirements of the end user and to understand those requirements so that no money or time is wasted for misunderstandings or lack of vision on both parts. In some projects that involve both a client and an end user, many times the products developed for the end user are unusable. For this reason, this document suggests a close relationship with the end user, so as to obtain a product that is both usable and deployable.

For the purpose of understanding the problem and the needs of the user, the engineer or person in charge must create a needs document in which he or she may have a record of all requirements of the project. This record should be carefully revised and researched so that there are precise objectives for the project. The needs document could be consulted on a periodic basis to make sure that the project is on track. The needs document may be divided into subsections. The following categories for the needs document are suggested:

- Client Involvement
- End User Involvement
- Translation of Information into Design Criteria.

The Client Involvement section of the needs document requires that the engineer understands who the client is, who is responsible for making decisions both about the project and finances, what the client requires for the product and the time span that is planned, and project technical information.

The End User involvement section requires that the engineer makes contact with the end users and records them in a journal. The interface makes sure the engineer keeps the product to be delivered both deployable and usable. The interaction with the end user makes sure that the engineer is not building something that may not be of use to the end users.

The final step in the needs document should be to convert the specifications of the project into design criteria, including the costs for labor and material and a general list of criteria needed to build the design.

2.0 BASE TECHNOLOGY SELECTION

The second step in technology integration of technology is the selection of the base technology, the platform for all subsequent integration designs. The selection should be based on economic and technical criteria. Both cases are crucial since, maybe for example, the base technology may be performing adequately, but its operating costs may be too high. Another example would be if the base technology is cost-efficient but lacks a certain feature that may only be done with the aid of another separate technology.

2.1 General Investigation of Base Technology

A general investigation of the base technology should be done to ensure that the design criteria formulated in the needs document are kept in mind and also to ensure that the base technology is within the focus of the design. In general, the investigation of the base technology should be comprised of the following:

Economic Analysis

The examination of the economic aspects of the base technology should be performed to determine if pursuing a technology integration would be a viable option (i.e., the new technology may work well, but the savings from it would be less than its production costs).

Technical Analysis

In this part of the investigation, the engineer should analyze if the design requirements for the project may be met by the base technology. The design analysis may serve to determine if the base technology would be capable of meeting the requirements needed to perform part of the job required from the needs document.

2.2 Detailed Base Technology Analyses

Detailed analysis should be done for the economical as well as the technical aspects. This is a continuation of the previous step, the general investigation of the base technology. The previous step has presumably eliminated some baseline technology choices, which are out of scope. In this part, only those technologies that are possible candidates may be submitted for the rigorous analysis. For the economical analysis, the following is recommended:

- Benefit-Cost Ratio Analysis
- Return on Investment Analysis
- Break-even Analysis

Benefit-Cost Ratio Analysis

The benefit-cost ratio analysis requires that all the various consequences of a proposed project be classified and placed into either the numerator or the denominator of the ratio.

Rate of Return Analysis

This analysis will allow the user to compute the rate of return as a percentage of the invested quantity.

Breakeven Analysis

The breakeven analysis may help the user in determining the time required for return on investment. This will help the user to determine if it is worth it to carry out the integration.

It is clear that without an economical analysis, the technology's future is uncertain. An economic analysis that projects the costs of the technology into the future or the future costs into the present would allow a clear comparison of its economic viability. In many cases, the selection of the base technology should be done not only with the purpose of cost savings but also with the idea of generating a new profit center through the commercialization of the resulting new integrated technology.

When selecting the baseline technology, the following materials may be consulted:

Vendor Catalogs and Databases

Vendor catalogs and databases are a very important source for finding technologies.

Internet

The Internet serves as a great tool for information on companies and new products. Recently, most companies have started publishing on the web their products and services. Searching capabilities are available through the major search engines on the World Wide Web.

Industry Surveys

Industry surveys are polls conducted with actual workers in the field. These may be the most valuable source, since these workers usually have experience working with these machines and may be able to suggest improvements.

Current Periodicals

Current periodicals may be a useful source for recent information on the newly developed technologies and how these technologies are doing in the market. Such guides may give clues as to whether it is feasible to implement the technology in the market.

Books

The following book Engineering Economic Analysis by Donald G. Newnam and Bruce Johnson may be used as an economics reference. Any and all references used in the project should be noted and presented in project reports.

For the technical aspects, an in-depth analysis of the base technology may help to rule out the equipment that is not generally suitable to serve as the base technology. The following analyses are recommended:

Electrical Analysis

This analysis should be done to determine if the base technology is electrically compatible for the application or if it can be easily adapted to the environment to which it would be subjected.

Mechanical Analysis

This analysis should be done to make sure that the mechanical aspects of the machine are compatible with the specific requirements.

General Technical Analyses

These analyses should include the specific focuses of the project. For example, if the size of the machine is to be within a certain range, then this step should help determine if the base technology is suitable. Other items to consider could be weight, portability, fragility, or any other applicable condition of the base technology.

The user should generate a short list. In this short list, the user should list the possible alternatives for the base technology in order of preference, if possible. This short list will aid in the selection of primary and secondary technologies. The purpose of having a primary and a secondary technology is to have a main alternative and other choices to fall back on.

2.3 Generation of a Performance Parameter Database and Study of the Feasibility of Integration of the Base Technology

It is necessary to have the performance parameters of the base technology available, so that it is easy to access and refer to them as necessary during the process. The performance parameters of the technologies should be listed in a way that facilitates comparison. This calls for the use of a database. The fields of the database should contain the most important aspects for the integration. Many database programs are available that allow the easy access and printing of information in the form of reports. These programs may be helpful if there are many candidates for integration and a decision needs to be made. Examples of this type of program are MS ACCESS or DBASE.

After the database is generated, the user may want to brainstorm using the information that has been collected. Brainstorming is an effective technique for spelling out the most suitable decision if used correctly. As an example of a step-by-step procedure on brainstorming, the user may refer to a decision matrix, which is a series of systematic steps that allows the parameters to be compared in an organized way.[1]

2.4 Primary and Secondary Base Technology Selection

Once the analyses have been done, the user will be able to select two choices for the base technology, a primary and secondary candidate. These candidates for integration must be chosen with the help of experienced design engineers.

1 A decision matrix is a tool that serves to make complex decisions using an organized and methodical way. A decision matrix can also be described as a graphical representation of a decision process in which the elements of decision are combined in a table-like manner. This graphical representation provides a better tool for making decisions.

3.0 DELINEATION OF INTEGRATION TECHNOLOGIES

The next step in the process is to identify those technologies that are suitable for integration with the base technology. At this point there should be a clear understanding of all of the baseline technology deficiencies and/or requirements that must be addressed by the integration process. With this in mind, a search can be performed for technologies that will address the identified baseline technology deficiencies and /or requirements.

For example, a current FIU-HCET project involves both radiation detection and decontamination activities. At present, these two processes are done separately. A feasible solution would be to integrate radiation sensors with a decontamination technology to produce one machine that is capable of decontaminating and measuring its level of success at the same time.

3.1 Delineate and Investigate Specific Technology Categories

In analyzing technologies for a possible integration fit, one must look at the aspects that the base technology lacks in order to locate and design system improvements. To perform such analyses, the categories must first be delineated. Once they are delineated, then each category should be thoroughly investigated, and a "short list" should be created. This short list should contain the technologies, that have the highest potential for a successful integration. The following resources as a minimum are recommended to the reader for the integration of technologies.

Obtain information from in-house expertise

This is a very important step, especially if there are knowledgeable people in the workplace that may give some advice and/or specific details about the feasibility of any technology with the new apparatus. The in-house expertise may include engineers, economists, and scientists or project managers.

Feedback from field workers

The field workers can respond to questions at a less technical level; however, they usually have seen many machines in operation and may be able to tell if these new technologies may do the job. The field workers may also give suggestions that could be essential in determining which technologies are suitable for integration.

