

## **DOE-EM'S In-Situ Decommissioning Strategy**

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### **ABSTRACT**

This paper addressed the current status of decommissioning projects within the Department of Energy (DOE) that have an end state of permanent entombment, referred to as in-situ decommissioning (ISD). The substance of a Department of Energy, Office of Environmental Management (DOE-EM) review of ISD and the development of a strategy are summarized. The strategy first recognizes ISD as a viable decommissioning end state; secondly addresses the integration of this approach within the external and internal regulatory regimes; subsequently identifies tools that need developing; and finally presents guidance for implementation. The overall conclusion is that ISD is a viable mode of decommissioning that can be conducted within the existing structure of rules and regulations.

### **BACKGROUND**

The term “In-Situ Decommissioning” refers to permanent entombment of a structure, and on a case-by-case basis, inclusion of its contiguous area and related facilities within the project scope. It is referenced by the acronym “ISD.” ISD is not a new concept; a search of the literature shows past use referring to undersea pipeline decommissioning as well as to nuclear power plants.

Within the United States, ISD has not been applied to commercial power plants. In contrast, within the DOE complex ISD has been fully implemented for one facility and has achieved Environmental Protection Agency (EPA) approval and State concurrence via the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process for several others.

### **PURPOSE OF THE STRATEGY**

At a number of sites the future EM scope, schedule and cost baseline planning includes ISD for selected facilities. EM undertook the development an ISD strategy to ensure a general recognition of ISD as a viable method of decommissioning. Such recognition is important when applying the body of rules, regulation, and guidance that are currently silent with regard to the ISD concept; in particular when the nuances of ISD require an objective perspective with regard to the original bases for those requirements. In addition, current ISD project field experience provides insights that are used to identify the need for tools and technology, and for developing guidance useful for future projects. The purpose was also to review whether there is a need for modification of current D&D policy within EM.

## **DEFINITION OF ISD**

Prior to this work, ISD has not been addressed in the DOE-EM lexicon. The definition suggested for use by DOE is:

“In-situ decommissioning (ISD) is a general expression used within the DOE to refer to permanent entombment of a facility that contains residual radiological and/or chemical contamination. The entombed end state is a result of established regulatory review and approval processes for decommissioning of DOE facilities.”

It is important that the reference to the DOE be kept in this definition because other references to ISD apply to offshore oil platforms and large diameter pipelines, which do not necessarily address residual contamination, and for which the regulatory regime is completely different. The use of “in-situ decommissioning” or “ISD” is for convenience in referring to the concept and to create a common definition. Currently there is no intent that ISD be formally defined for regulatory purposes.

## **CURRENT PROJECTS**

ISD has been and is currently in various stages of planning and implementation at Hanford, Idaho, and Savannah River. At all three, the site land use where the to-be-entombed facility is located is one of perpetual federal institutional control, which means maintaining control until the facility/area can meet DOE O 5400.5 requirements for unrestricted release.

There are differences in the details of planned implementation at each site. These differences result from the physical attributes of facilities and their contents, the types and distribution of radiological and chemical contamination, extent of hazardous materials, environmental characteristics, and local regulatory agreements and preferences. Regardless, they all will meet the long term performance objectives as enforced by the EPA under CERCLA and by the DOE under the Atomic Energy Act.

The projects at these three sites are summarized below. There may have been facilities that were buried in place prior to the establishment of DOE-EM (anecdotally; the BORAX reactor experiment). These are not subject of the ISD strategy.

### **Hanford**

In 1996, the DOE initiated the Canyon Disposition Initiative (CDI) to develop a disposition path for Hanford’s five canyons. The U-Canyon (Figure 1) was selected as the pilot for this initiative. The project involved significant multi-year efforts including the implementation of a Large Scale Demonstration Project, which was part of a former DOE technology program.

The U-Canyon is a very large, reinforced concrete structure. Consistent with the CERCLA Final Record of Decision issued in October 2005, the U-Canyon will be partially cleaned out and decontaminated, equipment will be consolidated in below grade cells, the above grade portion will be partially demolished, the remainder will be filled with grout, and a cover system will be emplaced. At present several optimization studies have been initiated or are planned.



**Figure 1 – U-Canyon**

### **Idaho National Laboratory (INL)**

Closure of the Old Waste Calcination Facility was completed in 1999, making it the first completed project within the DOE complex to be closed in an entombed manner. The calciner processed high-level radioactive waste from 1963 to 1987; calcining waste from 1963 through 1981 followed by evaporator operations from 1983 through 1987. The Hazardous Waste Management Act (HWMA)/RCRA Closure Plan was approved in August 1997 and closure was completed in 1999. Post closure monitoring and care is conducted under a post-closure permit.

