



BACKGROUND

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Mixed Oxide Fuel

Background

With the end of the Cold War, the United States and the former Soviet Union began dismantling thousands of nuclear weapons. This dismantlement resulted in large quantities of surplus weapons-usable highly enriched uranium and plutonium. Proper safeguards and management are needed to address the concerns these excess materials raise regarding environmental, health, safety and safeguards issues.

One of the challenges is how to dispose of this surplus material so that the accessibility and attractiveness for retrieval and future use in weapons is significantly reduced. In September 2000, the United States and Russia signed an agreement committing each country to dispose of 34 metric tons of surplus plutonium.

In Jan. 2000, DOE initially identified a hybrid approach to dispose of up to 50 metric tons of surplus United States weapons plutonium and to construct and operate three new facilities at its Savannah River Site. This strategy involved: (1) immobilization, in which up to 17 metric tons of surplus plutonium is mixed with ceramic and then surrounded by vitrified high level radioactive waste, and (2) irradiation, in which up to 34 metric tons of surplus plutonium is mixed with uranium and converted to mixed oxide (MOX) fuel and used as fuel in existing U.S. commercial nuclear reactors. Ultimately, both approaches would involve disposal in a geologic repository pursuant to the Nuclear Waste Policy Act.

However, on Jan. 23, 2002, DOE announced that it no longer planned to immobilize the plutonium and would only pursue converting 34 metric tons of the surplus weapons-grade plutonium to reactor fuel. DOE proposes to do the conversion at the new facilities at the Savannah River Site.

European countries such as the United Kingdom, Germany, Belgium and France have been fabricating MOX fuel for many years. Commercial MOX-fueled light water reactors are used in France, the United Kingdom, Germany, Switzerland, and Belgium. In the U.S., MOX fuel was fabricated and used in several commercial reactors in the 1970's as part of a development program.

NRC Role & Authority

The Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 (sec. 3134) provided the NRC with the regulatory and licensing authority over the MOX fuel fabrication facility at the Savannah River Site. The facility would make fuel assemblies for commercial nuclear power plants. The agency is required to evaluate the safety aspects of the MOX facility as well as its impacts on the environment. If the MOX fuel fabrication facility is built, the NRC would also perform inspections during construction and operation. Because MOX fuel is not currently being produced in the U.S., this would be the first fuel fabrication facility licensed by NRC that converts weapons-grade plutonium into fuel for commercial nuclear reactors.

Under NRC regulations, an application for a MOX fuel fabrication facility must be submitted to NRC before construction of the facility. To request construction, the applicant must provide:

- an environmental report;
- a description of the plant site;
- a description and safety assessment of the design of principal structures, systems and components; and
- a description of the quality assurance program.

The NRC is also responsible for licensing the use of the MOX fuel in commercial nuclear power plants. For a plant to use MOX fuel, the NRC would have to amend its operating license. Although reactors are not specifically designed to use weapons-grade plutonium, which is in MOX fuel, they do use the reactor-grade plutonium that is generated in the uranium fuel during normal operation.

If approved by the NRC, the reactor licensee would test the MOX fuel by first operating with lead test fuel assemblies in the reactor for a few years. This would be used to verify the ability of models to predict fuel performance and applicability of European experience with MOX fuel. If the outcome is satisfactory and the NRC approves, the plant licensee could insert a maximum of 40 percent of the reactor core with MOX fuel.

No reprocessing or subsequent reuse of this spent fuel (once-through fuel cycle) is planned. Using the plutonium in the reactor as MOX fuel makes using it for any other purposes difficult. Once the cycle is completed, the spent MOX fuel will ultimately be disposed of in a geologic repository.

Discussion

In March 1999, DOE signed a contract with a consortium comprised of Duke, Cogema, and Stone & Webster (DCS) to: (a) design commercial MOX fuel; (b) design, construct, operate and deactivate a MOX fuel fabrication facility; (c) design and execute the reactor modifications necessary for use of MOX fuel; and (d) provide the architect/engineering and construction management services associated with these activities. The Catawba and McGuire nuclear power plants were then designated for use of MOX.

