1.0 GENERAL INFORMATION

1.1 FACILITY AND PROCESS OVERVIEW

1.1.1 CONDUCT OF REVIEW

This chapter of the draft Safety Evaluation Report (DSER) discusses general information contained in Chapter 1 of the Mixed Oxide Fuel Fabrication Facility (MFFF or the facility) Construction Authorization Request (CAR) (Reference 1.1.3.1). Chapter 1 of the MFFF CAR provides general information about the facility processes and the site. It consists of a general facility description, material flow, and process overview. The objective of this chapter is to familiarize the reader with the pertinent features of the facility and the site.

1.1.1.1. General Facility Description

The facility is a "plutonium processing and fuel fabrication plant" as defined in 10 CFR 70.4. The facility is designed to produce fuel assemblies for commercial nuclear power plants. The assemblies are composed of fuel rods which contain fuel pellets consisting of a blend of uranium and plutonium oxides (i.e., mixed oxides). The plutonium oxide to be used would be obtained from weapons-grade plutonium inventories held by the U.S. Department of Energy (DOE), which are declared surplus to national security needs.

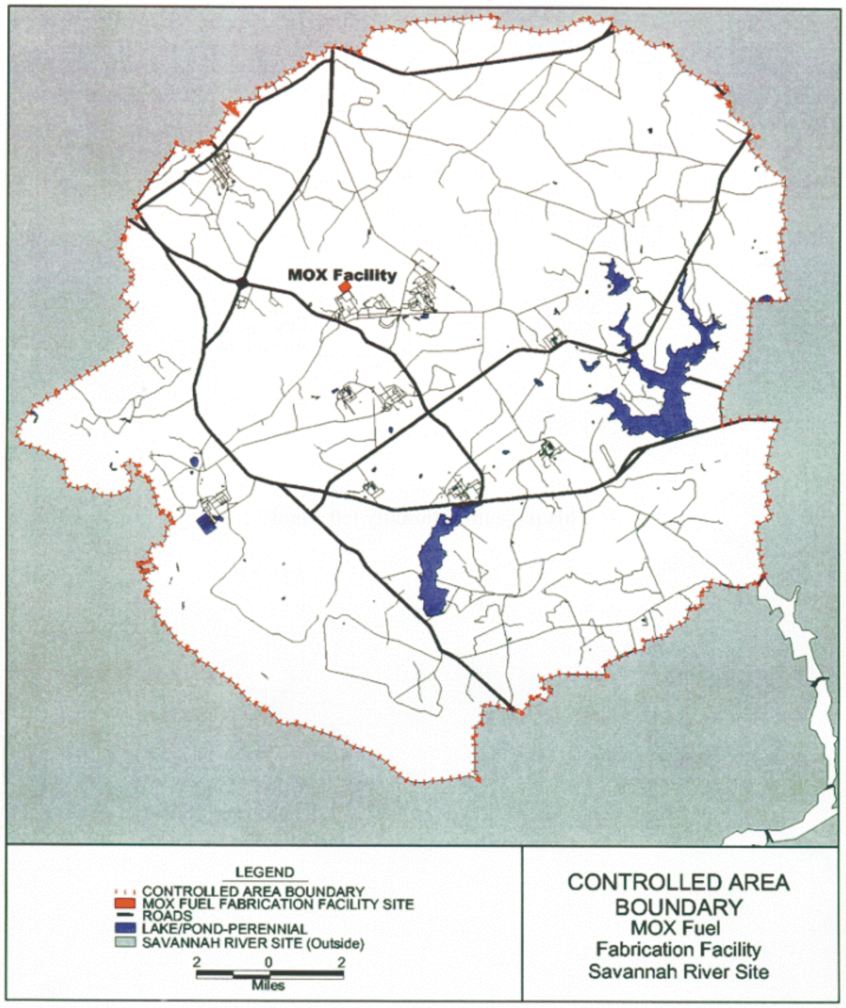
The facility is to be located in the F Area of DOE's Savannah River Site (SRS) near Aiken, South Carolina. The site encompasses approximately 80 acres (6.324 km^2)of which approximately 17 acres ($6.9x10^{-2}$ km^2)will be developed with roads, facilities or buildings. No roads, railroads, or waterways traverse the MFFF site. The nearest public transportation route is South Carolina Route 125, approximately 4 miles (6.4 km) to the west.

