11.0 PLANT SYSTEMS
11.7 MATERIAL TRANSPORT SYSTEM

11.7.1 CONDUCT OF REVIEW

This chapter of the draft Safety Evaluation Report (SER) contains the staff's review of the material transport systems described by the applicant in Chapter 11.0 of the Construction Authorization Request (CAR). The objective of this review is to determine whether the material transport systems PSSCs and their design bases identified by the applicant provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents. The staff evaluated the information provided by the applicant for material transport systems by reviewing Chapter 11.0 of the CAR, other sections of the CAR, supplementary information provided by the applicant, and relevant documents available at the applicant's offices but not submitted by the applicant. The review of material transport systems design bases and strategies was closely coordinated with the review of accident sequences described in the Safety Assessment of the Design Bases (see Chapter 5.0 of this SER), and the review of other plant systems.

The staff reviewed how the information in the CAR addresses the following regulations:

- Section 70.23(b) of 10 CFR states, as a prerequisite to construction approval, that the design bases of the PSSCs and the quality assurance program be found to provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

- Section 70.64 of 10 CFR requires that baseline design criteria (BDC) and defense-in-depth practices be incorporated into the design of new facilities. It specifically addresses quality standards; natural phenomena hazards; fire protection; environmental conditions and dynamic effects; emergency capability; inspection, testing and maintenance; criticality control; and instrumentation and controls.

The review for this construction approval focused on the design bases of material transport systems, their components, and other related information. For material transport systems, the staff reviewed information provided by the applicant for the safety function, system description, and safety analysis. The review also encompassed proposed design basis considerations such as redundancy, independence, reliability, and quality. The staff used Chapter 11.0 in NUREG-1718 as guidance in performing the review.

As stated in the 10 CFR Part 70 Subpart H rulemaking, IROFS may be described at the systems level, provided that there is enough detail to understand the function of the system in relation to the performance requirements. Accordingly, as discussed in DSER below, the staff finds it acceptable to identify PSSCs at the systems level.

In the DSER discussions that follow, the system descriptions are provided as well as function, major components, control concepts, and system interfaces. These discussions include, but are not limited to, PSSCs, to provide an understanding of the system. Design bases of PSSCs are provided in Section 11.7.1.3.

11.7.1.1 System Description

CAR Section 11.7 describes the functional requirements and design basis for equipment designed to transfer MOX fuel production material that is in a dry, solid form. Examples of such forms are PuO_2 and UO_2 powders, master blends of mixed oxide (MOX) powder, production batches of MOX powder, green pellets, sintered pellets, and fuel rods/assemblies. The equipment described in this section is located inside the MOX process (MP) area and shipping and receiving area. Due to the nature of the equipment, that is, being inside and attached or supported by gloveboxes, certain parts of this review relate to gloveboxes. Most of the staff's review of the confinement system and gloveboxes can be found in Section 11.4 of this SER. Descriptions of the MP (dry) process and the AP process are given in CAR Sections 11.2 and 11.3, respectively, and are discussed in the corresponding DSER sections. A description of the process control system is given in DSER Section 11.6.

Different material handling equipment is used to transport material in the MFFF, depending on the form of the product, the container used to carry it, and the configuration of the process equipment that receives the container. Fuel material in the MP is in one of five forms: powder, pellets, rods, assemblies, and waste. The material transport system, specifically the material handing equipment, reviewed in this section of the DSER, includes the receipt and opening of PuO_2 and UO_2 containers in the powder area, the pellet process and fuel rod assembly areas, the fuel assembly inspection area, the fuel assembly storage area, the fresh fuel cask loading area and the cask loading onto over-the-road trailers.

Material handling equipment that can be used during this process includes, but is not limited to: scales, pallet trucks, fork lifts, drum-tilting devices, storage frames, handling monorails, pouring stations, feeding lines and control valves, hoppers, monorail cranes, standard and vibrating conveyors, turntables, traveling cranes, bridge cranes, various types of gloveboxes such as transfer, process, maintenance, and buffer storage gloveboxes, storage arrays, pneumatic transfer stations, airlocks, hoppers, impactors, funnels, can opening/closing devices, support frames, elevators, clamping devices, grippers, inspection stands, cleaning stations, jars, molybdenum boats, sintering furnaces, three-dimensional stackers, trolleys, winches, sintering furnaces, transfer tunnels, grinders, tray stackers, tilting tables, casks, and air pallets.

