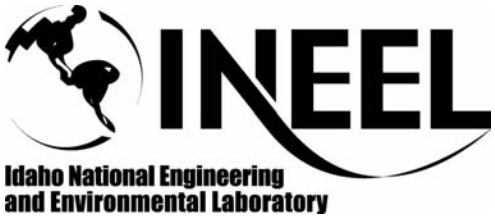

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Improving D&D Planning And Waste Management With Cutting And Packaging Simulation

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IMPROVING D&D PLANNING AND WASTE MANAGEMENT WITH CUTTING AND PACKAGING SIMULATION

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This paper discusses improving D&D planning and waste management through computer simulation of the cutting and packaging of waste arising from decommissioning projects.

Introduction

The increased amount of decontamination and decommissioning (D&D) being performed throughout the world not only strains nuclear cleanup budgets, but places severe demands on the capacities of nuclear waste disposal sites. Although budgets and waste disposal sites have been able to accommodate the demand thus far, the increasing number of large facilities being decommissioned will cause major impacts to the waste disposal process. It is thus imperative that new and innovative technologies are applied within the D&D industry to reduce costs and waste disposal requirements for the decommissioning of our inventory of large and aging nuclear facilities.

One of the most significant problems reactor owner's deal with is the accurate determination of the types and volumes of wastes that will be generated during decommissioning of their facilities. Waste disposal costs, restrictions, and transportation issues can account for as much as 30% of the total costs to decommission a facility and thus it is very important to have accurate waste volume estimates. The use of simulation technologies to estimate and reduce decommissioning waste volumes provides a new way to manage risks associated with this work. Simulation improves the process by allowing facility owners to obtain accurate estimates of the types and amounts of waste prior to starting the actual D&D work. This reduces risk by permitting earlier and better negotiations with the disposal sites, and more time to resolve transportation issues. While simulation is a tool to be used by the D&D contractors, its real value is in reducing risks and costs to the reactor owners.

An example of how simulation can help occurred during decommissioning of the Connecticut Yankee reactor in the USA. This occurred before simulation software for waste volume reduction was developed and thus accurate estimates were not available at the beginning of the project. A contract was established for the removal and disposition of all wastes. After decommissioning work started however it was determined that the actual volumes of expensive to dispose waste types were much larger than expected. This caused severe budget problems and resulted in shutdown of the work until a new contract could be established for transportation and disposal of the waste. These issues could have been avoided had simulation technology been applied before

the project was started. Since most D&D projects are based on a turnkey type contract for the disposal of some estimated amount of waste of a mean density, big risks are incurred by inaccurate estimates of the waste volume. This places demands for the contractor to get better waste volume estimates, or, that we change the way we do waste disposal contracts. The value added by the use of simulation technology is to reduce the cost and risk of performing decommissioning work.

Current Planning Process

Well-defined sets of actions are taken in the process of decommissioning a nuclear facility. These start with shutdown of the facility and end with completion of D&D operations. Between these two actions other activities such as surveillance and maintenance, characterization, writing the D&D plan, selection of a decommissioning contractor, etc. must be performed. Following are brief descriptions of these elements of the current decommissioning planning process.

Facility Shutdown. At the end of the useful, or planned, life of a nuclear facility steps are taken to cease operations activities and shut it down in preparation for decontamination and decommissioning. The goal of this activity is to remove all liquids, hazardous chemicals, etc. and leave the facility in a safe and stable condition. An attempt is made to minimize associated surveillance and maintenance costs until such time that D&D can be started, while at the same time protecting the workers, the environment, and the public.

Surveillance and Maintenance. These activities maintain the facility in a safe and stable condition between the time operations stop and it is shut down, and the time D&D activities start. In general surveillance and maintenance activities should include periodic inspections, prevention of intrusion by birds, animals, and people, and any effort needed to insure that contaminants are not spread.

Characterization. Before a meaningful D&D plan and cost estimate can be prepared the facility must be thoroughly characterized. This means that a physical, radiological, and chemical inventory must be made of the entire facility. This is done to identify the type, amount, and location of all hazardous materials in the facility. From this information, waste volumes, costs, personnel exposure, and any unique technologies required to decommission the facility can be identified and included in the D&D plan. The results of the characterization are reported in a Characterization Report that becomes the basis of the Decontamination and Decommissioning plan. Guidance on the preparation of Characterization plans for nuclear facilities can be found in ASTM E1892 Standard Guide for Preparing Characterization Plans for Decommissioning Nuclear Facilities.