An approach being applied at INL to several test reactors and other facilities is to demolish the above grade superstructure (much of which is not reinforced concrete), partially clean out and decontaminate the below grade portion (which is robust concrete structure), and fill the remaining basement with grout. In these cases, the reactor vessels and selected other radioactive components are removed and disposed at the local CERCLA disposal facility. It should be noted that these reactor vessels are considerably smaller than those at Hanford and Savannah River.

In addition, at least one set of basins (CPP-603) have been grouted in place, but are yet to be permanently closed.

### **Savannah River Site**

At Savannah River, the P-Reactor Area Closure Project is in an early stage and the final mode of entombment has not been decided. P-Reactor (Figure 2) is one of five reactors at the site and second to go operational. Operations were suspended in 1988 and the facility was placed in cold shutdown in 1991. The reactor has been de-fueled and is currently undergoing hazard removal and deactivation.

The reactor is being addressed as a sub-unit of the P-Area Operable Unit (PAOU). The P-Area encompasses 100 acres over which 25 ancillary buildings and structures have been removed; only the reactor and some co-located structures remain.



**Figure 2 – P-Area**

As currently envisioned, the to-be-selected ISD alternative will leave some level of fixed contamination and equipment in place; the largest sources remaining will include the disassembly basin and the reactor vessel. Contaminated above grade equipment will be removed and below grade spaces, drains and equipment will be grouted in place. Details include removal of the stack, actuator tower, conduits, cables, hangers, steel superstructure and miscellaneous steel outside façade. The remaining structure will be sealed to prevent intrusion by humans and animals. Six basic alternatives have been identified, most of which vary in the extent of the remaining above grade portion of the facility.

## **POTENTIAL NUMBER OF ISD PROJECTS**

The Facility Information Management System (FIMS) is DOE’s database that maintains the attributes and characteristics of all its facilities. FIMS was screened to identify facilities that are potential for ISD; the purpose of this screening is simply to provide a perspective on the magnitude of facilities that could be decommissioned to an ISD end state. From a strategic viewpoint, it is useful to know if the potential ISD facilities number in the tens or in hundreds. An idea of the land area (i.e., footprint) represented is also of interest.

Criteria for ISD have been applied to first create a list of facility types and then to down-select on a facility-by-facility basis. There are technical criteria, such as robustness of construction of the facility; and non-technical criteria, such as perpetual institutional control of the site (the latter cannot be determined from FIMS). The screening process employed is shown in Figure 3. Tanks and waste storage vaults were automatically excluded since their closure is being addressed by other programs. Facilities were eliminated by categories based on a criterion of “obviously” not being relevant (for example, roadways, sidewalks, parking areas, storage yards, pads, and utility services). Mobile offices, trailers, and any record with “Office Building” designation were eliminated since typically they are not structures that would satisfy the robust structure criterion.

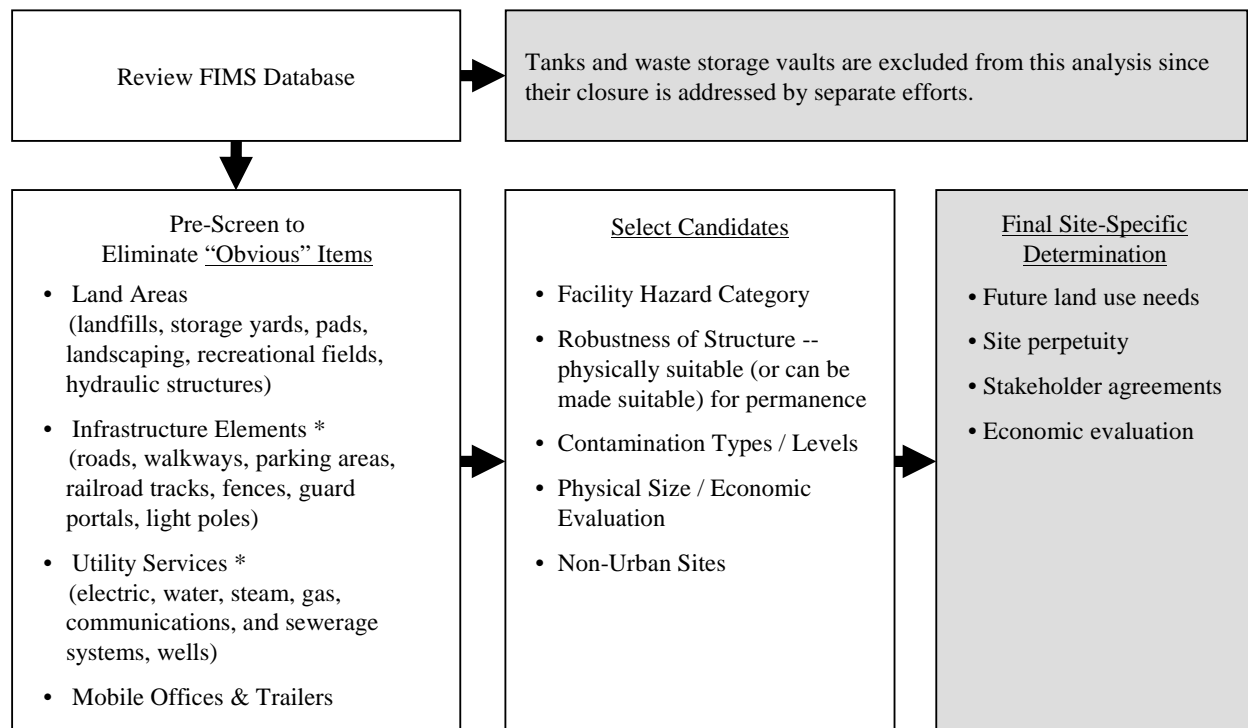
The remaining database population was culled by:

