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Paper

DEVELOPMENT AND IMPLEMENTATION OF AUTOMATED RADIOACTIVE MATERIALS HANDLING SYSTEMS

BY

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ABSTRACT

Material handling of radioactive and hazardous materials has forced the need to pursue remotely operated and robotic systems in light of operational safety concerns. Manual maneuvering, repackaging, overpacking and inspecting of containers which store radioactive and hazardous materials is the present mode of operation at the Department of Energy (DOE) Fernald Environmental Management Project (FEMP) in Fernald, Ohio. The manual methods are unacceptable in the eyes of concerned site workers and influential community oversight committees. As an example to respond to the FEMP material handling needs, design efforts have been initiated to provide a remotely operated system to repackage thousands of degradated drums containing radioactive Thorium. Later, the repackaged Thorium will be shipped offsite to a pre-designated repository again requiring remote operation.

I. *INTRODUCTION*

In order to help meet Consent Agreement and Tri-Party Agreement Milestones established between the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (USEPA) and state regulators, the Assistant Secretary of Energy for Environmental Restoration and Waste Management (ER/WM) initiated the Office of Technology Development (OTD). The OTD Program is focussed to provide newly developed technologies that are safer, faster and cheaper methods to cleanup DOE sites across the country. [1]

The leading DOE site in the environmental cleanup effort is the Fernald Environmental Management Project in Fernald, Ohio. The FEMP has hundreds of thousands of cubic yards of radioactively contaminated soil, process residues, and buried wastes. The FEMP has over 30 uranium contaminated buildings and greater than 200,000 stored drums containing radioactive and hazardous materials. [2]

The scope of this project is to focus development efforts in the areas of remote material handling and surveillance to support site cleanup activities. The opportunity to remove operations personnel from radiological and other environmental dangers through application of remote and robotic technologies will be pursued. Remote operations will become essential in order to reduce radiological personnel exposure and reduce risk of incident. The FEMP will work with multiple partners to meet site-specific effectiveness goals and schedules relative to material handling. To support early development, three-dimensional graphical models representing material flow and subsystem components will be generated.

In a later section, a general description of several systems are discussed. These systems were derived from FEMP site need assessments conducted by several independent groups over the last few years. [3] These systems will provide immediate benefit to the site and are hoped to be adopted by other DOE sites that share the same needs in material handling and waste minimization. The more intersite support and communication exists within the DOE community the greater the dollar savings to the taxpayer. With estimates to clean up the environment within the DOE complex exceeding $1.0 Trillion, the DOE needs to be cognizant of not re-inventing the wheel, share cleanup solutions, and utilize the talents of industry and academia to focus on what could be possibly be the #1 issue in this country once the national deficit is eliminated.