D&D Plan. The D&D Plan becomes the guide, or basis, for performing the decommissioning operations. It is the document that is approved by the customer, regulators, etc. The D&D Plan describes the work that is to be done, how it will be done, the end state and release, or completion criteria, for the facility, and defines all hazardous aspects of performing the D&D operations work. It also provides an overview of the projected budget and schedule for the project. This plan should also specify the amount and types of wastes expected from the project and where they will be disposed. D&D plans are often supported by other documents including Waste Management Plans, Finance Plans, Health and Safety Plan, Quality Assurance Plan, Emergency Plan, Radiological Protection Plan, Security Plan, and Environmental Monitoring Plans. Guidance on the preparation of D&D plans can be found in ASTM Standard Guide E1281 Standard Guide for Nuclear Facility Decommissioning Plans.

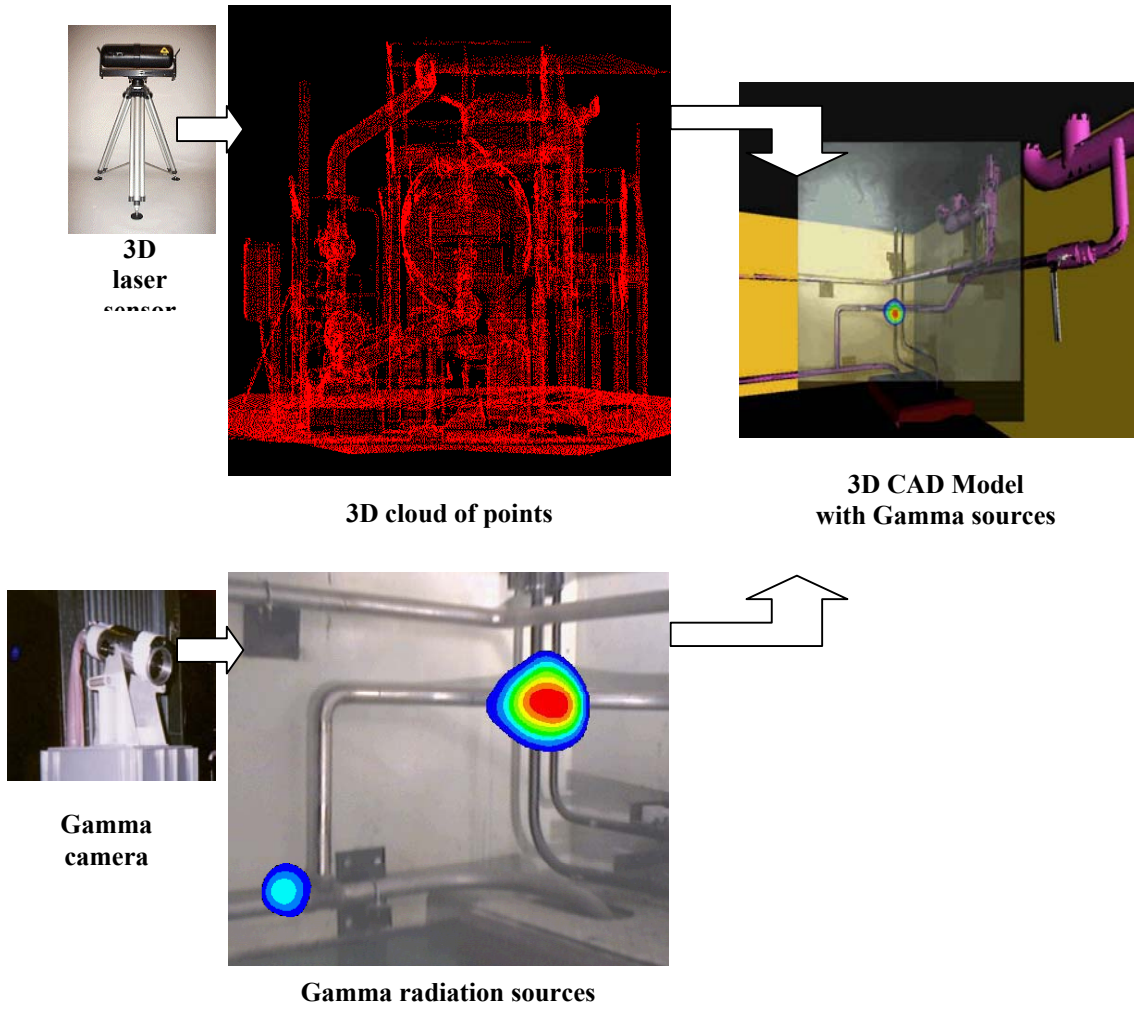
Award of D&D Contract. In most cases the actual decommissioning operations will be performed by a decommissioning operations contractor (DOC). Thus a document such as a Request for Proposal (RFP) will need to be prepared. Whatever means is used to obtain a DOC, care must be taken to insure that all aspects of the work are covered to the satisfaction of the customer, regulators, and other stakeholders. Periodic review of DOC performance against the D&D plan by the customer, and perhaps outside consultants familiar with D&D activities, is recommended.

