EM-5.22 Lessons Learned Bulletin

October 2018

In Situ Decommissioning

Contact: **Rodney Lehman,** rodney.lehman@em.doe.gov
301-903-6104

Date: **10/16/2018**

When the DOE Office of Environmental Management is deciding how best to decommission radioactively contaminated facilities, one alternative that is not too well known, but has been used in the past, should be considered. This option is In-Situ Decommissioning (ISD). ISD is the permanent entombment (in grout or concrete) of a facility that contains residual radiological and/or chemical contamination. ISD has been used at the Savannah River Site, Idaho and Hanford to decommission reactor and canyon facilities. In some cases, the ISD approach can be a safer, and more cost-effective alternative to both demolition and complete removal of a structure and its content (including the cost of transport and disposal of waste). In addition, the effective use of ISD can reduce human health and safety risks while helping to attain sustainability goals through the reduction of petroleum consumption and waste generation. The disadvantage to using ISD, however, is that long term maintenance and surveillance is required. ISD is a long term commitment to maintaining the site, whereas other decommissioning options may allow eventual release of the site and its land for commercial uses.

This lessons learned bulletin provides a discussion on the use of ISD versus the more commonly applied D&D approaches and also includes lessons learned in applying this option at DOE sites.

Discussion:

Background

In Situ decommissioning is the permanent entombment in grout of a contaminated facility. Entombment means that facilities are permanently encased within a structural material (such as grout or concrete), and then are monitored until the radioactivity decays to a level that will permit release of the facility. ISD is not a revolutionary concept. Since the 1970s, the U.S. Nuclear Regulatory Commission (NRC) has recognized entombment as a decommissioning option. In some, but not all cases, the above grade part of the facility is removed and the below grade portion is filled with grout. The selected facility is of robust construction, usually of reinforced concrete that provides a barrier to the migration of contamination from the interior to the outside environment. All significant interior voids in the facility including piping and tanks are backfilled or grouted. Some ISD projects will leave below grade contaminated equipment in place and then use the grout to entomb them; other ISD projects will load above grade contaminated material into the below grade portion of the facility to limit waste disposal. Importation and disposal of wastes not specifically derived from the facility to be entombed has not been attempted, although a GAO audit strongly suggests its reliability.

ISD leaves the facility in a permanent decommissioned end-state. This final condition is passive, i.e., there is no further operational activity required within the facility. However, these type of projects do require monitoring and are presumed to be under indefinite institutional control of the U.S. government, therefore not allowing any potential reuse of the land. [1]

Discussion

The DOE Office of Environmental Management has many excess radioactive facilities that require deactivation, decommissioning, demolition and disposal of large amount of contaminated waste. Many of the facilities are sturdy, hardened buildings containing contaminated equipment and process equipment that may include enormous lengths of piping and tons of waste. It is for these facilities that ISD may provide a more cost effective and equally safe alternative than the standard demolition and disposal. There are a number of factors to be considered in choosing ISD over standard D&D[1]:

- For a sturdy, hardened facility, does it make sense to demolish the structure and then transport the waste to a disposal facility that could either be a few miles away or across the country? The environmental consequences

are comparable or less than the alternative of complete removal – either the ISD facility or the waste disposal facility must both be permanently monitored.
- Is the exposure to radiation for the field workers being considered? ISD in many cases provides the ALARA (as low as reasonably achievable) solution to having to expose workers (and potentially the environment) to significant contamination as demolition occurs.
- With the limited resources at hand for D&D, is it less costly to use ISD instead of other D&D end state alternatives?

There are several criteria that need to be addressed before selecting the ISD approach. These include:
- Facilities that are located on DOE federal sites where controls will be in place for the foreseeable future. This will rule out most urban and suburban locations and other DOE sites where government ownership is not considered indefinite.
- Candidate facilities must have a robust construction characteristics, and be of sufficient size that there is a clear advantage to entomb rather than demolish. Most facilities will have large below grade openings that make it easier and more technically feasible to fill with grout.
- Safety of workers should be a primary concern with ISD in most cases providing much less potential of worker exposure to radiations versus having to handle and transport waste.
- Long term risk factors should be considered such as the comparison of the risks of ISD to risks of permanent disposal of waste at an on- or off-site waste disposal facility.
- A comprehensive and highly defensible safety case (release function modeling, exposure modeling, performance assessments, etc…) must be prepared to bound as left conditions.

The type of facilities that could be considered as ideal for ISD are[2]:
- Process canyons
- Large reactors
- Small reactors below grade
- Other robust concrete facilities

There have been approximately 80–90 DOE facilities identified as strong candidates for ISD through the Facilities Information Management System database[2].