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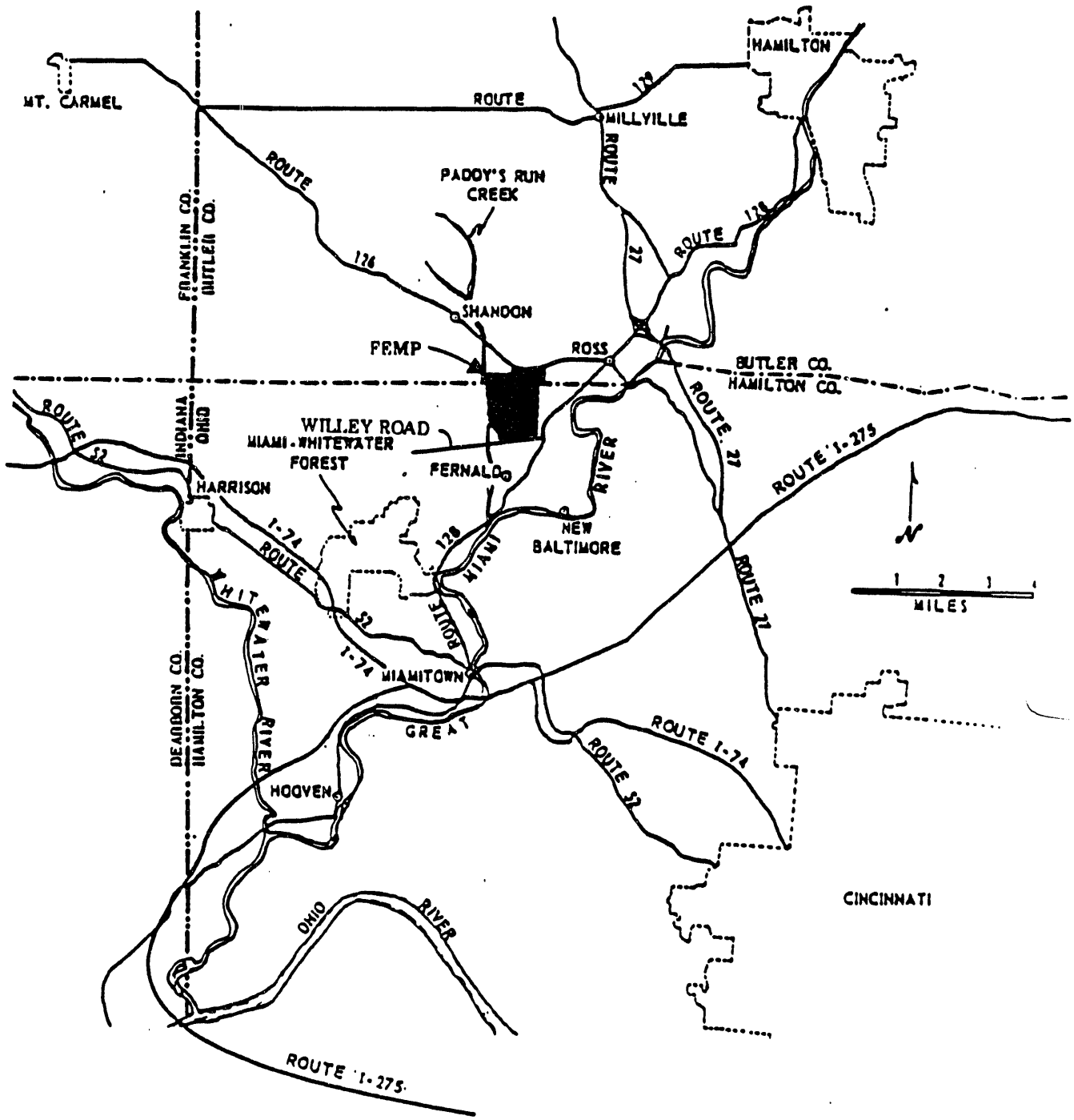