MOX Fuel Fabrication Facility

Because no MOX fuel is made in the U.S. at this time, a facility needs to be built as part of the national strategy to dispose of excess weapons-grade plutonium by using it for power production. The MOX fabrication facility would be U.S. Government-owned and located at a DOE site – later determined to be Savannah River, S.C. It would be used only for the purpose of disposition of surplus plutonium and would be subject to Nuclear Regulatory Commission (NRC) requirements and approval. The facility would be shut down when the plutonium disposition is completed.

In Nov. 1999, DOE published a Surplus Plutonium Disposition Final Environmental Impact Statement (Final EIS). The Final EIS analyzed the impacts of three facilities for the disposition of surplus plutonium, including mixed oxide (MOX) fuel fabrication and the associated environmental impacts of using MOX fuel in nuclear reactors. Two of the three facilities – Catawba and McGuire commercial power plants – were selected by DOE to use MOX fuel.

Potential operators of a fuel fabrication plant must obtain authorization from the NRC to begin construction and obtain a license before operating the facility. Following publication of its draft plan in

Feb. and a public meeting in May, the NRC, in Aug. 2000, identified its final plan to review an expected application for a MOX fuel fabrication facility. The agency planned to perform safety, safeguards, and environmental reviews of applications for both construction and operation. Information to be reviewed included:

- General information about the applicant and the plant site;
- Applicant's financial qualifications to construct and operate the facility;
- Provisions for protection from radiation exposure, chemical exposure, fires, and other emergencies;
- Plans to protect against theft, loss or diversion of special nuclear material; and
- Management and administrative procedures.

DCS submitted an environmental report to NRC in Dec. 2000, and an application Feb. 28, 2001, to construct a MOX fuel fabrication facility at the DOE's Savannah River Site near Aiken, S.C.

Several public meetings were held in the course of NRC's review of information and development of an environmental impact statement. Some of the areas covered included: health and safety, waste management, transportation, handling of hazardous materials, background radiation, water and earth resources, air quality, land use, noise, ecological resources, socioeconomic issues, and natural disasters. The NRC issued a final Environmental Impact Statement (NUREG-1767) in Jan. 2005.

Following additional public meetings, NRC issued an initial draft Safety Evaluation Report (SER) on April 30, 2002, on the construction application, a revised draft SER on April 30, 2003, and a final SER March 30, 2005, authorizing construction of the fuel fabrication facility. The facility will be owned by the DOE's National Nuclear Security Administration and DCS, a DOE contractor, will build and operate the facility. Before the facility can operate, DCS must obtain a license from the NRC to possess and use uranium and plutonium. NRC will provide oversight to ensure that public health and safety, the common defense and security, and the environment remain protected.

MOX Use in U.S. Reactors

Surplus plutonium is mixed with uranium to fabricate MOX fuel for use in a commercial nuclear power plant. Traditionally, fuel for commercial nuclear power plants is made of low-enriched uranium. MOX fuel contains 5 percent plutonium.

In Feb. 2003, Duke Power submitted its application to use MOX test assemblies in its Catawba nuclear power plant located near Rock Hill, S.C. The NRC issued a license amendment on March 3, 2005, authorizing Duke to test four MOX fuel assemblies at Catawba. The assemblies were manufactured in France using surplus U.S. weapons-grade plutonium. The NRC also approved revisions to Duke's physical security plan and additional protective measures that will provide enhanced security of the MOX assemblies.

A hearing was held by the NRC Atomic Safety and Licensing Board on reactor safety issues and the Board issued its Decision on Dec. 22, 2004. Another hearing was held on physical security issues and the Board issued its Decision on March 10, 2005, which included four measures that were to be completed before Catawba received the MOX fuel.

MOX fuel was transported from France in April 2005, to DOE and then shipped safely by DOE to the plant at the end of April. Duke plans to introduce the MOX into its Catawba reactor during its next refueling outage scheduled for late spring 2005.

Public Process

Over a five-year period, NRC conducted the MOX program in an open process. More than a dozen public meetings were held to discuss safety and environmental aspects of the fuel fabrication facility and use of MOX fuel in the Catawba reactor. In addition, several public meetings of NRC's Advisory Committee on Reactor Safeguards included discussions of various aspects of the MOX program, and hearings provided further opportunities for public involvement in discussions of security, material control and accounting, and seismic hazards. Also, numerous documents were made available for public scrutiny and comment throughout the process.

Additional Information

Additional information on MOX can be found on the NRC's website at:

<http://www.nrc.gov/materials/fuel-cycle-fac/mox/licensing.html>.

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