Examples of completed In Situ Decommissioning projects in the DOE complex include[3]:
- Savannah River Site
    - P-Area and R-Area Production Reactors
    - Heavy Water Components Test Reactor (HWCTR)
- Hanford Site
    - U-Plant Canyon
- Idaho National Engineering Laboratory Site
    - Old Waste Calcination Facility
    - Fuel Reprocessing Facilities Chemical Processing Plant
    - EBR II/FMC 725 Experimental Breeder Reactor II

Conclusion

In some cases, the use of In Situ Decommissioning may prove to be a more effective means of decommissioning radioactive facilities across the DOE complex. This option has already been used at multiple sites including Hanford, Idaho and the Savannah River Site. There are a number of criteria which must be evaluated and met in order to choose permanent entombment of a facility over the more stand deactivation, decommissioning, demolition and disposal of waste at licensed disposal facility. In many cases, from both a safety and cost perspective, it may be more effective to choose the filling of a below grade facility with grout rather than demolishing, handling and transporting waste to a disposal site. However, the disadvantages of this option are the requirement for long term or possibly perpetual institutional control versus the near term potential for reuse of the land.

Recommended Actions:

Lessons Learned[1]:

- Contracting and Subcontract Management – A decision must be made of how much work should be subcontracted versus self-performed. It is important to realize that there are companies that are familiar with handling large quantities of grout and concrete, however, they will not be familiar with a radiologically contaminated facility. So the decision of what to subcontract, and how the interfaces are controlled are very important in an in situ decommissioning project.
- Utilization of remote access technologies to collect needed characterization data can help since many ISD facilities can be difficult to access due to physical constraints and extent of contamination.
- Conducting engineering studies well in advance of actual project start is beneficial in determining best path forward for support of field work.
- Investigate the design and actual construction of facilities to be demolished in order to have a good understanding of the robustness of structures, such as the amount of reinforced steel in the structure.
- Ensure that water management plans are in place to contain rain water and dust suppression water. Also ensure that piping containing liquids, even though reported as tapped and drained, are empty of liquids.
- Ensure that there is proper ventilation for tanks, vessels, and piping to ensure that complete filling of these area with grout is accomplished since there must be an exit path for air as the process of filling is underway.
- Utilization of different types of visualization methods and hardware can be very helpful in the planning and work management of an ISD project such as 3D physical models, graphical display methods, or sacrificial video cameras in areas that are hard to view.
- Awareness of casually written technical statement need to be completely understood with regard to the real project requirements. For example, grout typically does not provide structural stability, even though technical descriptors of grout specifications can include "…with good compressive strength". Misunderstanding this statement can lead to the use of over specified grout.
- A thorough understanding of material-grout interaction is needed. As an example a different and specific grout formulation had to be used in the reactor vessel (SRS) to prevent the generation of hydrogen gas.
- Understand the overall logistics and coordination of an ISD project. For example, having an on-site batch plants, even if temporary is extremely beneficial. In fact, having a second source, even if off-site is important to ensure or increase capacity. ISD projects require significant number of trucks to transport the grout to the job site, so traffic control are essential.
- Attention to detail for placement of grout is important. Different types of grout formulations may be used for filling of large bulk voids, a more flowable grout for filling pipes and a more rigid formulation to replace or fill structure walls or barriers.

Critical Decision(s):	CD-0 to CD-4
Facility Type(s):	All
Work Function(s):	Project/Program Management
Technical Discipline(s):	All

References:

1. "DOE EM Project Experience for In Situ Decommissioning", Department of Energy Office of Environmental Management, Office of D&D and FE, EM-13, February 2013.
2. "In-Situ Decommissioning – A Strategy for Environmental Management", U.S. Department of Energy Office of Engineering and Technology,

3. Bergren, Chris and Long, Tony, “Deactivation & Decommissioning at SRS”, DOE Office of Environmental Management Robotics Team Visit to SRS, December 8, 2015.
4. “Agencies from U.S., U.K., Canada, and Japan Discuss In Situ Decommissioning”, U.S. DOE Office of Environmental Management, January 23, 2018.
5. Langton, C.A., Stefnako, D.B., Serrato, M.G., Blankenship, J.K., Griffin, W.G., Long, J.T., “Use of Cementitious Materials for SRS Reactor Facility In-Situ Decommissioning”
6. Negin, Charles A., Urland, Charles S., Szilagyi, Andrew P., “In Situ Decommissioning Lessons Learned – 14042”, WM2014 Conference, March 2-4, 2014.
7. Lee, Patricia L., Gladden, John B., Jannik, G. Timothy, Langton, Christina A. , Serrato, Michael G., Urland, Chuck, Reynolds, Erick, “Technology Requirements for In Situ Decommissioning (ISD) Workshop Report”, SNRL-RP-2009-00269 Rev 0, Savannah River National Laboratory, June 2009.
8. Laraia, M., “On-site disposal as a decommissioning strategy”, International Atomic Energy Agency, IAEA-TECDOC-1124, November 1999.