Operations. Decommissioning operations are performed using the D&D Plan and other supporting documentation, including where appropriate, detailed operating procedures. D&D operations are basically a "deconstruction" activity complicated by the presence of radiation fields and other hazardous materials. Care must always be exercised to conduct these activities in a safe manner with an emphasis placed on maintaining exposures to works As Low As Reasonably Achievable (ALARA). In recent years many new and innovative technologies have become available that greatly improve D&D operations. These generally reduce costs, shorten schedules, and improve safety for the workers. No D&D project should be attempted without reviewing the decommissioning plan for opportunities to incorporate these new technologies. Operations are not complete until the previously agreed final criteria for the site or facility are attained. It is often a good idea to seek outside review of the final status of the site to help insure that all completion, or release criteria have been met.

New Technologies available

- Characterization tools are on the shelf. They include hand-held radiation detectors which also provide isotopic radiation information, portable lead and PCB analyzers, and a variety of robot deployed survey instruments. Technologies to visualize and characterize underwater areas such as fuel pools are also available.
- Equipment is also available to provide automated physical, radiological and chemical characterization of waste.
- 3D CAD software such as PRO-E, AVEVA, SOLIDWORKS are available to create three-dimensional models of the facilities. They can input data from laser scanning to insure that the 3D model is faithful to the as-built facility (Figure 1).
- In addition to physically modeling the facility, radiological simulation tools allow users to display models in 3D of radiological sources in the facility, and to simulate exposure to workers.
- Although current practices still involve manual packaging of waste items, software is being developed to optimize waste container filling, and to automate packaging of the containers.

Figure 1



How Simulation Improves the Process

As indicated, improvement in the overall process is needed. This can be done through a refinement of the existing process. If more and better data are available (better, faster, cheaper data), and these are used with new and innovative technologies, improvements in the overall D&D planning process can be attained. New technologies do exist in the areas of characterization, process planning, and simulation. When these processes and technologies are combined, great improvements can be achieved in the overall D&D program with resulting improvements in worker safety and significant reductions in the volumes of waste disposed.

The new simulation process and technologies described above provide many advantages to the overall D&D process. Under the right circumstances huge savings can be made in the volumes of waste disposed, exposures to workers, costs, and project schedules. These are extremely important considerations when planning and executing D&D work. One of the negative attitudes associated with nuclear power is the belief that decommissioning and waste disposal are difficult and costly to deal with. Any technology that reduces the amount of waste, improves the safety of workers, and at the same time reduces costs and shortens schedules should be incorporated in the planning process.

There are drawbacks associated with the use of these technologies however. They do require personnel skilled in the use of highly complex computer software. Creating a three dimensional model of a nuclear facility can be time consuming and somewhat expensive. Thus this process is more cost effective when applied to large complex facilities, which will generate large volumes of waste when decommissioned. It is probably not cost effective to apply this process to small facilities, which are simple in design and hence do not present much challenge in either the physical dismantlement or waste disposal aspects of the D&D process.