1.1.1.1.1 Controlled Area Boundary

With respect to the controlled area boundary, 10 CFR 70.61(f) requires that the applicant establish a controlled area, as defined in 10 CFR 20.1003. Section 20.1003 of 10 CFR defines the controlled area as an area outside of the restricted area but inside the site boundary, access to which can be restricted by the licensee for any reason. In addition, 10 CFR 70.61(f) states that the licensee must retain the authority to exclude or remove personnel and property from the controlled area. The applicant has chosen the controlled area boundary to be largely coincident with the boundary of DOE's SRS. It is shown in Figure 1.1-3 in the CAR, which has been reproduced as Figure 1.1-1 in this DSER.

The controlled area proposed by the applicant includes over 300 square miles (777 km^2) of the SRS. This area includes a population of 13,616 individuals working for DOE, the United States Forest Service, the Savannah River Ecology Lab and various other contractor organizations. The NRC regulations that apply to these individuals include 10 CFR Parts 19, 20 and 70. The applicability of specific sections within these regulations to individuals in the controlled area depends on three principal factors: (1) the location of the individual, (2) whether the individual's assigned duties involve exposure to radiation or to radioactive material and (3) whether the individual has received training in accordance with Section 70.61(f)(2) of the NRC regulations.

Figure 1.1-1 MOX Fuel Fabrication Facility Controlled Area Boundary



With respect to the first factor described above, the NRC regards all individuals in the restricted area (which is coincident with the MFFF protected area) as workers. The term "workers" is defined in 10 CFR Part 20 and is also used to define individuals in the 10 CFR 70, Subpart H regulations. The Subpart H regulations include the requirements for an Integrated Safety Analysis (ISA) (see DSER Section 5.0). Individuals in the controlled area may be either members of the public or workers, depending on whether the individual's assigned duties involve exposure to radiation or to radioactive material, which is the second discriminating factor. This distinction is important because the performance requirements defined in 10 CFR Part 70 require that the applicant either differentiate members of the public from workers within the controlled area, or comply with the provisions of Section 70.61(f)(2) that allow the applicant to treat individuals in the controlled area as workers, for the purposes of the Section 70.61 performance requirements, provided the applicant meets the training, noticing and posting provisions of 10 CFR 19.12(1)-(5) and maintains notices stating where the information in 10 CFR 19.11(a) may be examined by these individuals. This latter provision forms the third discriminating factor to determine whether individuals in the controlled area may be treated as workers in the ISA.

In the CAR, the applicant has committed to meet the requirements of Section 70.61(f)(2). To do so, the applicant intends to establish a protocol with the DOE-SRS to ensure that DOE augments the existing SRS radiation protection training program and provides posting and maintenance of notices in conspicuous locations within F area. This protocol will also provide for integration of the MFFF with existing SRS emergency preparedness and response program, including limitation of site access in the event of an emergency at the MFFF.

This commitment is acceptable to the staff for construction authorization because it meets the requirements of the regulation at section 70.61(f) with respect to establishing a controlled area. However, the staff conditions its final approval of this controlled area designation upon the conclusion of the staff's review of the applicant's protocol agreement with DOE-SRS, including the augmented DOE radiation protection training program information. The staff will review this as part of the license application review.

With regard to the controlled area boundary designation, the provisions of section 70.61(f) that allow an individual who is not a worker to be treated as a worker for the purposes of the section 70.61 performance requirements may not be used to demonstrate compliance with the regulations in 10 CFR Part 20. Under Part 20, an individual in the controlled area whose assigned duties do not involve exposure to radiation or to radioactive material would be considered a member of the public, regardless of the training provided under section 70.61(f)(2). In this instance, for example, the 10 CFR 20.1301 limitations on dose to an individual member of the public would apply. The staff will review the applicant's Radiation Protection Program, which should address this issue, during review of the license application.

The staff recognizes that roads used by members of the public traverse the controlled area. This situation was considered during the 10 CFR Part 70 rulemaking. In Reference 1.1.3.2, the Commission stated that use of the integrated safety analysis to determine the risks to individuals who make infrequent visits to the controlled area would need to consider second-order effects such as the probability of the individual being present at the time that the unlikely or highly unlikely accident occurred. The Commission concluded that this level of detail is unnecessary to accomplish the purpose of the Part 70 rule (i.e., to document and maintain the safety basis of the facility design and operations). The Commission also concluded that the regulations of 10 CFR Part 20 afford an adequate level of protection to these individuals.