The Internet

May also serve as a great tool for information on the selection of new technologies. There are many web pages on the Internet, many of which are company sites that have information about their products. There are also many companies that review technologies. The Department of Energy has specific sections, which relate to current projects that are being carried out under their supervision. The user may CONSULT their site for information about projects.

Vendor literature

There is a short list provided with this module that may help in getting to other companies related to DOE and in contacting some of the vendors that are listed in the appendix. Another possibility is to consult the vendor database created to conduct one of the projects for FIU-HCET.

4.0 REVIEW PERFORMANCE PARAMETERS OF INTEGRATION TECHNOLOGIES

In this part the user should review the performance parameters of those technologies identified in the Delineation of Integration Technologies (step 3). The user should obtain at least two technologies that are possible candidates for integration at a minimum. A prime candidate and a secondary candidate should be chosen. After selection, most of the energy should be focused on the prime candidate. The secondary candidate is aimed to serve as a backup, should there be a major difficulty along the process.

The requirements identified in the needs evaluation document should be used to focus on technologies, which could possibly be the solution. With this information, the user will be comparing aspects of those technologies, which are required to solve the technology integration problem. This means that the user will not be looking at other parts of the integration technologies, which are not an essential part of the final model. For example, in integrating a radiation sensor with a decontamination technology, some of the qualities of the radiation sensor, such as portability and/or calibration, may be of vital importance to the new machine. Some factors such as operating voltage may be less important since an inexpensive voltage adapter may be easily incorporated. The key to this is to focus only on the elements that are necessary to the successful operation of the machine. The reason for doing this is that adding many other elements may complicate further the decision-making process.

4.1 Generation of Performance Parameter Database

In this step of the technology integration process, a performance parameter database of integration technologies will be generated. The performance parameter database will be used in the next step (Final Selection of Integration Technologies) as a comparative tool. This database will aid the user by providing an organized and straightforward approach to the selection of the integration technologies. At this stage the user should be dealing with all of the integration technologies that are possible candidates. This new database should be generated with the aid of the short list written in step 3.1 (Delineation of Specific Technology Categories). The database should have all of the performance parameters, but mainly those that are of major importance to the integration. It should also have the same format as the previously generated database for the selection of the base technology.

5.0 FINAL SELECTION OF INTEGRATION TECHNOLOGIES

The final selection of integration technologies should be a carefully managed process that includes the input of not only the person in charge of the project, but also of the in-house expertise and, if possible, of persons working in the field. The selection of the final technologies for integration should be based on the previous analyses. It is important that the results of the previous steps give an accurate picture of the candidate technologies. The picture should be considered from the technical as well as the financial point of view. The technical point of view implies the technical aspects of the technology that need to be assessed in order to determine if the technologies are compatible and if the technologies can work in harmony. For example, a radiation sensor that is too fragile should be looked at closely to see if it will work in an environment where it is subject to high and sudden impact. Other factors such as if the technologies can be easily attached should also be seen, for it is crucial to determine how easily these machines may assemble when a cost of production analysis is done in future steps. The financial point of view implies the cost of the integration technology. As a general rule, an integration technology that costs more than one-fourth of the estimated project cost should not be used.

5.1 Generate Two or More Conceptual Integration Designs

In the process of the selection of the integration technologies, the user should generate two-to-four conceptual integration designs. Choosing two-to-four candidates gives the project an added security. Along the technology integration process, some of the technologies may fail to meet a specific requirement. If the user provides no other options, the technology integration process would have to be delayed, and a new integration technology would have to be selected and evaluated. This would provide added costs to the project and is to be avoided.

5.2 Use Brainstorming Techniques to Aid in the Selection of the Technologies

Once there is more than one conceptual integration design, the designs must be compared, and the most promising alternatives should be selected.

To generate the conceptual design, a number of techniques may be employed. One of the most productive is brainstorming. There are many forms of brainstorming. One of these forms is the traditional laying of ideas on a piece of paper with graphical images of thoughts circled around a main core which is ultimately the final goal to be reached. This method allows the user to expose all of the possible alternatives around the main focus. The user then must select among the presented ideas to see which one takes on a better solution to the problem.

Another way to brainstorm was presented by Dr. Milhany Lenart for some of the projects currently taking place at FIU-HCET. The method, which Lenart explains applied to the integration of two technologies, involves the generation of multiple choices for integration and filtering of each of these choices through a series of selection barriers. In this process the user should be able to backtrack and use any other alternative previously discarded if the chosen one turns out to be farther from the wanted solution. This module provides an appendix in which the reference is listed for the evaluation of the user. One final recommended technique is the use of the decision matrix to decide which technologies should be selected,

5.3 Generate a Comparison Report

After the use of the suggested brainstorming techniques, the user should generate a comparison report, which lists the steps followed leading to the selection of the two technologies and the selection parameters of the technologies, which may include specs and technical data. The report should be kept as a record, which may be used at a later point to analyze why the technologies were chosen and also to aid in possible technology integration projects.

In general, the comparison report may be done in the form of a document/database. It should have the following elements, which may be adjusted depending on the specific project.

- List the integration technologies to be analyzed.
- Make a list of the parameters to be compared.
- Use the methods described, namely, the brainstorming techniques, to obtain an objective comparison/evaluation of performance parameters and characteristics.
- Generate conceptual integration designs.
- Generate a final report.

6.0 DETAILED INTEGRATION FEASIBILITY STUDY

At this stage the project manager should be dealing with a baseline technology and the conceptual designs generated in the previous step. In order to proceed further, an integration feasibility study is to technically evaluate the feasibility of integrating the technologies chosen. The feasibility study may address the following areas of design:

- **Mechanical Design Considerations**. This study should refer to the ease and difficulty of physically integrating the technologies.
- **Electrical Design Considerations**. This study should focus on the electrical part of the technology integration. This would include any adjustments of circuitry necessary to make the technologies work under their voltage/power specifications.
- **Commercial Availability of the Design Components**. In this study, the user should consult catalogs and call distributing companies to check if the parts needed for the integration are readily available.
- **System Engineering**. Analyses to address systems engineering issues and inter-component communications and connections.
- **Economic Analyses**.T he economic analyses may be further subdivided into:
    1. **General Integration Cost**. In the general integration cost, the user should make sure that integration costs do not exceed the combined price of the system and components. This should be taken as a rule of thumb.
    2. **Return on Investment Analysis, Cost-Benefit Analysis, and Breakeven Analysis**. These should be followed, as previously done on the detailed base technology analyses.
- **New Performance Parameters**. In this study, the user should evaluate the performance parameters of the new hybrid technology. If this can't be evaluated theoretically, then empirical tests will need to be specified and run. This may involve delineation of new project tasks and tests.

7.0 FIRST ITERATION INTEGRATION DESIGN

This stage of the process involves performance of any necessary engineering design tasks technical investigations, and generation of technical drawings. The first round iteration design may be subdivided into the following engineering tasks, which may change accordingly with the areas.

1. Stress Analyses
2. Bearing Design
3. Static and Dynamic Analyses
4. Vibration Analyses
5. Heat Transfer Analyses
6. Electrical Analyses, i.e., power
7. Sizing/Dimensioning/Tolerance Analyses

Drawing Generation

After all necessary analyses have been performed, the next step will be to generate design and assembly drawings for a prototype unit. The drawings would ideally be computer-generated using one of the major CADD/CAE programs, such as AutoCAD, Microstation, or ProEngineer. Use of SmartCAM may be done to evaluate the design for manufacturability, and Boothroyd and Dewhurst methods for DFMA may also be considered. Stress analysis reports should be documented with user-developed programs or analysis outputs of ABAQUS/ANSYS.

