DEMONSTRATION OF INTEGRATED DECONTAMINATION AND CHARACTERIZATION TECHNOLOGIES AT RANCHO SECO AND BIG ROCK POINT COMMERCIAL NUCLEAR FACILITIES

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ABSTRACT

The purpose of the demonstrations carried out at Rancho Seco and Big Rock Point nuclear facilities was to test and evaluate the performance of the technologies developed by the Hemispheric Center for Environmental Technology (HCET) at Florida International University (FIU). The two technologies demonstrated at Big Rock Point and Rancho Seco nuclear facilities are integrated decontamination and characterization technologies that yield significant time and cost savings. This paper describes the demonstration of the two technologies at the respective sites and provides an assessment of the data collected and analyzed as a result.

INTRODUCTION

The deactivation and decommissioning of 10,000 buildings in the U.S. Department of Energy (DOE) complex will require the disposition of miles of pipe and millions of cubic meters of concrete. These situations require systems capable of decontaminating as well as characterizing the pipe and concrete. Current systems require individual application of characterization and decontamination, which in turn requires cessation of decontamination while characterization surveys are carried out.

The Mobile Integrated Pipe Decontamination and Characterization System (MIP-DCS) can decontaminate, characterize, and segregate piping and structural steel with little or no human interaction. Since most of the pipes are contaminated both internally and externally, there was no existing decontamination system usable as a solution. The MIP-DCS is capable of decontaminating pipes internally and externally. Thus, MIP-DCS avoids the other options of disposal of contaminated piping, which are labor-intensive and involve large costs. The MIP-DCS developed at HCET is composed of decontamination, ventilation, characterization, and off-loading modules. The system was demonstrated at Consumer Energy’s Big Rock Point Facility (BRP) in Michigan on April 7, 2000, as part of the cooperative efforts between the utility industry and the DOE.

The Integrated Floor Decontamination and Characterization System (IF-DCS) is a prototype system consisting of decontamination technology capable of cleaning concrete floor and a characterization technology capable of carrying out in-process measurement of the extent of the decontamination. The IF-DCS was demonstrated in the turbine-generator building of the Rancho Seco Nuclear Power facility in California from May 8 to 18, 2000, as part of cooperative effort between DOE-NETL, EPRI, and some other commercial companies.
MIP-DCS DEMO AT BIG ROCK POINT

Demonstration Objective

The overall objective was to demonstrate the system's ability to decontaminate pipes that were used in a radioactive environment for free release or reuse. The demonstration was also to test the innovative technology for the purpose of characterizing and decontaminating large bore pipes for use in order to reduce the cost to perform decontamination and safe disposal operations.

MIP-DCS Description

As mentioned in the introduction, the system is composed of decontamination, ventilation, characterization, and off-loading modules, as well as a conveyor mechanism for the pipe transfer between modules.

Figure 1 indicates the layout of the different modules of the MIP-DCS.

![Fig. 1. MIP-DCS System – Module Layout](image)

The pipes or structural elements to be cleaned are loaded onto the entrance conveyor of the decontamination module, which forwards the contaminated pipe to a centrifugal wheel grit blast chamber for external pipe decontamination.

A ventilation module equipped with a dust collector and nuclear-rated HEPA filtration system supports the decontamination module, ensuring operations are performed under negative pressure. The conveyor then transfers the pipe or structural element to a second station where the pipe is lifted, rotated, and blasted by using a compressed air lance for internal pipe decontamination. The pipe or structural element is then transferred to a characterization module capable of measuring reactor and uranium contaminants [2]. The module also detects whether the pipe is completely clean and sends the signal to the off-loading module.

The last of the modules is the off-loading system that receives the pipes from the characterization module and segregates the pipes based on signal received from the characterization module.
Demonstration Phases

Setup of containment structure

The containment structure erected at the Big Rock Point facility for the MIP-DCS consisted of a custom-made large tent, which was 140’ long, 60’ wide, and 45’ high. The purpose of the tent was to enclose the MIP-DCS against the environment and weather conditions. This tent had an opening that was 16’ x 16’ at either end of its length as well and two person-entry doors for easy access to the containment.

Figure 2 shows the construction of the containment for the MIP-DCS at the BRP facility.

System setup

After the containment tent was installed, the different modules of MIP-DCS were moved into place one by one according to the layout shown in Figure 1. The characterization module was the first one to be put into place, followed by the pipe-handling conveyors, the decontamination module, the ventilation module, and finally the off-loading module.

Figure 3 shows the decontamination module of the MIP-DCS after the complete system was set up within the containment at the BRP facility.
System demonstration

The MIP-DCS was demonstrated using contaminated 8-inch-diameter carbon steel and 17-inch-diameter stainless steel pipes. The pipes processed ranged between 5 feet to 7 feet in length. A total of 90 linear feet of pipe was processed with a total surface area of 655 ft². The total weight of the pipes cleaned by the system was approximately 10,000 pounds.