- Eliminating all records with Hazard Category field as “Not Applicable” or “Blank” because from a strategic DOE-EM perspective, only contaminated facilities are of interest.
- Selecting attributes that represented robust construction using the database Model Building fields of “Concrete Moment Frame,” “Concrete Shear Walls,” and “Pre-cast Concrete Frames w/ Concrete Shear Walls.”

Manual additions were made to the database sort to account for idiosyncrasies in the FIMS database (such as missing records, inconsistent attribute assignment, data entry errors, etc.). Judgment was applied to manually delete unlikely facilities. These included:

- Laboratory structures for which removal of equipment (such as glove box units and lab hoods) will reduce the extent of contamination so that demolition (or reuse) becomes attractive; or the facility will no longer be radioactive, thus eliminating its potential for ISD.
- Structures located at small sites where the value of real estate dictates that building sites be reused to support new and/or ongoing mission needs.
- Storage or other miscellaneous structures unlikely for ISD because of construction style or prior use.

The screening confirmed the intuitive perspective that the most likely facilities for an ISD end state are production reactors and canyon process buildings. Other facilities (i.e., diversion boxes, exhaust filter houses, and other process facilities) that have similar methods of construction and extensive levels of contamination are also considered for an ISD end state.



\* Infrastructure elements and utility services may be abandoned in place at some sites, but by definition this is not considered ISD.

**Figure 3 – Screening Steps to Identify Potential ISD Facilities**

Screening FIMS using the criteria described above resulted in a total of 80 facilities at 10 sites representing a footprint of about two million square feet. With a few exceptions these are not included in any current project plans for ISD, although the overall site baselines do make such an assumption for some. Another 90 facilities had the structural attributes, but were eliminated from the list for the following reasons.

- Small size (< 1,000 sq ft) making ISD economically unattractive
- Removal of contamination source that will render building non-radioactive and/or make demolition or reuse attractive.
- Located on small site or urban where reuse of the property clearly has considerable worth.
- Not likely because of construction style or previous use.

The count of 80 potential candidates does not include facilities that cannot be obtained from FIMS for the following reasons:

- Facilities that are robust concrete below grade but steel structure above grade are not discernable from the data base fields
- Facilities that are not yet constructed, such as the Waste Treatment Plant at Hanford or the Salt Waste Processing Facility at SRS.

It is judged that these two considerations might double the total, resulting in an overall estimate somewhere between 150 and 200 facilities that could be considered among the various sites.

## **POTENTIAL TECHNOLOGY NEEDS**

A cursory evaluation of potential ISD technologies was performed to identify existing technologies and gaps. Results indicate the following potential needs:

- Improved simulation of cementitious barriers for the purpose of better modeling of concrete as a barrier with the expectation that the simulation results will show much lower risk and dose for a given source.
- Development of screening factors for remaining radionuclides to quickly estimate, on a planning basis, the allowable curie loading related to the dimensions and properties of a facility's existing structure with grout that may be added to fill voids.
- Grouting of large spaces; most, if not all, ISD projects involve placement of large quantities of grout in cells, basements, and other large open volumes within a structure. Delivery and placement of concrete is a state of the art technology. Nevertheless, there are optimization opportunities that should be pursued for efficiency and assurance of proper placement and for encapsulation of various waste forms.
- Significant sources within and outside of an ISD facility walls; there are instances of highly radioactive or difficult to access sources associated with a canyon or reactor building that may become entombed along with the facility. There will be needs to characterize such sources, perhaps remove some of them, and to permanently stabilize others. The focus in this area is most likely by application of remote technologies.

