

# Designing Reactors to Facilitate Decommissioning

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# **DESIGNING REACTORS TO FACILITATE DECOMMISSIONING**

## **Introduction**

Critics of nuclear power often cite issues with tail-end-of-the-fuel-cycle activities as reasons to oppose the building of new reactors. In fact, waste disposal and the decommissioning of large nuclear reactors have proven more challenging than anticipated. In the early days of the nuclear power industry the design and operation of various reactor systems was given a great deal of attention. Little effort, however, was expended on end-of-the-cycle activities, such as decommissioning and disposal of wastes. As early power and test reactors have been decommissioned difficulties with end-of-the-fuel-cycle activities have become evident. Even the small test reactors common at the INEEL were not designed to facilitate their eventual decontamination, decommissioning, and dismantlement. The results are that decommissioning of these facilities is expensive, time consuming, relatively hazardous, and generates large volumes of waste. This situation clearly supports critics concerns about building a new generation of power reactors.

## **DOE Order on New Nuclear Designs**

Understanding limitations of the original designs, and anticipating public reluctance to accept more waste and higher costs, the Department of Energy (DOE) issued an Order on Radioactive Waste Management. This Order (DOE 5820.2A) not only addresses waste management issues, but in Chapter V addresses, Decommissioning of Radioactively Contaminated Facilities.

Section 3.b of that chapter addresses facility design. It states specifically, “Facilities in which radioactive or other hazardous materials are utilized shall be designed to simplify decontamination and decommissioning and/or increase the potential for reuse. Features and procedures that simplify and facilitate decommissioning shall be identified during the planning and design phase based upon a proposed decommissioning method or conversion to another use.” Both the DOE in Order 6430.1, and the International Atomic Energy Agency (IAEA), in Technical Report Series No. 382, provide guidance on the design and construction of nuclear power plants to facilitate decommissioning.

## **Benefits to the Nuclear Industry**

As design of Generation IV reactors proceeds one of the major challenges will be to correct deficiencies or weaknesses of previous designs. This means that the new reactors must be designed to facilitate decommissioning and to produce less waste in the process. If these issues can be overcome, Generation IV reactors will prove safer, less costly, and quicker to decommission. This will result in the ability to produce power at lower rates with less impact on the population and on the environment. The current cost of decommissioning nuclear power plants ranges from about \$350M to almost \$700M. Designs to facilitate decommissioning could reduce these costs by 20% or more. This represents significant savings to the operators of these facilities. Of even more importance is the reduced impact on radioactive waste disposal sites that would result from lower decommissioning waste volumes from these facilities. In addition to the financial aspects of facilitating the decommissioning of nuclear facilities, DOE Order 5820 must be complied with.

## **Design Considerations**

Both the DOE and the IAEA have performed some work on improved reactor designs to facilitate decommissioning. New generation reactors should not only include design and construction features that facilitate operation and maintenance, but also features that facilitate decommissioning. The goals in this context should be to:

- Minimize hazards to decommissioning personnel and the public
- Minimize environmental impact
- Ease dismantling
- Minimize the production of radioactive waste
- Reduce decommissioning costs

Basic design aspects that must be considered to facilitate decommissioning include:

- Plant layout and access
- Material specification
- Material handling provisions
- Surface conditioning and contamination control
- Post-shutdown requirements

Design features to facilitate decommissioning include:

- Reducing the radiation source
- Reducing activation products in metals
- Reducing surface contamination
- Improving neutron shielding

These items are engineering problems, which can be solved. It is imperative however that they be solved early in the design of the new Generation IV reactors so that old problems and issues are not transferred to the next generation of the world's power reactors.

## **Recommendations**

The following recommendations are made with respect to improving Generation IV reactors by facilitating their decommissioning.

- (1) A task be funded to identify design and operation features to facilitate decommissioning of the new reactors. The basis for these recommendations would be the DOE and IAEA documents that address the topic of reactor design to facilitate decommissioning. In addition, INEEL experience in decommissioning over 200 facilities should be considered and documented from a lessons learned standpoint. The use of new and innovative technologies that facilitate decommissioning should also be considered as part of the overall reactor design recommendations. The basis for the technology recommendation will be the vast amount of decommissioning technology information derived from the Large Scale Demonstration and Deployment Projects conducted at the INEEL during the past few years.
- (2) Decommissioning experts from the INEEL and other organizations should work closely with Generation IV personnel as the design of the new reactor progresses. Periodic reviews of design features should be conducted and documented with specific emphasis on features that facilitate decommissioning.
- (3) Areas should be identified and documented where additional research could lead to significant improvement in reactor decommissioning technology or processes.