The staff concludes that the applicant's location of the controlled area boundary meets the requirements in 10 CFR 70.61(f). The staff will review whether the applicant meets its remaining 10 CFR 70.61(f) commitments as part of the review of the license application.

1.1.1.1.2 MFFF Buildings and Structures

MFFF buildings consist of the mixed oxide (MOX) fuel fabrication building (the main building on the site), the emergency diesel generator building, the standby diesel generator building, the secured warehouse building, the administration building, the technical support building, and the reagents processing building. Miscellaneous site structures consist of a gas storage pad, heating ventilation air conditioning and process chiller pads, diesel fuel filling stations, electrical transformers, and other minor structures.

The main building is the MOX fuel fabrication building. This building contains all of the plutonium oxide handling, fuel processing, and fuel fabrication operations of the MFFF. It is a reinforced concrete building having a footprint of approximately 300 feet (91.5 m) by 400 feet

(122 m) by approximately 73 feet (22.3 m) above grade. The building is comprised of three major functional areas as follows: the MOX Processing Area, the aqueous polishing (AP) area, and the shipping and receiving area. In the AP area, plutonium oxide (PuO_2) received from the pit disassembly and conversion facility (PDCF) is purified to remove impurities such as gallium and americium. The purified PuO_2 is then blended with depleted uranium (DU) powder and processed into MOX fuel and ultimately fuel assemblies in the MOX processing area. In the shipping and receiving area, plutonium and uranium oxides are received along with other materials necessary to produce fuel assemblies; completed fuel assemblies are shipped from this area to commercial nuclear power plants.

Most reagents (e.g., nitric acid, hydrogen peroxide, hydroxylamine nitrate [HAN], hydrazine, oxalic acid, sodium carbonate, diluent [TPH], and tributyl phosphate [TBP]) are stored and solutions are prepared in the Reagent Processing Building for use in the AP area of the MFFF. The building is divided into discrete rooms/areas to segregate chemicals and the associated equipment and vessels to prevent inadvertent chemical interaction. It has a below-grade collection tank room that receives waste chemicals from the building. A loading dock at one end of the building is used for unloading and transfer of chemical containers and drums. Liquid chemical containers are located inside curbed areas to contain accidental spills. The applicant does not intend to store, process, or commingle radioactive materials or radiochemicals in this building. Chemicals are transferred to the AP area from the Reagents Processing Building via piping located in a concrete, below-grade trench between the two buildings.

Figure 1.1-2 in the CAR shows the site layout and the main MFFF buildings and has been reproduced in this DSER as Figure 1.1-2.

1.1.1.2 Material Flow

The MFFF receives PuO_2 from the PDCF, located on the SRS near the MFFF. The material is transported to the shipping and receiving area of the MFFF in approved shipping containers. The material is unloaded and inspected according to the material control and account (MC&A) and radiation protection program. The material is then moved to the MOX processing area. The MFFF also receives depleted uranium oxide (DUO_2) at the material receipt area of the secured warehouse building, where it is also inspected according to the MC&A and radiation protection program. The DUO_2 is trucked to the shipping and receiving area of the MFFF as needed for processing. Fresh MOX fuel assemblies are stored in the assembly storage vault in the MFFF before shipping offsite. For shipping to the commercial power plants, the assemblies are moved to the shipping and receiving area of the MFFF where they are loaded into a MOX fresh fuel transportation package that has been approved by NRC, and then loaded onto a secure transport vehicle for transport to the commercial power plants for irradiation.

Airborne effluents from the MOX fuel fabrication building are treated, pass through a final two-stage high efficiency particulate air (HEPA) filter to remove radioactive particles, and then discharged through a continuously monitored stack. The exhaust streams come from building ventilation systems, gloveboxes, process vents of tanks, vessels and other equipment, and the sintering furnaces.

Figure removed under 10 CFR 2.390.