Although this technology is in the development and demonstration stage, there are actual D&D examples of its potential benefit. The first of these examples occurred during decommissioning of an old laundry facility at the Idaho National (INL) in the U.S. This facility had previously been used to launder radioactively contaminated clothing for the workforce at the INL. It was shut down and in the process of being decommissioned. A small basement room of the facility was filled with piping, small tanks, and valves. It was decided to model the room using the Decontamination, Decommissioning, and Remediation Optimal Planning System (DDROPS), which had been developed for this purpose. Using this software the room was modeled using the DDROPS software that provided optimized cutting locations. The modeled cut pieces were then placed in model waste containers using the software. This process indicated that all of the waste in this room should fit into less than two waste containers. Workers were then allowed to proceed with the job using cutting and packaging procedures that were standard practice at the time. They used five waste containers to package the waste from that room. A photograph of the room is shown in Figure 2 and the DDROPS model is shown in Figure 3.

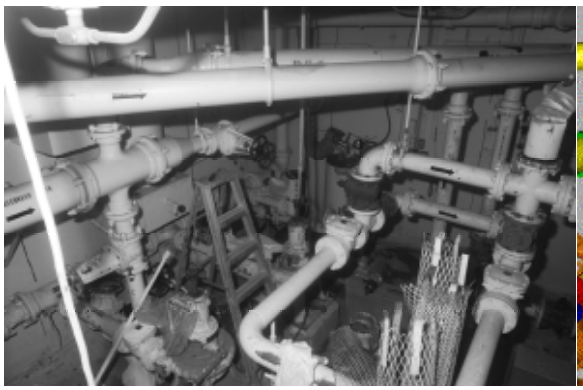


Figure 2

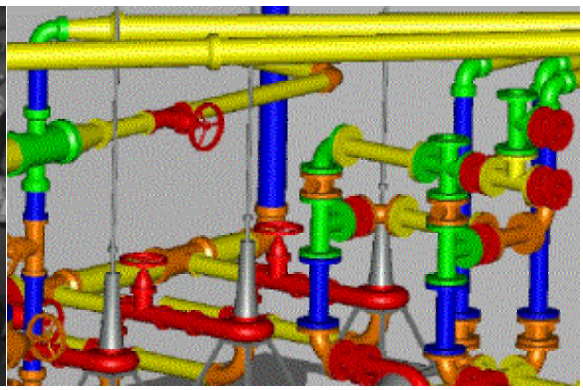


Figure 3

Another example of the benefit of using simulation to enhance D&D operations occurred while decommissioning the Advanced Reactivity Measurement Facility (ARMF) reactor at the INL. In this case it was believed that because of high radiation fields it would be necessary to use underwater cutting techniques to disassemble the core support structure, an expensive and time consuming process. After modeling the structure and applying the VizRad feature of DDROPS it was determined that the structure could be removed in one piece and cut into smaller pieces using conventional cutting technologies. This saved a large amount of time and money. A reproduction of the VizRad DDROPS model is shown in Figure 4.

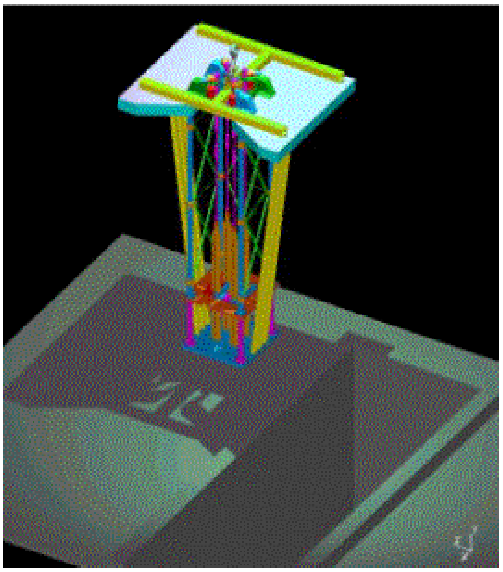


Figure 4

Conclusions

Although these new and innovative simulation technologies are available, and have been demonstrated in actual decommissioning projects, some additional development work is needed. This additional work is primarily in the areas of making the technology more user-friendly, and in more efficient ways of inputting facility details into the software. Making it more user-friendly is simply a matter of adding details to the software that will allow less experienced operators to utilize it. At the present time facility input is done by typing details from facility engineering drawings into the computer and allowing the software to create the model. More advanced methods, such as input from Laser scans, would be faster and more accurate. This technique has been developed for other purposes and it is believed that adequate capability in this area exists. We are confident that these technology upgrades can be accomplished.

If enhancements in this technology can be completed and applied to large, complex decommissioning projects the results will be safer, faster, less expensive decommissioning of the world's outdated and shut down nuclear facilities.