Figure 1: Map showing the location of the FEMP

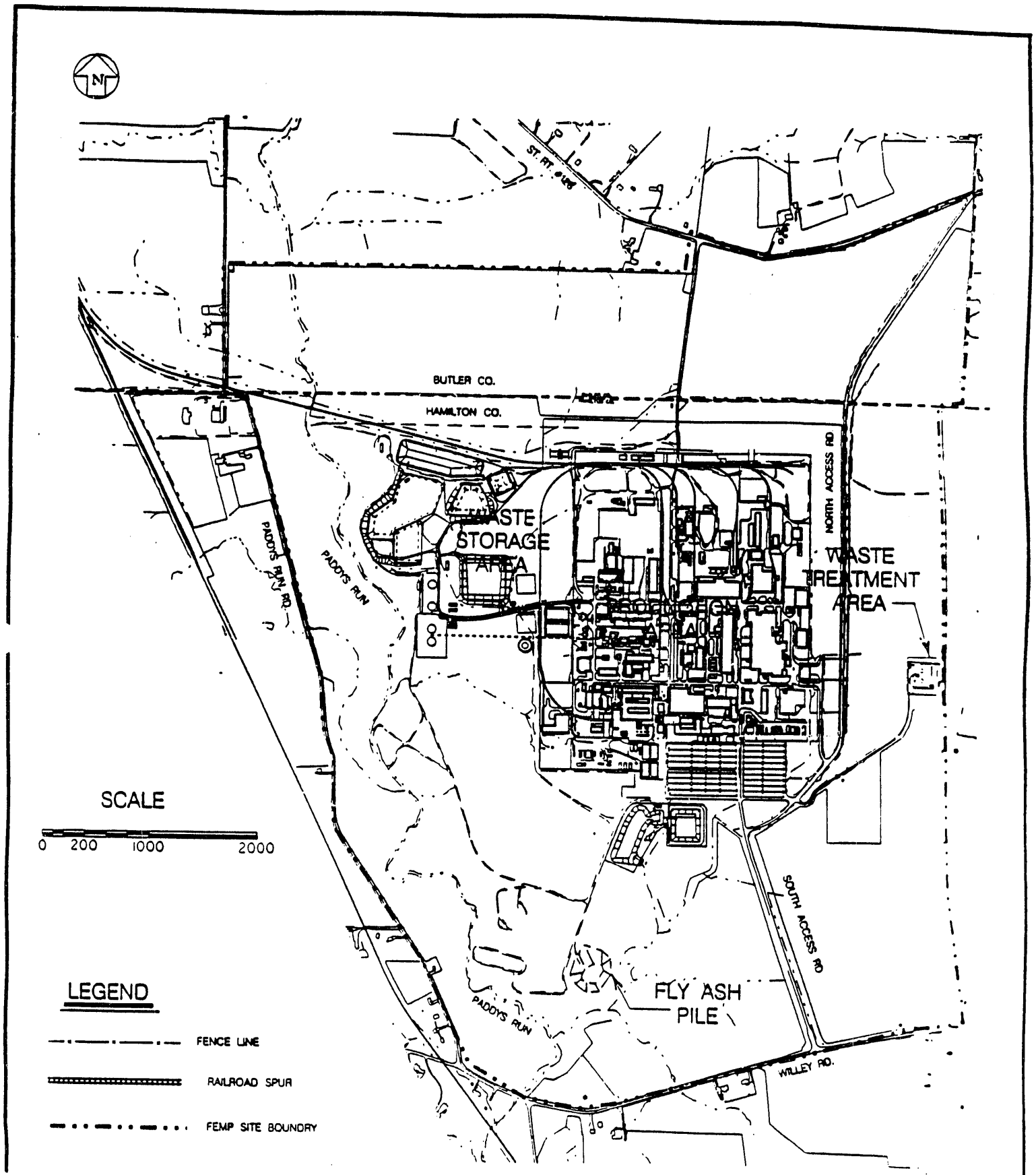

FIGURE 1-2
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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II. *BACKGROUND*

The Atomic Energy Commission, predecessor to the U.S. DOE, established a production complex in the early 1950's for processing uranium and its compounds from natural uranium ore concentrates mined in the U.S and abroad and through reprocessing of bi-products generated from DOE sister sites. This site, was known as the Feed Materials Production Center (FMPC) and was located on 1050 acres in a rural area approximately 18 miles northwest of Cincinnati, Ohio.

The FMPC consisted of a large central production area as well as other surrounding storage and greenbelt areas. The production area covered 136 acres near the center of the project. Production peaked in 1960 at approximately 10,000 metric tons of uranium (MTU) per year. A product decline began in 1964, to a low in 1975 of about 1230 MTUs. In 1989, the site adopted a new mission and with the new mission a new name, the Fernald Environmental Management Project (FEMP).

In 1989, the FEMP was placed on the USEPA National Priority List for cleanup under the Comprehensive Environmental and Response, Compensation and Liability Act (CERCLA). Since that time, all uranium production has ceased on site and a remedial investigation was initiated. Most of the site characterization, drum sampling, treatability testing, and evaluation of remediation alternatives has been completed to provide input to a DOE/USEPA record of decision. Safe shutdown procedures and requirements have been drafted to provide controlled methods for safe operations.

III. *APPLICATION AREAS*

A. Remote Drum Content Repackaging

Drums which are found defective during inspection must be repackaged. This requires moving the defective drums to the repackaging station, manipulating it into position, delidding the drum, emptying the contents into a new container and then closing the container. The greatest hazard in this process is the possibility of spilling radioactive materials and exposing personnel. The problem must be addressed and fail safe methods developed to eliminate this possibility. [4]

The objective of this task is to develop a system to remotely and safely open and empty degradated and damaged drums containing low level radioactive constituents. It is anticipated that the system will have the capability to periodically confirm and/or sample contents. This adaptable system will have the capability to operate with varied drum sizes (5, 30, 55, and 80 gallon drums are widely used across the site) and remove lodged or jammed items that will not come out by simply inverting the opened drum. The system will be required to repackage the contents into containers lined with plastic bag type liners which meet or exceed Department of Transportation shipping requirements.

