1.0 GENERAL INFORMATION
1.1 FACILITY AND PROCESS OVERVIEW

1.1.1 CONDUCT OF REVIEW

This chapter of the revised draft Safety Evaluation Report (DSER) discusses general information contained in Chapter 1 of the revised Mixed Oxide Fuel Fabrication Facility (MFFF or the facility) Construction Authorization Request (CAR) (Reference 1.1.3.1). Chapter 1 of the MFFF revised 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 proposed facility and the site.

1.1.1.1 General Facility Description

The proposed 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 dioxides (i.e., mixed oxides). The plutonium dioxide 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.

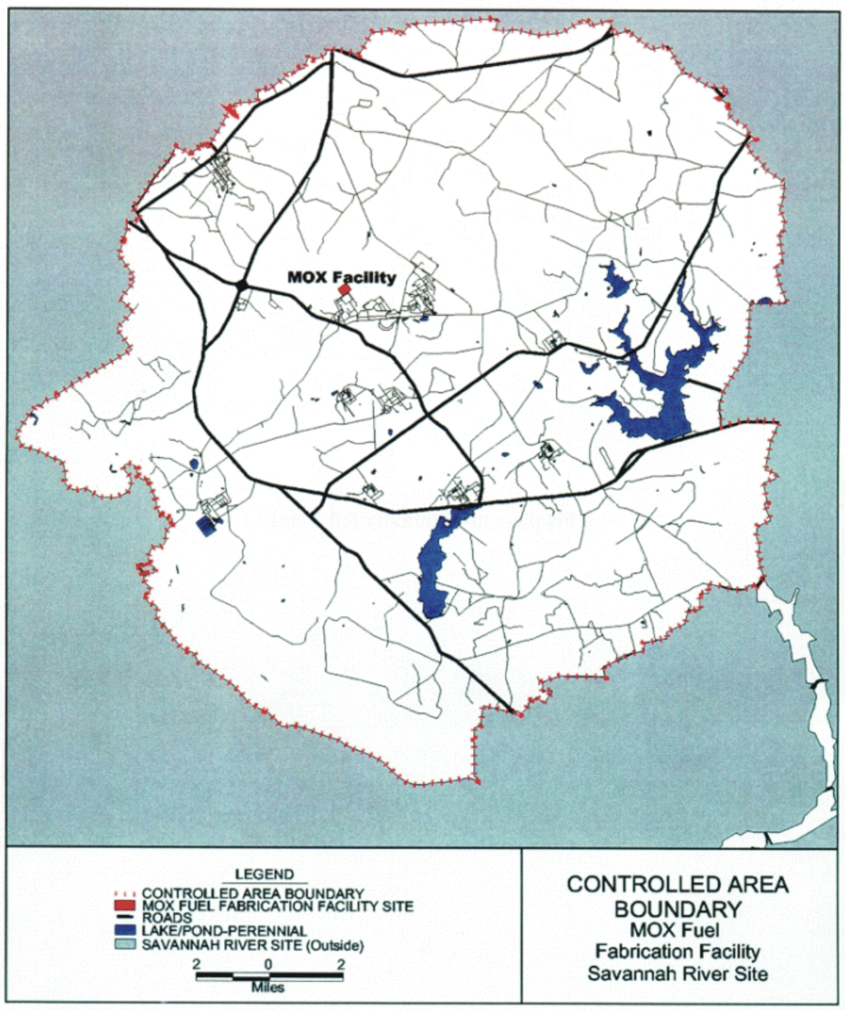
The facility is to be located in the F-Area of DOE's Savannah River Site (SRS) near Aiken, South Carolina. The site encompasses approximately 41 acres (0.17 km^2)of which approximately 17 acres ($6.9x10^{-2}$ km^2)will be developed with roads, facilities or buildings. No roads, railroads, or waterways traverse the facility 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. Section 20.1003 of 10 CFR defines the term "restricted area" as an area the "access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation." Additionally, 10 CFR 20.1003 defines "site boundary" as the "line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee." Here, as discussed further below, the site boundary line for the proposed facility would correspond with the SRS boundary limits. Within the SRS boundary limits, DCS plans to establish a controlled area and a smaller restricted area. Methods to prevent unauthorized access to controlled areas and restricted areas are not specified in 10 CFR. Part 20 or in 10 CFR 70.61(f). Similarly, these regulations do not specify a required size of the "controlled area." Section 70.61(f) of 10 CFR does require DCS to 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. The SRS boundary is the boundary for which DOE currently controls access to SRS. The SRS boundary is shown in Figure 1.1-3 in the revised CAR, which has been reproduced as Figure 1.1-1 in this revised DSER. As shown, the controlled area proposed by the applicant includes over 300 square miles (777 km^2) of the SRS. DCS has committed to enter into an agreement with DOE (Reference 1.1.3.1) whereby DOE would continue to control access to the SRS site boundary using its existing methods -- a combination of physical barriers (such as wire fencing and gates at points of site access along state highways) and administrative controls (such as posting and border surveillance by DOE security force patrols). Since the DOE infrastructure, programs, and personnel regarding SRS site security are already in place, DCS proposes to control access to the MOX facility's controlled area using the established DOE security system.