The technical drawings should be stored electronically allowing easy modification and the possibility of saving different drafts. Copies of the technical drawings should be conserved in both electronic and hard copy formats. A rigorous document control system should be implemented to ensure that all revisions are tracked and recorded properly during the life of the project. In the case of electronic filing, which utilizes Intranet office systems, care should be given to ensure that proper user access/restrictions are given to the appropriate members of the staff.

8.0 COMMERCIALIZATION PLAN

The purpose of the commercialization plan is to develop a step-by-step guideline for identifying the markets for the developed technology and then selling the technology or related services in those markets.

The major components of the commercialization plan are as follows:

1. Market Analysis: In the market analysis, the following must be analyzed:
    * Market size
    * Market location
    * Growth trends
    * Customer profile
    * Competition analysis.
2. Marketing Plan
3. Estimated Costs of Commercialization
4. Estimated Earnings from Commercialization

5. Expected Life Span
6. Legal Issues: Patents, intellectual property, and copyright
7. Financing Issues, such as sources of money and budget required.

9.0 PROTOTYPE GENERATION

The prototype generation is the process in which the development team actually builds the integrated technology. At this point, the team should have a list of all of the parts that they need to begin the building process. Using the design and assembly drawings, a parts list should be generated and the procurement process begun.

Once all the parts and equipment are available, the team should divide the work into tasks and subtasks, thus setting a goal for finishing the prototype on a given date. The common divisions of the tasks could be materials management, project supervision, technical implementation, small-scale testing, or any other applicable tasks among the team. Industry-accepted project management tools such as Gantt charts and timelines should be utilized.

The following task descriptions should aid the reader in the division of tasks among the integration team:

The Project Manager is responsible for making sure that the team stays on track based on the set deadlines. He or she must set the goals for the completion of every phase of the project.

The Materials Manager is responsible for the procurement of all the needed materials. If there are any exceptions or problems, he/she should obtain authorization from the project manager.

One or more members of the team may carry out the Technical Implementation. These team member/s should be in charge of the construction/assembly of the prototype.

10.0 FIRST ITERATION PERFORMANCE EVALUATION

The first round iteration evaluation is a very important step in the process of integration technology. It is a process that most inventors and engineers go through when developing a new product or material. One of the many purposes of this step is to check the work done on the previous step. The performance evaluation tests the actual physical working of the integration. This testing should be done in the environment in which the machine is supposed to work, or it can be simulated to approximate the conditions to which the machine will be exposed. Another very important purpose of this step is that the team should be able to do a comparison test based on the theoretical workings and the actual workings of the machine. Every test that is done should be recorded and compared with the expected result to be able to calculate a yield of the first prototype. The summary of the steps follows:

- Find a suitable test environment for the finished technology. The environment should resemble as much as possible the actual setting where the technology will be used.
- Perform suitable performance evaluation tests. These tests should be based on the needs identified on the first step. For example, technology integration previously mentioned, namely the radiation sensor and the aggressive removal would have to be tested on a concrete

wall with some percentage of contamination or some other simulated effects if no such wall is available.

- Every test that is performed should be compared with the expected results of the technology integration.
- A logbook should be kept of all the modification processes made. The logbook should be kept with indelible ink and should have page numbers. If errors are made, then they should be crossed out with one single line.
- A summary report should be generated at the end of the process, stating the changes made. The report must include the tests performed; the results of these tests, as well as suggestions for improvement for the next phase of the process, namely, the modification stage.

11.0 FIRST ITERATION MODIFICATIONS

The results from the performance evaluation should be used to establish what needs to be changed or modified from the prototype. If the testing yielded expected results, then the first round modifications are trivial and should only be done if the team considers that a major improvement could be made by simply making minor changes. This process may not be very involved if the machine performs close to expected; however, in most cases this is not so. Most engineering applications require many modifications after the first prototype and commonly many more. The process of modification and testing is one that is sometimes repeated many times until the actual desired outcome is achieved. Because there are many limiting factors to this type of iteration, this module will only go through two modification and testing stages. This does not mean that this process is limited to this number. The case is that the process should be repeated depending on the time and budget constraints that the project has. It is therefore necessary to adjust the time spent on each modifications according to the limitations based on the specific situation. In the first round modifications, the team should analyze the following:

- What were the areas where the project failed to perform? These areas of failure should be identified and documented for every possible modification.
- Identify if the parts that failed are independent or depend on other parts for their correct functioning. Independent also means those parts that are simply not linked to any other process but their own function. For example, a part that controls the functioning of another part is not considered independent, although other parts do not limit its own functioning. Those parts that are independent may be analyzed separately, while those others that are dependent may need further study.
- Proceed with modifications for those parts that are independent. Adjust the necessary factors that would make those independent components work as desired.
- Analyze the parts that are dependent or that control the functioning of those other components. This analysis process may be done by isolating the device and testing it. If these tests prove that the part is doing its work, check the dependent/controlled parts separately for their functioning.

12.0 SECOND ITERATION PERFORMANCE EVALUATION

The second iteration of the performance evaluation should be very similar to the first iteration performance evaluation, since the same procedures may be followed. This performance evaluation should theoretically be shorter, but it should be more elaborate than the first since some modifications have already been made.

It is possible that severe design problems may be revealed during the first iteration. Therefore, all design criteria and project objectives should be visited during this phase for comparison against the demonstrated performance of the prototype.

Once all the objectives and design criteria have been evaluated against the first iteration prototype performance, the next step, the Second Iteration Modifications, can be performed.

13.0 SECOND ITERATION MODIFICATIONS

The second iteration of modifications should be very similar to those of the first modifications; however, these may be more complex if an unexpected problem is discovered. At every point the option of termination of the project should be considered in case a problem becomes too expensive or impossible given the parameters of the project.

14.0 FINAL COMMERCIALIZATION PLAN

The final commercialization plan should present the polished prototype working as it was intended with a final economic analysis and market analysis. Should any major changes occur during the modification processes, those would have to be identified, and a new economic analysis will have to be generated in order to present as a final report. This economic analysis should include those changes made and the impact of the new changes. The team should keep a record of the project documenting all of the changes made and a timeline with the events that led to the conclusion of the project.

APPENDIX B

TECHNOLOGY AND TECHNOLOGY COMBINATION LISTS FOR INTEGRATION

Table B.1
Lists of Technologies and Combinations for Technology Integration

Decontamination and Characterization Technologies Suitable for Technology Integration:

This list has certain missing information, which could not be included due to the requirement of extensive data entry. Most of this data is also available at FIU-HCET in the vendor catalogs. Since the requirement is only to generate the list of names of technologies, the details have not been worked out.

TECHNOLOGY	VENDOR	DESCRIPTION	CONTACT INFO
LASERS & RELATED (DISTANCE MEASUREMENT)			
Sonic Laser 305-306	HiTech Technologies, Inc.	ultrasonic laser: .1-10 ft	
PLS proximity scanner – EN 954	Sick Optics	infrared laser and time of flight measurement	(612) 941-6780
DME 3000: Distance measurement sensor	Sick Optics	class 2, red laser for distance measurement	(612) 941-6780
Electric field proximity sensor	Russll Bik Design	micro-electronic based device that can detect stationary and moving objects through solid materials	(805) 481-4378
DME 2000: Distance measurement sensor	Sick Optics	class 2, red laser for distance measurement	(612) 941-6780
WTA 24 – distance measurement sensor	Sick Optics	infrared laser and parabolic mirors to produce analog readings of low reflectivity items	(612) 941-6780
Position and velocity transducers	PSCC Rayelco	wire-wound potentiometer for position and velocity data	
H-100T Anaglog Tachometer	Electro Sensors	visual indication of RPM (for wheel speed)	(800) 328-6170
Impluse laser – distance measurement (accuracy btw 3-5 cm)	Laser technology Inc.	lasers for distance measurement	(303) 705-0056
Fourier Transform Profilometry (FTP)	DIAL – diagnostic instrumentation and analysis laboratory.	Reads light interference patterns to produce a profile of the read surface.	(601) 325-2105