Figure 4 shows the pipe loading into the decontamination unit of the MIP-DCS during the demonstration at the BRP facility.

Pre-decontamination and post-decontamination radiological surveys were collected by BRP’s Health Physics (HP) personnel using a hand-held frisker and by taking smears for gamma analysis in the laboratory. Pipe contamination data were also collected by MIP-DCS’s characterization module and compared to the manual swipe collection.

Demonstration Results

The production rate obtained for the 8-inch-diameter carbon steel pipes averaged 0.17 ft/min. (pipe length considered is double the actual length since the pipes were decontaminated both externally and internally). The production rate obtained for 17-inch stainless steel pipes averaged 0.14 ft/min.

The total radioactivity readings varied among the different pipes processed. Total radioactivity levels for a carbon steel pipe were 10,000 dpm/100cm² (hand-held frisker) before decontamination and <5,000 dpm/100cm² after decontamination. The corresponding readings taken by MIP-DCS’s characterization module averaged 16,000 dpm/100cm² before decontamination and 326 dpm/100cm² after decontamination.

Total activity for stainless steel pipes was 750,000 dpm/100cm² (hand-held frisker) before decontamination and 60,000 dpm/100cm² after decontamination. For the same pipe, the MIP-DCS recorded an average of 54,464 dpm/100cm² after decontamination. The decontamination factors (DF) computed from the characterization data are 50 and 14, respectively, for the above-mentioned pipes.
IF-DCS DEMO AT RANCHO SECO NUCLEAR FACILITY

IF-DCS Description

The IF-DCS is composed of a decontamination technology, characterization system, and waste collection vacuum system. Figure 5 shows the IF-DCS.

![IF-DCS Side View](image)

The decontamination technology used is the electrically powered, self-propelled, portable centrifugal shot-blasting unit. The unit has a blast area of 13.8 inches (350mm) and is capable of removing 1/4 inch of concrete by mechanical abrasion. The characterization system consists of two large-area (6in × 4in) gas proportional detectors, with one in front of the shot blast chamber and the other behind the chamber, all mounted at a distance of 2” from the floor. The detectors have an efficiency of 1% for γ, 10%-30% for β, and 0-100% for α radiations.

A computer and a flat panel display, mounted on the machine, display the count rate from both detectors for a real-time measurement of decontamination. A custom software application developed by HCET controls the supporting modules and calibrates the detectors based on the work area.

Demonstration Description

HCET personnel trained Rancho Seco staff in the operation of various subsystems during the first week of demonstration. The actual demonstration commenced during the second week, with trained Rancho Seco personnel handling the system operations.

Figure 6 shows the demonstration of IF-DCS in progress at the Rancho Seco nuclear facility.
The demonstration was to be carried out by decontaminating concrete floor in the turbine-generator building of the Rancho Seco facility, where the contamination was caused due to leaks of slightly radioactive steam and/or water during plant operations. Data pertaining to the surface contamination levels in the demonstration area were collected through a pancake frisker survey carried out by the Rancho Seco HP personnel. The depth of the contamination was estimated to be within the range of 1/16 – 1/8 inch.

### Demonstration Results

#### Data collection

The Rancho Seco HP personnel collected surface contamination levels in the demonstration area through a pancake frisker survey before and after decontamination. The contamination levels were in the range of 200-1600 cpm/ft² before decontamination. The post-decontamination survey by Rancho Seco personnel showed readings less than background level, which is set to 60cpm/ft².

The IF-DCS also collected the pre-decontamination and post-decontamination surface contamination levels from its characterization subsystem. The IF-DCS measured contamination levels ranging 144-1440 cpm/ft² before decontamination and 36cpm/ft² after decontamination for the areas cleaned.

#### Data analysis

The survey data collected from the demonstration site by the frisker and the IF-DCS before and after decontamination were compared, and the comparison is depicted in the form of a graph shown in Figure 7.
The survey data in the graph are corrected counts per minute per the respective probe area in feet squared. The DFs as computed from the data obtained from the IF-DCS are 40 and 4, whereas those computed from the frisker survey data are 3 and 1.5.

CONCLUSIONS

HCET staff assessed the performance of the integrated decontamination and characterization systems through demonstrations carried out at Big Rock Point and Rancho Seco nuclear power facilities. As observed from the demonstration results, the integrated systems justify their capabilities.

The MIP-DCS reduces the quantity of disposable waste if the contaminated pipes were to be disposed instead of being cleaned and reused. The IF-DCS demonstrated the advantage of having an online characterization system that allows the operator to monitor the amount of decontamination during the process. The demonstrations further provided valuable information as feedback and evaluations from observers regarding possible modifications toward more effective and efficient systems.

ACKNOWLEDGMENTS

This report is based on work supported by the U.S. Department of Energy, Office of Environmental Management, Office of Science and Technology’s Deactivation and Decommissioning Focus Area, National Energy Technology Laboratory. HCET would like to thank Dr. Paul Hart for providing the opportunity and support to work on this project.

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