Figure 1.1-1 MOX Fuel Fabrication Facility Controlled Area Boundary



The staff recognizes that roads used by members of the public traverse the proposed 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 any hypothetical accidents 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.

Accordingly, the staff finds that the applicant's proposed location of the controlled area boundary meets the requirements in 10 CFR 70.61(f) and 10 CFR Part 20. A DCS-DOE agreement to control access to the controlled area has not yet been reached, and will be submitted by DCS as part of its application for an SNM possession and use license.

The proposed controlled area includes a population of 13,590 individuals working for DOE, the United States Forest Service, the Savannah River Ecology Lab and various other contractor organizations (Reference 1.1.3.1). The NRC regulations that apply to these individuals include 10 CFR Parts 19, 20 and 70. As discussed below, 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 10 CFR 70.61(f)(2).

With respect to the individuals to be located within the restricted area of the proposed facility, the NRC regards all such individuals as workers. In the revised CAR, DCS refers to these individuals as “facility workers.” The term “worker” as defined in 10 CFR Part 70.4, means an individual who receives an “occupational dose.” The term “occupational dose” (as defined in 10 C.F.R. 20.1003) means the dose received by an individual during employment in which the individual's assigned employment duties involve exposure to radiation or to radioactive material, and excludes doses received from background radiation or medical administrations. Individuals to be located within the controlled area (but outside of the restricted area) of the proposed facility 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. In the revised CAR, DCS refers to these individuals as “site workers.” The distinction between workers and members of the public 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 10 CFR 70.61(f)(2). These provisions 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.

However, these 10 CFR 70.61(f)(2) provisions that allow an individual who is not a worker to be treated as a worker for purposes of meeting the 10 CFR 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 of the proposed MFFF whose employment duties do not involve exposure to radiation or to radioactive material would be considered a member of the public, regardless of the training provided pursuant to 10 CFR 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. This issue must be addressed by DCS in its proposed Radiation Protection Program, to be submitted by DCS as part of its application for an SNM possession and use license.

In the revised CAR, the applicant has committed to meet the provisions of 10 CFR 70.61(f)(2). To do so, the applicant intends to establish a protocol with the DOE 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 proposed MFFF with the existing SRS emergency preparedness and response program, including limitation of site access in the event of an emergency at the MFFF.

The above-referenced DCS-DOE protocol agreement has not yet been entered into, and will be submitted by DCS as part of its application for an SNM possession and use license. The staff finds this commitment to be acceptable at the construction authorization stage. However, before any SNM possession and use license application could be approved, the NRC staff would have to review and approve the DCS-DOE protocol agreement

In this revised DSER, the staff has adopted the applicant's usage for names of individuals for whom accident risks must be limited. That is, "facility workers," are workers in the restricted area. "Site workers" are either: (1) members of the public in the controlled area who have received 10 CFR 70.61(f)(2) training and for whom the 10 CFR Part 19 posting requirements are met; or (2) workers in the controlled area. "Public" or "members of the public" refers to individuals at the controlled area boundary. A fourth receptor protected under the provisions of 10 CFR 70.61 is the environment, which is understood by both the applicant and NRC staff to be all areas outside the restricted area.

1.1.1.1.2 Facility Buildings and Structures

Facility 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 dioxide handling, fuel processing, and fuel fabrication operations of the facility. It is a reinforced concrete building having a footprint of approximately 300 feet (91.5 m) by 450 feet (137 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 dioxide (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 dioxides 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 facility. 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 revised CAR shows the site layout and the main facility buildings.

1.1.1.2 Material Flow

The facility receives PuO_2 from the PDCF, located on the SRS near the facility, and other DOE sources (i.e., alternate feedstock). The material is transported to the shipping and receiving area of the facility 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 facility also receives depleted uranium dioxide (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 facility as needed for processing. Fresh MOX fuel assemblies are stored in the assembly storage vault in the facility before shipping offsite. For shipping to the commercial power plants, the assemblies are moved to the shipping and receiving area of the facility 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.