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	ONTACT INFO
LASERS & RELATED (DISTANCE MEASUREMENT)			
GeoExplorer II	Trimble	smallest and lightest, stores 9000 positions and accepts differential corrections. 2-5 meter accuracy after differential correction. Data output in format accepted by over 140 GIS databases.	
7400 Msi	Trimble	real-time kinematic GPS receiver designed for dynamic machine guidance and control applications. Most advanced receiver available.	
ACE GPS moule	Trimble	miniature, 8 channel GPS module for navigation, tracking, data logging and timing applications	
GPS Pathfinder Pro XL	Trimble	small backpack with antenna and hand-held unit.	
GPS 4800	Trimble	integrated GPS receiver, micro-centered GPS, antenna, radio modem for centimeter level surveying.	
DATA LOGGERS			
MEI DH01	MEI	dowhhole two channel data logger	(800) 592-3282
MEI DH02	MEI	dowhhole two channel transmitting data logger	(800) 592-3282
MEI AG01 NEMA 4	MEI	enclosed 2 channel above ground data logger	(800) 592-3282
MEI AG02 NEMA 4	MEI	enclosed 2 channel above ground transmitting data logger	(800) 592-3282
MEI B01	MEI	base station receiver	(800) 592-3282
MEI R01	MEI	Repeater	(800) 592-3282
Suvery Instrument Point	Metretek	remote data logger with integral modem, four pulse data input channles. Operates via phone line or RF modem.	(407) 259-9700
RTM 900	Metretek	uses short wave radio to transmit data from devices	(407) 259-9700
Marc RTU	Metretek	Measurement, acquisition recording control -- remote terminal unit	(407) 259-9700
Portable Data logger, model 6004	Unidata	portable data logger, without transmission capabilities	(503) 6973570
Remote data logger	Industrial Automation Specialist Corporation	for very harsh mechanical and electrical environments; powered by battery; connects to PC for data viewing.	

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	ONTACT INFO
		DATA LOGGERS	
RTU data logger: remote controller with radio telemetry	Synetcom	economical data logger with remote controller, radio telemetry. Transmits back to computer from field.	
Model 245 Data Logger	Doric	up to 500 inputs; serial port connections for modems, computers, etc. has alarms and programmable.	
CR500	Campbell Scientific	long term monitoring in harsh environments; supports all CSI telecommunication and data retrieval options;	
CR23X Micrologger	Campbell Scientific	A portable, rugged, powerful data acquisition system.	(435) 753-2342
remote stations, base station and repeaters	Campbell Scientific	miscl hardware for all applications	(435) 753-2342
Wireless logger	Fluke	Rugged, RF modem, logger, for hazardous duty. Good unit.	(800) 443-5853
"Out there" – remote data logger	Validyne	remotely accessible data logger; accessible through phone line and modem; software downloads from Net; creates data files which can be manipulated remotely, etc.	
Robust mobile data acquisition	Intelligent Systems Engineering	integrated GPS, data logging, RF telemetry, PCMCIA plug in, etc.	27 21 8544230
		RF MODEMS	
Dataker Transceiver System	Data Electronics	Transmits data through walls and ceilings. Line of sight distances of up to 20 miles. Will also serve as repeaters. Spread spectrum radio transmission.	(800) 956-4437 or (714) 851-5300
Adam-4550: RF modem	Advantech	Radio Modem with many features	
Data remote	Signal communications	Interface between sensor and phone line/remote computer	(800) 492-8369
Portable air monitor	NRC	Scintillation detector, with vacuum pump and ratemeter. Portable unit.	(215) 343-5900
SAM 2500	PPM Corp	Unattended, continuous, real-time monitoring for dusts and aersols; uses electro-optical sensor	
PCAM-TX	PPM Corp	Portable, continuous aersol monitor; self-contained; weighs 20 lb;8x9x16";	

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	CONTACT INFO
AIRBORNE PARTICULATE			
Model 1060	PPM Corp	Hand-held aerosol monitor with detached sensor; real-time for dust, smoke and mist; uses near forward light scattering techniques from light emitting diodes; .5-10 micrometers;	
DataRam	MIE	real-time aerosol monitor; .0001 – 400 mg/m3; provides respirable, PM-2.5 & PM-10 correlated measurements;	(888) MIE4YOU
Personal Dataram	MIE	Personal monitor and data logger; hand-held aerosol monitor; dust, smoke mist and fumes; logged data can be downloaded to a PC;	(888) MIE4YOU
IDS-10 Industrial dust sensor	MIE	Continuous, unattended workplace industrial dust sensor; no pumps or moving parts; .01 – 100 mg/m3; analog output;gas purgeable; rugged;	(888) MIE4YOU
RAM-S Real-time Aerosol sensor	MIE	.001-200 mg/m3; analog output; has pump	(888) MIE4YOU
PDM-3 Miniram	MIE	.01 – 100 mg/m3; pulsed infrared light-emitting diode with silicon detector; self contained and miniaturized	(888) MIE4YOU
BAM 1020 (beta attenuation mass monitor)	Met One instruments	for PM 10 and PM2.5 particulate monitoring; portable data logger and dust monitor; produced by Met One in cooperation with Sibata Sci of Tokyo.	
Particulate air monitor: HD-1000, Hazdust	Davis instruments	.01-50micro meters	(800) 368-2516
RADIATION MONITORS & RELATED			
Wireless radiation monitoring system	NRC	Gamma detector, ratemeter and RF modem	(215) 343-5900
SRA surface contamination monitor	SRA	alpha and beta radiation surveys of horizontal and veritcle surfaces	
DECONTAMINATION-MECHANICAL			
Decontamination-Mechanical	3M (2)	Scarification; Rotating brushes (wire) are used to remove contamination using friction.	612-733-1110
Decontamination-Mechanical	Unique Systems	Scarification; Hand-held unit which utilizes attached scarification media to remove surface coating.	

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	CONTACT INFO
		DECONTAMINATION-MECHANICAL	
Decontamination-Mechanical	Pentek Inc. (1)	Scarification; Hand held unit which utilizes attached scarification media to remove surface coating.	(412) 262-0725
Decontamination-Mechanical	Pentek Inc. (2)	Scarification; Mechanical methods are used in order to abrade or fracture surface.	(412) 262-0725
Decontamination-Mechanical	Textron Systems Division	Scarification; Electric current is passed through water by electrodes which cracks surface.	(617) 381-4325
Decontamination-Mechanical	Hotsym	Hot water Flushing; Hot water is used to dissolve chemical species or flushing loose debris.	
Decontamination-Mechanical	P.W. Stevens Environmental Co.	Ultra high pressure water; High water pressure is used to remove concrete. This technology is similar to hydroblasting.	
Decontamination-Mechanical		Steam cleaning; The technology takes advantage of the solvent nature of water to extract contaminants.	
Decontamination-Mechanical		Wet abrasive cleaning; Water containing suspended abrasives is pumped at high pressure against the surface.	
Decontamination-Mechanical		Hand grinding, honing, scraping; Hand held, electric grinders are used to remove layers of concrete.	
Decontamination-Mechanical		Wiping/Scrubbing; Industrial floor scrubbers are applied to surface in order to remove a layer of concrete.	
Decontamination-Mechanical		Fixative/Stabalizer coatings; Coating serves to make decontamination by a mechanical method easier or to seal the contamination to minimize exposure.	
Decontamination-Mechanical		Turbulator; A large tank where small steel components can be cleaned. The flow of cleaning solution is produced by propellers inside the tank.	
Decontamination-Mechanical		Strippable coatings; A polymer mixture is applied to surface. Contaminants are entrained in the polymer.	
Decontamination-Mechanical		Automated grinding; A diamond grinding wheel or tugsten-carbide surfacing discs are used to remove contamination.	
Decontamination-Mechanical		Drill and spall; A hole is drilled into the concrete and then a spalling tool is inserted in the hole. The concrete is spalled off.	