To improve the machine/man interface, it is conceived that force feedback back sensing will be necessary to give the operator the sense of touch while performing the required tasks with dual arm tele-operated manipulators. Visual aids using CCTV with zoom capabilities will be necessary to assist remote operations. Secondary waste normally generated during manual operations (coveralls, TiVex suits, respirators and booties) would be drastically reduced.

B. Scrap Metal Recycle

From the process of excessing inoperative and obsolete equipment and accumulating metal scrap normally generated from production operations, the FEMP as stock piled thousands of tons of scrap metal over the last 40 years. Knowing that the metal has varied levels of radioactive contamination, the scrap metal could not be sold to brokers prior to decontamination. The cost to

decontaminate the scrap would out weight the return from the scrap metal brokers. The cost to re-size the large structure and equipment, package and then ship to an offsite repository would be a greater cost to the taxpayer. The most logical step is to recycle the radioactively contaminated metal scrap for the use of manufacturing storage containers since the containers will eventually be buried in below- grade repositories, i.e. Nevada Test Site.

This scrap metal recycle system will use radioactively contaminated scrap metal as a resource to manufacture storage/shipping containers. The purpose of this effort is to reduce decontamination costs realized during metal cleaning to the level of "free release". Free release is a term used to indicate that the once contaminated material is now ready to be sold or distributed openly without restriction. The containers made from the contaminated metal would be used to store/ship radioactive wastes rather than purchase new containers and eventually contaminating the clean containers which inherently adds to the total waste volume.

C. Large-Volume Materials Handling & Packaging

Hundreds of thousands of cubic yards of radioactively contaminated soils, sludges, process residues, concrete, structural steel and construction rubble are being packaged or will be packaged over the next decade to support final remediation of the FEMP. Fork trucks, front-end loaders and other conventional means is the present mode of operation with intentions to improve the status quo. The standard storage/shipping containers are 55 gallon drums and 2 cubic-yard metal boxes. The present container sizes are conducive to packaging inefficiencies and the need for literally hundreds of thousands of containers to support the massive volumes. The more containers, inherently the more void space in the container per unit volume. With limited available space at waste repositories, volume minimization is a long term concern. Container design has not been sufficiently pursued with minimal efforts focussed on pre-compaction of materials prior to packaging.

Development and implementation of systems are needed to support handling of large volumes of waste and materials while maintaining control of airborne contaminants and dust. Process improvements to existing equipment is needed to further automate repetitive tasks and remove personnel from hostile environments. Highly efficient equipment that is sufficiently flexible to handle diverse waste forms is also needed. New waste container designs need to be investigated to get the most efficient packaging and storage arrangement. This is especially true to support volume minimization.

D. Container Inspection & Surveillance

Current CERCLA regulations require weekly inspections of stored radioactive materials. Some inspections are completed daily for suspect containers or containers stored in areas which would be an immediate impact to the environment if breached. The weekly inspections are presently done utilizing manual labor and clipboard recording. Single dimension bar code adhered to the container surface provides an identification number and date the contents were packaged. If more information is needed by the inspector, it is necessary to leave the storage area and obtain access to a computer to gain more information on the container in question.

Recall of drum conditions from week to week are virtually impossible since personnel rotation is a favored management control to reduce cumulative exposure on a per individual basis. If the same individual conducted the weekly inspection, there would be no guarantee of recall to identify gradual degradation, i.e. rust/corrosion.

Systems are currently being studied which could satisfy EPA inspection requirements, provide early detection of leaks, and assist in providing adequate information in making prompt management decisions. Various sensors are needed such as: alpha radiation detectors for container and floor monitoring; gamma detectors to obtain a radiological background baseline; video image storage for verification and week to week comparison of container integrity;two-dimensional bar coding for identification and content-specific data; and acoustic and chemical monitoring. The

appropriate sensor selection and configuration is important to both human and machine material handling.

IV. *CONCLUSIONS*

A brief review of some of the problems in hazardous and radiological materials handling which are amenable to remote manipulator and robotic solutions has been presented. Problems such as remote repackaging of drums, scrap metal recycling, large volume materials handling, and container inspection and surveillance were described to illustrate the FEMP site needs. The FEMP is attempting to make effective use of modern material handling technology to support site cleanup activities and reduce or eliminate exposure to personnel. This focus on environmental restoration is part of one of the most important problems facing the nation.

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