Liquid waste streams containing radioactive materials are sampled, characterized, and transferred to the SRS waste management program for final processing and disposal. No radioactive liquid waste streams would be released from the facility 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.

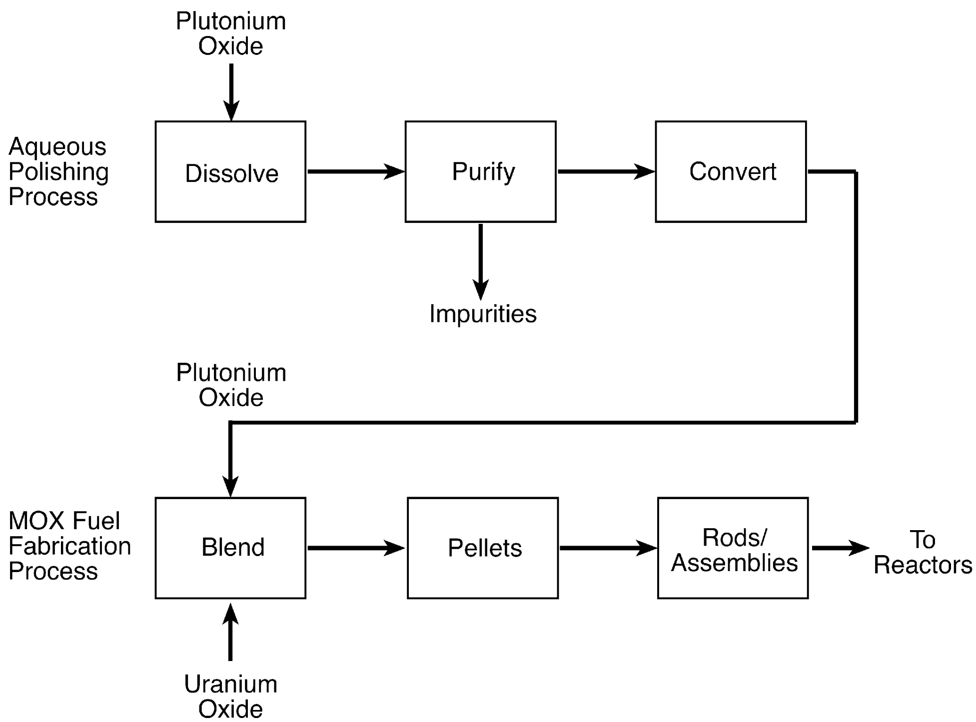
Solid radioactive wastes are typically placed in 55 gallon (208.2 L) drums, assayed, and transferred to SRS for processing and disposal under the SRS waste management program. The wastes would be compacted to reduce volume to the extent possible. These wastes include transuranic and low-level wastes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

1.1.1.3 Process Overview

The facility would have two main 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 dioxides into fuel pellets, fuel rods, and fuel assemblies. A summary of the major processes in the facility is provided below. A more detailed discussion of process chemistry and chemical safety is provided in Chapters 8, 11.2, and 11.3 of this revised 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

All feedstock, both from the PDCF and from other DOE sources, will be received as plutonium oxide. The plutonium dioxide received at the MFFF contains small amounts of impurities that must be removed for use of the MOX fuel in reactors. For the PDCF, the impurities are primarily gallium, americium, and highly enriched uranium. For alternate feedstock, the diversity of impurities and the level of impurities is higher. Some of this alternate feedstock may have higher than normal salts contaminants (other than chlorides), some will contain chloride contaminants, and some will contain small amounts of uranium. The aqueous polishing process is used to remove these impurities. 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 and other DOE sources 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 dioxide 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 dioxide 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.