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	CONTACT INFO
DECONTAMINATION-MECHANICAL			
Decontamination-Mechanical		Paving breaking and chipping hammer; Paving breakers are used to remove contaminated concrete by fracturing the surface.	
Decontamination-Mechanical		Piston scabbler; Tungsten carbide coated pistons impact the surface at high rate. This way chipping the concrete.	
Decontamination-Mechanical		Expansive grout; Holes are drilled into concrete. A cement-like mixture is poured into the holes and as the mixture expands the concrete cracks.	
Decontamination-Mechanical	Pegasus International Inc.	Shotblasting; steel shot is blasted against surface in order to abrasively remove concrete.	(412) 295-0066
Decontamination-Mechanical	Apheus Cleaning technologies Corp.	CO2 pellet blasting; CO2 pellets are shot against a surface where impact and thermal shock crack and remove layers of the surface.	909-481-6444
Decontamination-Mechanical	Flow International Environmental		
DECONTAMINATION-CHEMICAL			
Decontamination-Chemical		Acid etching; A carbonate salt solution is sprayed on the surface. Later an acidic solution is sprayed over the surface producing CO2 gas and the radionuclides are entrained in the bubbles.	
Decontamination-Chemical		Paint remover; An organic solvent is used to remove paint.	
Decontamination-Chemical		Organic Acids; Organic acids (oxalic, citric, or sufamic acid) are used to finish acid etching.	
Decontamination-Chemical	Numet Engineering Limited	Alkaline Permanganate; A process that oxidizes and then removes the oxides from a surface.	(705) 743-2708
Decontamination-Chemical		Foam decontamination; Foam is used to increase the time decontamination agents are in contact with surface. The cleaning agents are mixed with the foam and then sprayed on the surface.	
Decontamination-Chemical	Pegasus International, Inc.	Coating remover; this technology is used to remove chemically resistant coatings. It is an organic solvent mixture.	(412) 295-0066
Decontamination-Chemical		Chelation treatment; This process dissolves all metallic atoms (including radioactive ones).	

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	CONTACT INFO
DECONTAMINATION-CHEMICAL			
Decontamination-Chemical		Inorganic Acid treatment; An inorganic acid (hydrochloric acid) is sprayed on the surface.	
Decontamination-Chemical		Detergents Cleaning; Scrubbing with soap and water. Soap is a caustic solution of carbonate or phosphorous salts.	
Decontamination-Chemical		REDOX treatments; A metal surfaces is cleaned by oxidizing/ reducing its oxide layers.	
Decontamination-Chemical		Biological; Microorganisms are used to eliminate contamination in concrete.	
Decontamination-Chemical	Molten Metal Technology	Catalytic extraction process; Molten metal is used to separate radionuclides from non-radioactive substances.	(781) 487-9700
Decontamination-Chemical		Electrokinetic; A potential difference is created across contaminated soil. Radioniclides move due to the electric field.	
Decontamination-Chemical	Pegasus International, Inc. (3)	Coat removal; this technology is used to remove chemically resistant coatings. It is an organic solvent mixture.	(412) 295-0066
DECONTAMINATION-BLASTING			
Decontamination-Blasting	Va-Tran Systems, Inc.	CO2 pellet blasting; CO2 pellets are shot against a surface where impact and thermal shock crack and remove layers of the surface.	800-379-4231
Decontamination-Blasting	Cryogenesis	CO2 pellet blasting; CO2 pellets are shot against a surface where impact and thermal shock crack and remove layers of the surface.	(216) 696-8797
Decontamination-Blasting		Dry vacuum cleaning; A commercial grade vacuum with a high-efficiency particulate air filter is used to remove contamination.	
Decontamination-Blasting	IceSolv (2)	High pressure water; High pressure water is propelled against surface.	
Decontamination-Blasting	Surface Technology Systems	Sponge Blasting; Surface is blasted with different grades of sponges.	(330) 849-6695
Decontamination-Blasting	LTC Americas (2)	Grit blasting; Abrasive materials are projected against the surface using compressed air.	(800) 822-2332
Decontamination-Blasting	Pegasus International, Inc. (4)	Steel abrasive blasting; Steel shot is projected against surface using compressed air.	(412) 295-0066

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	CONTACT INFO
DECONTAMINATION-BLASTING			
Decontamination-Blasting	AEA O'Donell	Sponge blasting; Surface is blasted with different grades of sponges.	
Decontamination-Blasting	A.R.C.	Wet ice blasting; Low pressure air is used to project wet ice.	
Decontamination-Blasting		Hydroblasting; Water is pumped at high pressure against the surface in order to remove contamination.	
Decontamination-Blasting	Pegasus International, Inc. (2)	Shot blasting; Steel shot is projected against surface using compressed air.	(412) 295-0066
Decontamination-Blasting	J&B/Concrete cleaning	Grit blasting-steel grit; Steel grits are projected against the surface using compressed air.	(407) 339-7877
Decontamination-Blasting	Barlett	Plastic blasting; Plastic media shot against surface.	
Decontamination-Blasting	Church & Dwight	Sodium bicarbonate blasting; Low pressure air is used to propel carbonated water.	
Decontamination-Blasting	Environmental Alternatives, Inc.	CO2 pellet blasting; CO2 pellets are shot against a surface where impact and thermal shock crack and remove layers of the surface.	301-428-0822
Decontamination-Blasting	Cryo Dynamics Inc.	CO2 pellet blasting; CO2 pellets are shot against a surface where impact and thermal shock crack and remove layers of the surface.	423-220-9002
Decontamination-Blasting	Contam-Away Blasting Systems	Sodium bicarbonate blasting; Low pressure air is used to propel carbonated water.	315-437-6400
Decontamination-Blasting	Riso National Laboratory		45-4677-4677
Decontamination-Thermal			
Decontamination-Thermal		Microwave scabbling; Microwave heat is used to remove contamination.	
Decontamination-Thermal		Plasma arc; This technology uses plasma heat to cut through metal pieces.	
Decontamination-Thermal	EXITECH	Laser Etching Ablation; Laser energy is converted into heat which remove contamination.	(904) 983-9101
Decontamination-Thermal	Polygon/Parsons	Flashlamp cleaning; Flashlamp heats surface to char point. At this point it can be removed.	

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	CONTACT INFO
		RAD SENSORS	
Rad sensor	TM Analytic, Inc		630-860-9122
Rad sensor	Dosimeter, Div. Of Artisan Electronics		800-322-8258
Rad sensor	Eberlin Instrument Corp.		505-471-3232
Rad sensor	Framatome Technologies		804-832-3234
Rad sensor	Gamma Products, Inc		708-974-4100
Rad sensor	Helgeson Scientific Services, Inc.		510-846-3453
Rad sensor	Industrial Test Equipment Co. Inc.		516-883-1700
Rad sensor	Landauer, Inc		708-755-7000
Rad sensor	NDS Products Inc.		800-413-4750
Rad sensor	Nuclear Measurements Corp.		
Rad sensor	Ohmart Corp., The		513-272-0131
Rad sensor	Peerless Instrument Co., Inc		718-592-3300
Rad sensor	Picker International Inc.		440-473-300
Rad sensor	Random Corp		513-825-6635
Rad sensor	S.E. International, Inc		800-293-5759
Rad sensor	Scintrex Ltd.		905-669-2280
Rad sensor	Semco Instruments Inc		805-257-2000
Rad sensor	Solon Technologies, Inc		440-248-7400
Rad sensor	Technical Services Group, Inc		800-969-9729

Table B.1
Lists of Technologies and Combinations for Technology Integration (Continued)