It is important to note that this is a working list and does not represent decisions as to what to pursue. It is further expected that additional technology opportunities will be identified.

## **REGULATORY FRAMEWORK**

DOE decommissioning projects are regulated primarily under an existing regulatory framework as non-time critical removals per the joint EPA-DOE policy on decommissioning of DOE facilities under CERCLA. The EM development of strategy indicates that ISD should be similarly regulated.

Although ISD should not be considered a waste cell, the question arose as to whether ISD projects should be regulated similarly under DOE O 435.1, the Radioactive Waste Management Order. The key issue is one of when a CERCLA – DOE O 435.1 crosswalk must be conducted for purposes of DOE acceptance of the CERCLA Record of Decision (ROD). It was concluded that the requirement to prepare a crosswalk for an ISD project applies only when CERCLA response actions include the post-1988 importation of wastes from outside the CERCLA Area of Concern (AOC) that is unrelated to the facility's mission, thus in effect creating a facility for permanent waste-disposal that is subject to the DOE O 435.1.

In conducting a crosswalk, the objective is to identify those crosswalk items that show substantive compliance with the DOE O 435.1 without further effort and, conversely where additional effort would be required to satisfy the requirements of the Order. A detailed look at the crosswalk items by experts at the Savannah River National Laboratory (see acknowledgements) resulted in the preliminary conclusion that a limited number of the crosswalk items would be applicable to an ISD situation, and that of these limited number all but two or three result in substantive compliance without further work. One example of where additional work might be required is to develop waste acceptance criteria for waste "imported" from outside the AOC.

## **USE OF ISD FOR WASTE DISPOSAL**

A February 2005 Audit Report, DOE/IG-0672, *Department of Energy Efforts to Dispose of Hanford's Chemical Separation Facilities*, was critical of the initial planning for the Hanford Canyon Disposition Initiative for not sufficiently considering the value of using the Canyons for waste disposal. However, DOE's reason for not considering waste disposal were: a) the primary objective of the Initiative was to develop a viable disposition path for the five canyon buildings at the Hanford Site and not to determine the feasibility and benefit of using the canyons as disposal sites; and b) the decision to eliminate immobilized low-activity waste as a viable waste stream for the canyons was the result of an informed decision to avoid jeopardizing compliance with Tri-Party Agreement milestones.

During the course of developing this strategy, the subject of "importing" of waste not associated with the ISD facility's mission has arisen several times in the context of regulatory review discussed above. It is clear that ISD of facilities of robust concrete construction for which void spaces are grout-filled can provide performance as a disposal location for some wastes that can be as good as or better than disposal cells. The feasibility of such importation must be addressed on a project-by-project basis during the evaluation of alternatives per the CERCLA process and the results of the alternatives' performance assessment compared with the EPA cancer risk assessment criteria for decommissioning.

## **SUMMARY OF THE ISD STRATEGY**

Based on the initial identification of about 80 facilities where ISD could be the end state, the DOE has written a strategy for ISD that combines experience to date with input from its field offices and headquarters. The strategy addresses several points:

- It provides a clear definition that ISD is permanent closure and recognizes that ISD of contaminated facilities is a viable option that can be conducted within the existing regulatory framework.
- The recommendation, selection, and approval of a facility for ISD are clearly local responsibilities and are to be conducted under the established regime of regulatory authority for which EPA has the lead, and addresses DOE role as lead agency, federal facility agreements with States, and local stakeholder interests. The decision process will require a tailored approach to address a variety of specific factors at individual sites.
- With regard to policy, there is no compelling need for an “ISD policy;” clarification with regard to existing policy is provided.
- The benefits and impacts of ISD are described using information from the current projects.
- “Importation” of waste is recognized as a possibility. An efficient way of conducting the CERCLA – DOE O 435.1 crosswalk is described.
- The overall steps for an ISD project are presented.

Overall ISD can be a viable alternative in specific circumstances for substantial cost savings while providing environmental and worker safety equivalent to or better than the alternative of demolishing an entire facility and transporting the resulting massive quantity of waste to a disposal cell.

## **ACKNOWLEDGEMENT**

The Savannah River National Laboratories (SRNL) is authoring a companion report: “Applicability of Performance Assessment Methodologies to In-Situ Decommissioning.” This work contributed significantly to development of the strategy with regard to regulatory treatment, performance assessment and recommendations for research and development.