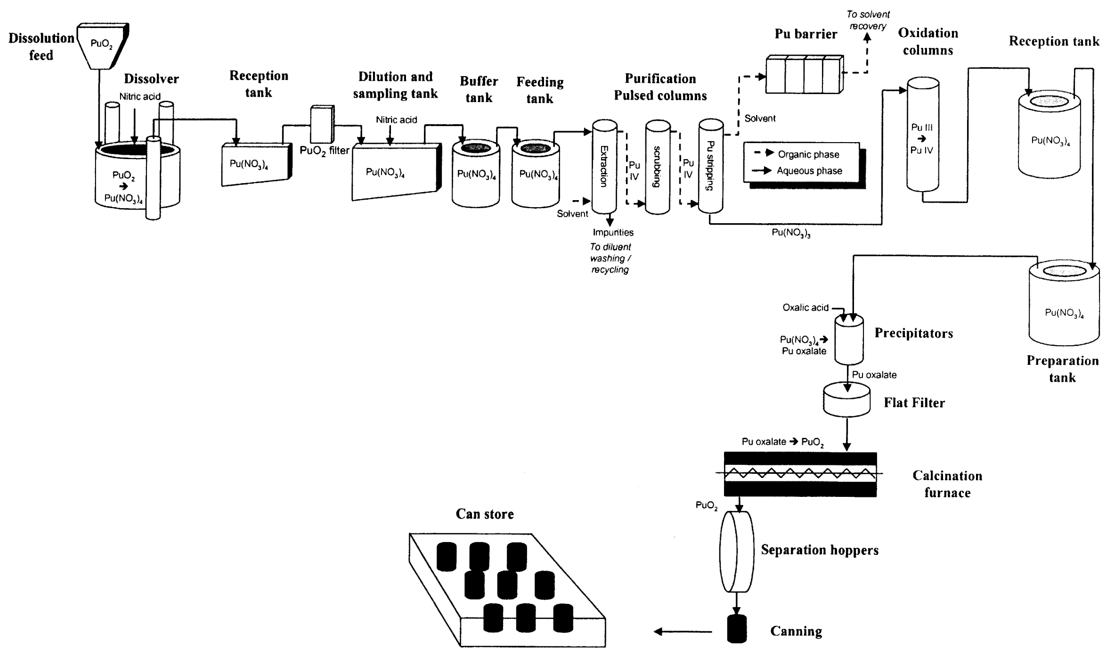
Figure 1.1-4 in the revised CAR shows the aqueous polishing process and has been reproduced in this revised DSER as Figure 1.1-4.

1.1.1.3.2 MP Overview

The purified PuO_2 powder is 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



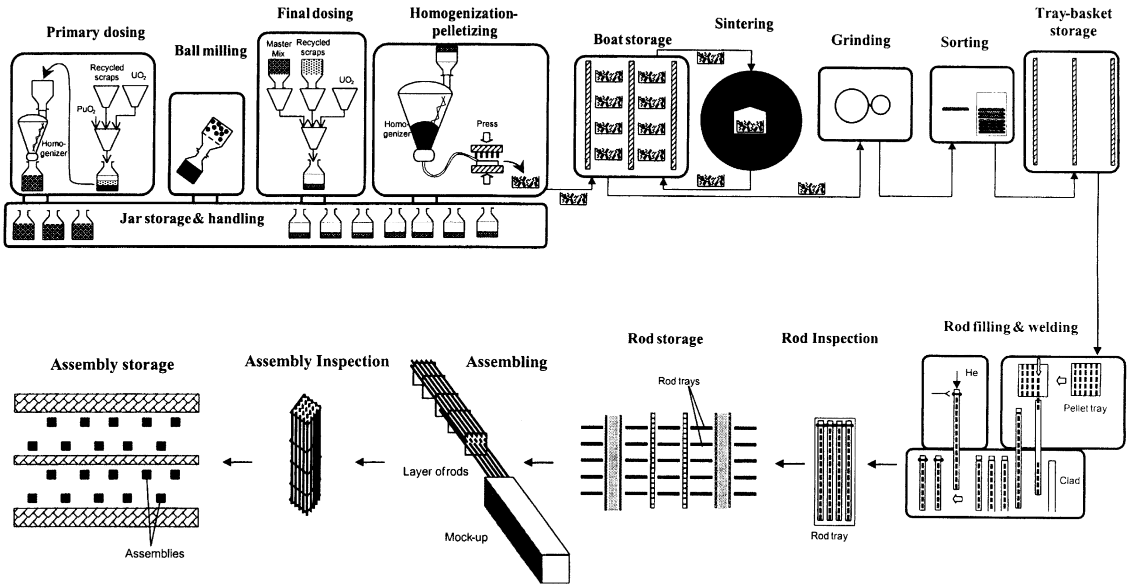
In the next step, the final blend is pressed to form pellets. These pellets are referred to as "green" pellets because they have not been sintered in the furnace. The green pellets are sintered in a furnace, whose atmosphere consists of a hydrogen and argon mixture, to obtain the required ceramic properties. 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 or 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 revised CAR shows the MOX fuel fabrication process and has been reproduced in this revised DSER as Figure 1.1-5.

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 revised CAR are sufficient for the staff to obtain introductory understanding of the facility and the processes. More detailed facility and process descriptions are provided in other sections of the revised CAR and are discussed in other chapters of this revised DSER.

1.1.3 REFERENCES

1.1.3.1 Ihde, R, Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission, RE. Mixed Oxide Fuel Fabrication Facility—Revised Construction Authorization Request, October 31, 2002.

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

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