TECHNOLOGY	VENDOR	DESCRIPTION	CONTACT INFO
RAD SENSORS			
Rad sensor	Teledyne Brown Engineering/Environmental Services		201-997-7070
Rad sensor	TGM Detectors, Inc		973-887-7100 x287
Rad sensor	Troxler Electronic laboratories, Inc		919-549-8661
Rad sensor	Wood, N., Counter laboratory, Inc.		219-926-3571
SPECIAL CASES			
Integrated array of radiation detection sensors	Chemrad	Abacus unit	
Phoswich detector			
Radstar by SAIC		personal dosimeter with RF modem	
GM detector	Victoreen	alpha, beta, gamma detector	
Rados Universal Survey Meter		RDS-120: advanced dose rate meter with built-in GM tubes	
NRC Radiac Set	AN/PDR-77	alpha/beta/gamma: detects plutonium under adverse conditions	
Delta 5 multi-purpose meter	NE Technology		
Bicron Electra portable ratemeter	Bicron		
Bicron PRM510 portable radiation meter			
Lrads	Thermo Nutech	portable remote sensing probe which provides maps etc.	
GPRS-II	Thermo Nutech	GPS/radiation sensor system for performing outdoor surveys	
Beta Scintillaiton Fiber Optics		beta detection via fiber optic cables	

Table B.2
List of Viable Combinations of Radiation Technologies with Chosen Decontamination Technology

RADIATION DETECTION TECHNOLOGY	INTEGRATION TECHNOLOGY
Abacus plastic scintillation detector array	1. Large floor decontamination machines (I.e. shot blasters). 2. Wall decontamination technologies (I.e. the wall walker rigging) 3. Robotic platforms
General radiation detection probes	Trimble GPS unit with repeater for indoor use
Radstar by SAIC	1. Floor decontamination units 2. Vertical decontamination units 3. Overhead decontamination units 4. Pentek squirrel 5. CO2 blasting guns 6. High pressure water washing guns
Rados Multi-purpose survey meter – RDS 110	1. Floor decontamination units 2. Vertical decontamination units 3. Overhead decontamination units 4. Pentek squirrel 5. CO2 blasting guns 6. High pressure water washing guns
NE Technology Delta 5 Advanced multi-purpose ratemeter	1. Floor decontamination units 2. Vertical decontamination units 3. Overhead decontamination units
Bicron Electra microprocessor based ratemeter	1. Floor decontamination units 2. Vertical decontamination units 3. Overhead decontamination units
Bicron PRM510 Portable Radiation monitor	1. Floor decontamination units 2. Vertical decontamination units 3. Overhead decontamination units
Bicron 600 cm2 scintillation probe, DP8	1. Floor decontamination units 2. Vertical decontamination units 3. Overhead decontamination units
LARADS	1. Floor decontamination units 2. Vertical decontamination units 3. Overhead decontamination units

Table B.3
List of Viable Technology Combinations of Chosen Decontamination (Concrete Removal) Technologies and Characterization Technologies

Technology 1	Technology 2
Marcrist DTF 25: Diamond drum concrete shaver	1. More powerful Vac system 2. Side windowed GM probe and ratemeter 3. Airborne particulate monitor 4. GPS with repeaters 5. Plastic scintillation probe for gamma 6. Gas proportional probe for beta-gamma 7. Signal processor/scaler 8. Data logger 9. Laptop computer 10. Ultrasonic positioner
Wall Walker	1. Ultrasonic rangefinder 2. DIAL FT pofilometer 3. GPS with repeaters 4. RF modem to transmit data 5. Gas proportional beta-gamma detector array 6. GM tube gamma detector 7. Plastic scintillation detector 8. Laptop computer 9. Data logger 10. Ultrasonic positioner 11. Velocity meter 12. Airborne particulate monitor
Pentek Squirrel	1. Vibration isolation coupling 2. Side windowed GM probe and rate meter
EBE Floor Shot Blaster	1. Ultrasonic rangefinder 2. Gas prop. Detector array 3. Plastic scintillatio probe in exit line 4. GM gamma detector tubes 5. GPS system with repeaters 6. Ultrasonic positioning array 7. Velocity meter 8. Data logger 9. RF modem 10. Airborne particulate monitor
Pentek Hand-held scarifiers	1. Phoswich detector, with protective encasing
Water flushing, Wet abrasive cleaning	1. Industrial wet vacuum 2. Inflatable containment berm.
CO2 pellet blasting	1. Collection nozzle

Table B.3
List of Viable Technology Combinations of Chosen Decontamination (Concrete Removal) Technologies and Characterization Technologies (Continued)

Technology 1	Technology 2
Pegasus verticle shot blaster	1. Characterization array 2. Ultrasonic rangefinder 3. Laser rangefinder 4. Ultrasonic positioner 5. GPS positioner 6. Robotic platform: remote and/or non-remote operated 7. Dial FT profilometer 8. Airborne particulate monitor 9. Laptop computer
STS ARMS	1. Characterization array 2. Ultrasonic rangefinder 3. Laser rangefinder 4. Ultrasonic positioner 5. GPS positioner 6. Exit line gamma detector 7. Dial FT profilometer 8. Airborne particulate monitor 9. Laptop computer
3M Milling Machine	1. Exit line gamma radiation detector 2. GPS 3. Ultrasonic positioning system 4. GM side window detector
LTC 1073 Vacuum Blasting Machine	1. Phoswich detector, with protective encasing 2. Exit line gamma detector
Roto-Peen Scaler (Scarification)	1. Mechanical fixture for pressurized application 2. Phoswich detector, with protective coating
Ultra-high Pressure Water Blasting	1. Inflatable containment berm
EBE Vertical Shot Blaster	1. Robotic platform to apply unit to wall 2. Radiation characterization array 3. Phoswich detector, protected 4. Laser rangefinder 5. Ultrasonic rangefinder 6. GM side window probe 7. Exit line gamma radiation detection 8. Airborne particulate monitor 9. Ultrasonic positioning system 10. GPS
Nelco Portashot - JHJ 2000	1. Mechanical fixture for pressurized application 2. Phoswich detector, with protective coating