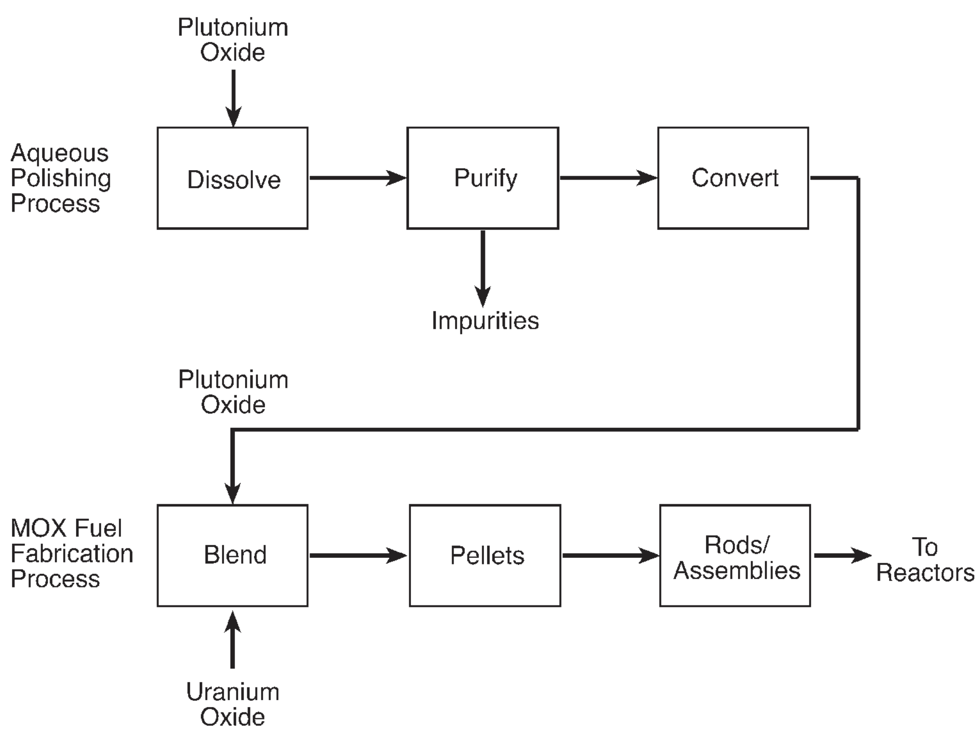
Liquid effluents containing radioactive materials are sampled, characterized, and transferred to the SRS waste management program for final processing and disposal. No radioactive liquid effluent will be released from the MFFF to the environment. Liquid waste streams include high alpha solutions containing americium, gallium, and silver from the dissolution process; uranium solutions containing enriched uranium; alkaline solutions; liquid low-level waste (e.g., acid recovery condensate, room heating, ventilation, and air conditioning (HVAC) condensate, laboratory rinsing, and sanitary washing); and solvent streams.

Solid radioactive wastes are typically placed in 55 gallon (208.2 L) drums, assayed, and transferred to SRS for processing and disposal under the SRS waste management program. The wastes will be compacted to reduce volume to the extent possible. These wastes include transuranic and low-level wastes which include uranium and/or plutonium contamination.

1.1.1.3 Process Overview

The MFFF has two major process operations: 1) an AP process that serves to remove impurities such as americium and gallium (i.e., polishing), and 2) the MOX fuel fabrication, or MOX process (MP), which processes the plutonium and depleted uranium oxides into fuel pellets, fuel rods, and fuel assemblies. A summary of the major processes in the MFFF is provided below.   A more detailed discussion of process chemistry and chemical safety is provided in Chapter 8 of this DSER. A block diagram of the AP and MP processes is shown as Figure 1.1-3.

Figure 1.1-3, Overview of AP and MP Process



1.1.1.3.1 AP Process Overview

The AP process consists of three major steps: 1) dissolution, 2) purification, and 3) conversion.

In the dissolution step, the PuO_2 powder received from the PDCF is placed into solution by electrolytic dissolution with silver in nitric acid.

The purification step involves purification of the plutonium solution in pulsed columns by solvent extraction (tri-butyl phosphate in dodecane). Nitrate impurities such as americium, gallium, and silver remain in the aqueous phase and are routed to an acid recovery unit after dodecane washing. The plutonium and uranium stream is scrubbed with nitric acid; the plutonium is reduced to trivalent plutonium by hydroxylamine nitrate and stripped (i.e., the plutonium is removed from solution) in another pulsed column using a solution of nitric acid, hydrazine nitrate, and HAN. The organic solvent, now without the plutonium, is mixed with an additional stripping solution in a plutonium barrier that assures that all plutonium is removed, before the organic solvent is transferred to the uranium stripping process, where the uranium is removed from solution using dilute nitric acid. The uranium stream is diluted with depleted uranium before being transferred to SRS. The remaining solvent stream, now without uranium, is routed to solvent recovery mixer-settlers to be recycled. In the purified plutonium stream, the plutonium valence is adjusted back to plutonium (IV) by driving nitrous oxide fumes through the plutonium solution in a column. The offgas is routed through an offgas treatment system and is then discharged to the atmosphere.

In the conversion step, the plutonium (IV) is converted to a powder oxide using a continuous oxylate conversion process. In this step, the plutonium (IV) reacts with excess oxalic acid to precipitate plutonium oxalate. The plutonium oxalate is collected on a filter, dried in a screw calciner to produce purified PuO_2 powder which is then blended and stored in sealed cans. The oxalic mother liquors are concentrated, reacted with manganese to destroy the oxalic acid, and recycled to the beginning of the extraction cycle.

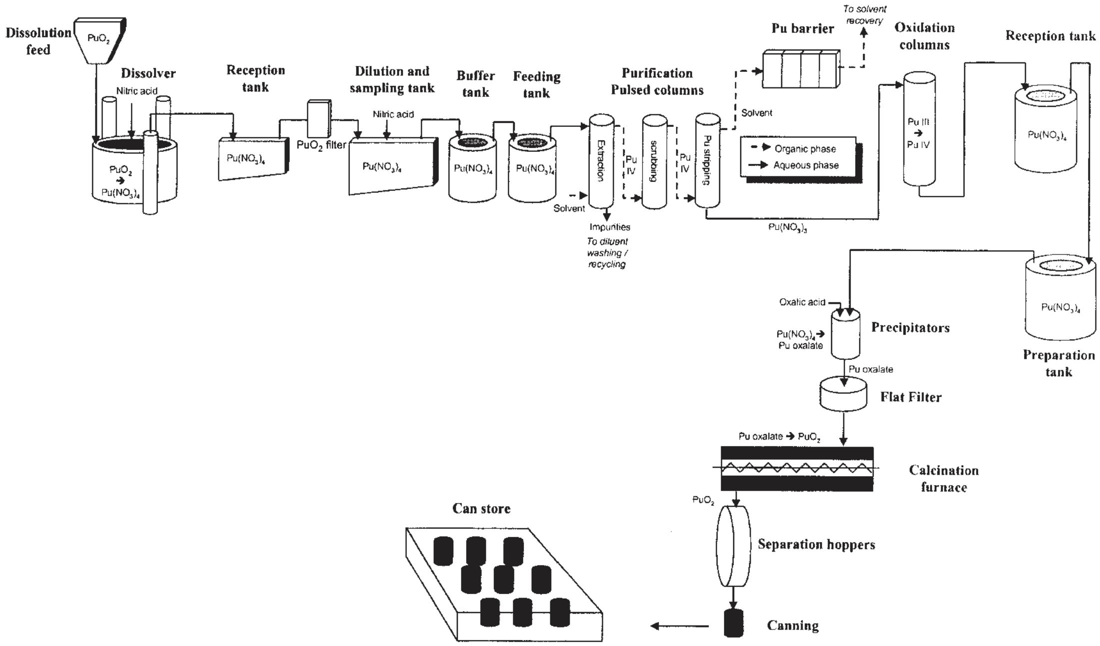
Figure 1.1-4 in the CAR shows the aqueous polishing process and has been reproduced in this DSER as Figure 1.1-4.

1.1.1.3.2 MP Overview

The purified PuO_2 powder is now used in the MP where it is blended with DUO_2 powder to make MOX fuel. The process employed to create pellet fuel that is characterized by a close mix of PuO_2 and DuO_2 powders is known as the micronized master blend (MIMAS) process, which has been used by Cogema and Belgonucleaire to manufacture MOX fuel in Europe. The MOX fuel fabrication process consists of four major steps: 1) powder blending, 2) pellet production, 3) rod production, and 4) fuel assembly production.

In the first step, a master blend of PuO_2 and DUO_2 powder and recycled powder is produced that consists of approximately 20 percent PuO_2. The powder mixture is ground in a ball mill and mixed with additional DUO_2 to produce a final mixture consisting of approximately 2-6 percent PuO_2. The final blend is homogenized to assure a uniform distribution of the PuO_2. Lubricants and poreformers, to control density, are added to the final mixture during homogenization.