APPENDIX C

AUTOCAD DESIGN DRAWING OF INTEGRATION OF ULTRASONIC SENSOR TECHNOLOGY AND SHOT BLASTING TECHNOLOGY

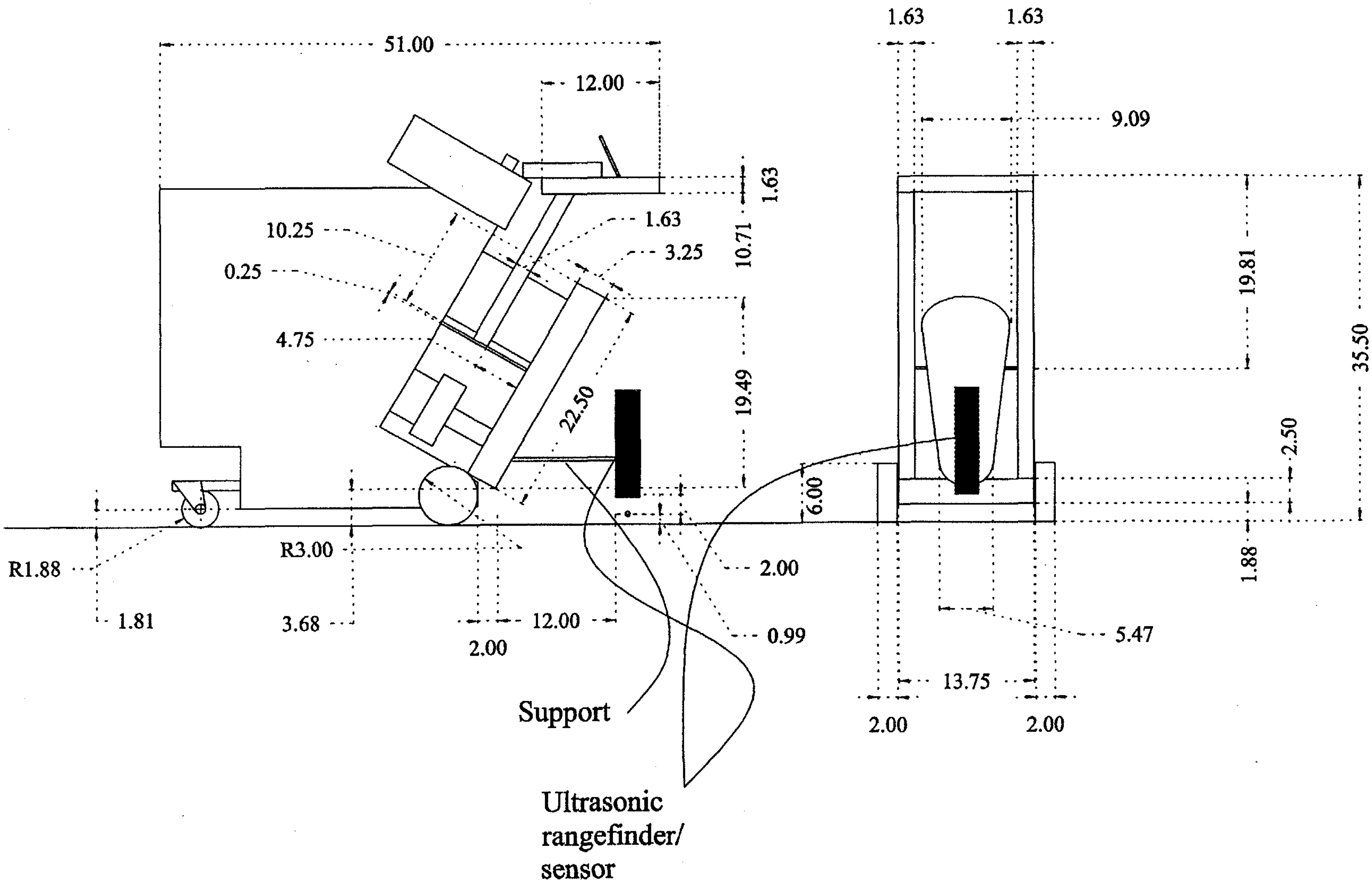

Figure 3. Preliminary Conceptual Feasibility Design Drawing of Integration of Ultrasonic Sensor Technology and Shot Blasting Technology.

APPENDIX D

FEASIBILITY STUDY OF THE ULTRASONIC SENSOR TECHNOLOGY FOR TECHNOLOGY INTEGRATION WITH CONCRETE REMOVAL TECHNOLOGY

FEASIBILITY STUDY OF THE ULTRASONIC SENSOR TECHNOLOGY FOR TECHNOLOGY INTEGRATION WITH CONCRETE REMOVAL TECHNOLOGY

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PURPOSE

The ultrasonic sensor also called ultrasonic range-finder, as it is basically used to find the range or in this case the absolute distance from the ultrasonic sensor to the target surface. The purpose is to expand the scope of technology integration by implementing and evaluating an example combination of commercially available technologies. An essential requirement of the online measurement project was of an instrument, which measures the distance between a reference level on the decontamination technology and the surface being decontaminated. This is an application for the Depth measurement category of the Characterization technologies.

The ultrasonic sensor has been procured as a result of research on the instruments that could meet the requirements of an online measurement technology. The sensor had to be tested and evaluated to assess its compatibility when combined with the Shot Blasting Technology, which is a Concrete Removal Technology. Some of the tests are to check the accuracy of the data, the sensitivity of the instrument and the degree to which it works in a disturbing environment.

DESCRIPTION OF THE ULTRASONIC SENSOR AND CONNECTIONS REQUIRED

The ultrasonic sensor is a simple-looking cube-shaped instrument with the probe at one end, which generates and receives the reflected ultrasonic waves. The instrument has been bought from the German company Pepperl-Fuchs, Inc. The sensor requires a DC power supply and a computer for the data acquisition. It sends the data signals to the COM port of the computer. The sensor is provided with a software called ULTRA2 which receives the sensor responses from the COM port and interprets the data in a readable format. The data can also be accessed directly using the HyperTerminal software to connect to the COM port. A detailed description of the software is provided in further sections in the document.

DATA ACCURACY AND RANGE VERIFICATION TEST

The purpose of this test is to verify the absolute distance between the probe and the target surface as read by the sensor against the same measured manually. The sensor has a range of 300 mm to 3000 mm (approximately 12`` to 120``). The test was run for distances ranging from 12`` to 18``. The summary of the results showed that the sensor shows a reading that is about 2 to 3 mm less than the manually measured distance, using a measuring tape. One reason could be the error in manual measurement. But the readings have always been consistent.

MINIMUM DETECTABLE AREA TEST

The purpose of this test is to estimate the smallest target surface area that can be detected by the ultrasonic sensor. The procedure used was a hit and trial procedure with square pieces of paper as the target surface. The results showed that the ultrasonic sensor could detect as small an area as 7x7 square millimeters when placed at a distance of 14`` from the sensor probe. For any area below this, the distance reading shown by the ultrasonic sensor was not readable (due to large variations).

TESTS ON DIFFERENT SURFACES

Tests were performed to observe the performance of the ultrasonic sensor on both smooth and rough surfaces when in motion as well as when stationary. The sensor gave consistent readings on smooth and flat target surfaces. The observations indicated a good performance on smooth surface when stationary as well as when in motion. But the readings given on rough surfaces had a wider range, which reduces the precision of the instrument in similar applications, but this problem could be overcome with further consultations with the vendor.

GENERAL SETUP FOR THE TESTING

The tests need the ultrasonic sensor on a flat surface. The target chosen was also a flat wooden surface placed straight in front of the sensor probe. The sensor power supply is to be connected and also connected to the COM port before the computer could be switched on and started. After the computer is started the ULTRA2 software has to be run from the DOS prompt by typing in the executable file name "ULTRA2". The COM port number has to be entered into the program and then the screen comes up with the readings of the absolute distance and other details like the presence of target, the working range of the sensor in millimeters, and the estimation procedures.

SOFTWARE DESCRIPTIONS AND DEFICIENCIES

The software requirement for the ultrasonic sensor is data acquisition from the COM port. ULTRA2 is the software provided by Pepperl-Fuchs, Inc., to meet the requirement. The software can run on Windows or DOS. The program starts with accepting the COM port number to be connected to receive the signals from the sensor. It then gives the data screen with the options of adjustable range, which could be anywhere between 300 mm and 3000mm. It displays the absolute distance between the probe and the target surface in mm along with a relative value. It indicates the presence of the target in the range. It provides an option for the user to set the interpolation or estimation method defining the method used as it receives the reflected ultrasonic waves from the target.

The absolute distance is sometimes very difficult to read especially when working on rough surfaces, as the variations occur in short intervals. Moreover, the software overwrites the data on the same position of the screen without completely erasing the previous data. This gives ambiguous and incorrect data sometimes.

It is not necessary to read the data using the ULTRA2 software, as the COM port can be accessed using the Windows Terminal software following the instructions given in the company manual.

COMPARISON WITH OTHER TECHNOLOGIES

A good technology that the ultrasonic sensor could be compared to in the context of this application is the laser technology. The ultrasonic sensor stands above the laser when we consider disturbing factors such as dust and other media that comes as a waste during decontamination. Lasers are too sensitive to dust particles, and this is unwanted in such an application.