Figure 1.1-4 Aqueous Polishing Process



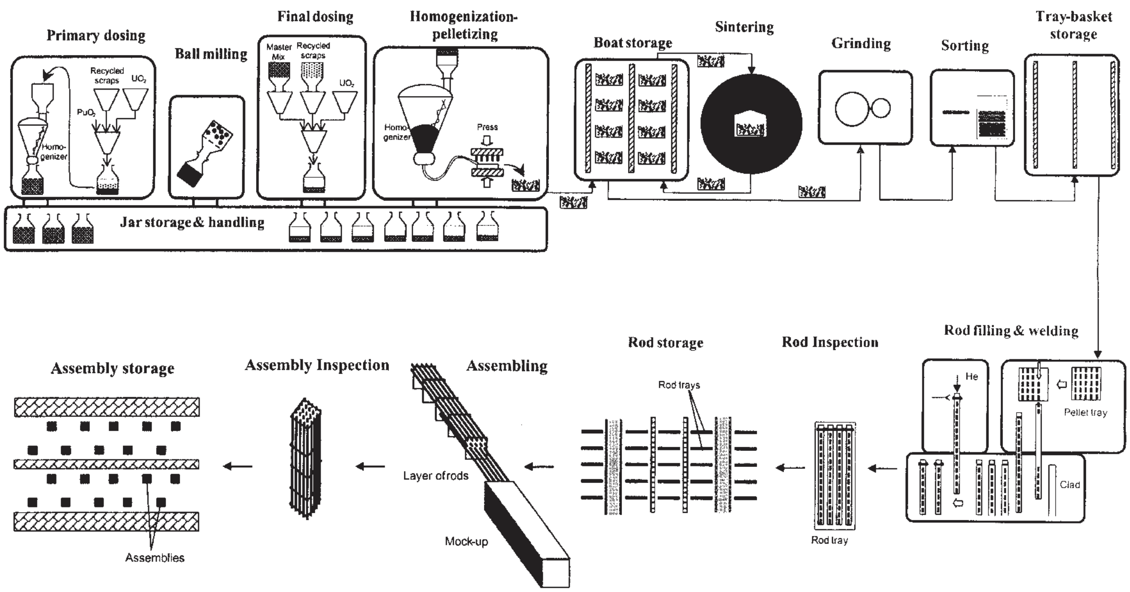
In the next step, the final blend is pressed to form pellets. These pellets are referred to as "green" pellets because they have not been sintered in the furnace. The green pellets are sintered in a furnace, whose atmosphere consists of a hydrogen and argon mixture, to obtain the required ceramic properties. The sintering also removes organic products from the pellets as well as the poreformer that was added to the powder earlier. The sintered pellets are ground to a specified diameter and sorted. Powder from the grinding operation and from discarded pellets are recycled through a ball mill and reused in the powder processing.

In the third step of the MP, fuel rods are loaded with the pellets to an adjusted pellet length column. The rods are welded, pressurized with helium, and decontaminated in gloveboxes. The filled rods are removed from gloveboxes, placed on racks, and inspected.

Finally, the filled rods are pulled through the fuel assembly skeleton to form completed fuel assemblies. Each assembly consists of a 17 x 17 square grid (fuel rods, control rod guide tubes, and instrument tubes). There are approximately 264 fuel rods (uranium and MOX fuel) per assembly. A variety of inspections are performed on the completed fuel assemblies. The completed assemblies are stored for shipment to the mission reactors.

Figure 1.1-5 in the CAR shows the MOX fuel fabrication process and has been reproduced in this DSER as Figure 1.1-5. A more detailed description of the MP is provided in DSER Appendix B.

Figure 1.1-5 MOX Fuel Fabrication Process



1.1.2 EVALUATION FINDINGS

The staff concludes that the facility and process overview descriptions provided by the applicant in section 1.1 of the CAR are sufficient for the staff to obtain and introductory understanding of the facility and the processes. More detailed facility and process descriptions are provided in other sections of the CAR and are discussed in other chapters of this DSER.

1.1.3 REFERENCES

1.1.3.1 Federal Register Notice, Vol. 64, No. 146, July 30, 1999; FRN 41338-41357

1.1.3.2 Ihde, R, Duke Cogema Stone & Webster, letter to W. Kane, U.S. Nuclear Regulatory Commission, RE. Mixed Oxide Fuel Fabrication Facility—Construction Authorization Request, February 28, 2001.