NOISE TEST

This test is to study and observe the effect of the disturbance caused to the sensor due to noise from the decontamination technology – shot blasting technology. Though we had the shot-blasting machine, it could not be used for this test directly. But the test was using the noise available from a video recording of a previous shot blasting concrete removal demonstration at FIU-HCET. The ultrasonic sensor was used in the region near the speakers of the television on which the shot blasting demonstration cassette was being played. The results showed that the readings given by the sensor were not disturbed by the disturbances from the noise generated by the shot-blasting unit.

CONCLUSIONS AND REMEDIES

It is observed and suggested that the performance of the sensor when in motion over very rough surfaces was not precise but satisfactory and needs to be improved by further consultations with the vendor. Since the range of the ultrasonic sensor tested in FIU-HCET started from 300mm from the target surface, there is the need to consider this fact when being integrated to the shot blasting technology. It has been conceptualized that, for an appropriate position on the shot blasting unit, the sensor may have to be located at more than 300mm height from the ground. Also the path of the ultrasonic waves from the sensor will have to be enclosed. The concept needs more application and can be developed further.

The ultrasonic sensor or the ultrasonic range-finder has proved to be a compatible Characterization Technology belonging to the Depth Measurement category, to be integrated with a concrete removal technology.

APPENDIX E

STRATEGIC ALLIANCES REPORT

STRATEGIC ALLIANCES REPORT

DOE, in its effort to develop innovative technologies that will benefit the general public, currently uses a valuable tool: strategic alliances. This document discusses the important role strategic alliances play in helping DOE meet its technological needs. Different types of programs are discussed as well as examples of projects currently in progress.

Two important mechanisms for strategic alliances are CRADAs and SBIRs. These acronyms are discussed in the following section. An advantage to using these mechanisms is that they also serve as tools for technology transfer. DOE laboratories are involved in CRADAs and SBIRs because they benefit both their partners as well as the laboratory.

The acronym CRADA stands for Cooperative Research and Development Agreements. Each partner in the agreement provides personnel and equipment to support their portion of the research, and under certain circumstances, private sector partners may also fund the DOE Site's portion of the work. Partners may be companies, trade associations, state and local governments, universities or non-profit organizations.

The acronym SBIR stands for Small Business Initiative Research. The program is a congressionally mandated program established to increase the participation of small businesses in federal research and development (R&D). Currently each participating government agency must reserve 2% of its extramural R&D for SBIR awards to competing small businesses. The goal of the SBIR program is to invest in the innovative capabilities of the small business community to help meet government R&D objectives while allowing small companies to develop technologies and products which they can then commercialize through sales back to the government or in the private sector. While the SBIR is structured for research and development, the main objective is eventual deployment and commercialization.

These programs have proven to be useful tools in meeting the technological needs of the DOE. An example of a project in progress would be the Strategic Alliance for Environmental Restoration. Within the Department of Energy, the Office of Environmental Management was chartered with the responsibility for management of DOE waste management and environmental operations and related applied research and development (R&D) programs and activities. A key mission of the DOE-EM continues to be the development and implementation of an aggressive program that provides for innovative environmental technologies to yield permanent technical solutions for waste and disposal issues at reduced costs. The DOE-EM Office of Science and Technology (OST/EM-50) functionally implements the mission for the innovative environmental technologies through management of, and direction to, focused problem/solution-oriented technology development programs. These programs are designed to provide complete innovative technologies and technology systems to meet end-user requirements and milestones and to reduce regulatory compliance costs.

The Strategic Alliance created by DOE-EM reflects a cooperative interest from industry, commercial nuclear utility, university and national laboratory team members to bring collaborative experience and strength to DOE. The Alliance fulfills many of its goals through the large-scale demonstration project at CP-5 and is comprised of the following members:

1. Duke Engineering and Services
2. 3M

3. Argonne National Laboratory
4. ICF Inc.
5. Florida International University
6. Commonwealth Edison

The Alliance is committed to identifying, selecting, demonstrating, and evaluating the maximum number of environmental technologies within the current planned time span for demonstration project. The optimum focus on technologies is on both those near commercialization and pilot scale demonstrations to achieve "fast-track" development of specific technologies for significant benefit to the complex. In addition to demonstrations, the Alliance provides a selection of evaluation reports for all technologies reviewed for project applicability. A final report will be generated at the close of the demonstration projects and will provide a comparative analysis of actual performance against established baselines, with qualification for commercialization and application to facilities with the DOE complex and private industry.

The Strategic Alliance approach to technology qualification and deployment provides DOE, through the Cooperative Agreement, with a new way of bringing industry principals to technology research and development activities. These principals will be directed to test those solutions against the major technological problems prevalent within the DOE complex. The practical approach to this effort will be to expedite technologies to the field to meet the EM-50 goal for "problem/solution-oriented results" within return on investment guidelines, and to identify technology activities which should be reviewed for support continuation, escalation, or cessation. The management approach of this effort reinforces DOE commitment to performance-based strategies in the conduct of Department business with additional benefits of diverse organization integration for optimized performance and proven business practices for rapid commercialization of technologies and application to the final D&D of the CP-5 Reactor and subsequently to the DOE complex as a whole.

Other examples of alliances are those with academic institutions. Currently, three national laboratories, Lawrence Livermore, Los Alamos, and Sandia, are involved in the Academic Strategic Alliances Program. This program was created in order to enhance the overall Accelerated Strategic Computing Initiative (ASCI). ASCI aims to develop computer simulation methods and computational methods in order to create virtual testing and prototyping capabilities for nuclear weapons. By 2010, the ASCI program will:

Develop high-performance, full-system, full-physics predictive codes to support weapon performance assessments, renewal process analyses, accident analyses, and certification.

Stimulate the U.S. computer manufacturing industry to create more powerful high-end supercomputing capability required by these applications.

Create a computational infrastructure and operating environment that makes these capabilities accessible and usable.

The objectives of the alliance are as follows:

1. Establish and validate the practices of large-scale modeling, simulation, and computation as a viable scientific methodology in key scientific and engineering applications that support DOE science-based stockpile stewardship goals and objectives.
2. Accelerate advances in critical basic sciences, mathematics, and computer science areas, in computational science and engineering, in high-performance computing systems, and in problem solving environments that support long-term ASCI needs.
3. Establish technical coupling of Strategic Alliances efforts with ongoing ASCI projects in DOE laboratories.
4. Leverage other basic science, high-performance computing systems, and problem-solving environments research in the academic community.
5. Strengthen training and research in areas of interest to ASCI.

ASCI academic Strategic Alliances Program Centers of Excellence are expected to be established at following locations:

Stanford University
Center for Integrated Turbulence Simulations (CITS)
Principal Investigator: William C. Reynolds
415-723-3840
wcr@thermo.stanford.edu

California Institute of Technology
Virtual Facility for Simulating Dynamic Response of Materials
Principal Investigator: Daniel I. Meiron
818-395-4563
dim@ama.caltech.edu

University of Chicago
Astrophysical Thermonuclear Flashes
Principal Investigator: Robert Rosner
773-702-0560
rrosner@oddjob.uchicago.edu

University of Utah
Center for Simulation of Accidental Fires & Explosions
Principal Investigator: David W. Pershing
801-581-7631
David.Pershing@dean.eng.utah.edu

University of Illinois
Center for Simulation of Advanced Rockets
Principal Investigator: Michael T. Heath
217-333-6268
m-heath@uiuc.edu

In this agreement, DOE computing laboratory resources will become available to investigators from the institutions listed above working on this project, matching some of the greatest academic resources with extraordinary resources in order to accomplish such an ambitious task.

These examples clearly illustrate the important role a strategic alliance plays in meeting a DOE objective. Working together, government and private resources are pieced together in order to create a final product. These alliances bring the best out of both: government and private entities. Also, working with academic institutions, intellectual resources are greatly enhanced by scholars in a broad range of specialties. Without strategic alliances DOE would have to invest more funds and take more time to meet its goals.