Various containers are also included in the list of equipment that will be used for material handling. The list includes: DOE Standard 3013 containers, 3013 transport casks, transfer containers, waste containers and drums, and MOX fresh fuel casks.

DOE Standard 3013 containers provide primary and secondary confinement for plutonium received at the facility. DOE Standard 3013 canister is a PSSC that provides primary and secondary confinement for plutonium received at the facility. This standard applies to plutonium-bearing metals and oxides containing at least 30 weight-percent Pu and uranium. It also applies to plutonium-oxide materials with significant chloride contamination. This standard applies to plutonium-bearing metals and oxides containing at least 30 weight-percent Pu and uranium. It also applies to plutonium-oxide materials with significant chloride contamination. The 3013 container is made up of an outer can, inner can, and convenience can. The outer and inner cans make up the primary and secondary containment, respectively.

Waste containers will be used to hold and ship MOX transuranic wastes. The waste transfer containers hold waste drums that provide the primary and secondary confinement for the waste.

The drums are bag-lined before loading and sealed with a gasketed cover. The drums are also provided with filters to prevent pressurization and prevent the release of wastes from the drum.

MOX fresh fuel casks will contain multiple fresh MOX fuel assemblies for shipping. The fresh fuel casks will be qualified to meet the requirements of 10 CFR Part 71. The NRC safety review of the fresh fuel casks for transportation is being performed separately from the MFFF review.

11.7.1.1.1 Function

The functions that the material transport system is designed to perform, include:

- Transferring MOX fuel material and components from one point in the process to another, in accordance with process throughput, positioning tolerance, mechanism reliability, and radiological shielding requirements.

- Maintaining structural integrity and control of process containers to ensure that the confinement boundary is not breached.

- Maintaining structural integrity and control of process containers to ensure that criticality control functions are performed.

- Working with fire barriers, as required, to transfer material across process atmosphere or fire barrier boundaries.

- Transferring tooling and equipment spare parts from point to point within the system.

The material handling equipment operation during those processes is summarized as follows:

The Pu powder arrives in a DOE safe, secure trailer to the shipping and receiving area at the Mixed Oxide Fuel Fabrication Facility (MFFF). The 3013 containers, on a shipping pallet, are transferred from the truck to the shipping bay laydown area by forklift. The pallet is unpacked on a turn-table and transported by roller conveyor to the 3013 storage area. Likewise for the depleted UO_2 receiving and storage unit, UO_2 is delivered to the secured warehouse building in palletized drums. From there they are sent to the MOX process area and are staged in a buffer area near the UO_2 drum emptying room. The 3013 containers are transferred to the transfer cask opening area to remove the overpack. A hoist lifts the 3013 package (of approximately 20 lb [9.1 kg]) onto a small roller conveyor. From there, the PuO_2/3013 storage crane transfers the 3013 package to PuO_2/3013 storage racks. When removed from storage, the package rides by conveyor to the decanning unit, that is fully enclosed in a glovebox. Inside this glovebox, the 3013 can is moved both horizontally and vertically and the outer can is removed. The inner can is transferred by pneumatic transfer tube to Level 4 of the aqueous polishing (AP) building where the inner can is opened. Following this operation, the “convenience can,” is opened. The opened convenience can is rotated and emptied into a homogenizer located in a glovebox immediate below the can opening glovebox. From there the homogenized Pu is transferred by pneumatic lift to the electrolyzer on Level 3 of the AP building. The electrolyzer marks the beginning of the AP chemical processing of the Pu. AP chemical processing of the plutonium is discussed in detail in Sections 8.0 and 11.3 of this SER.

Following AP chemical processing, the “wet” MOX material is returned to the MP process. The MOX material will remain within a glovebox from this point until it emerges in a completed, sealed fuel rod. First, the “wet” MOX material is heated in a high temperature calciner oven. In the calciner, the MOX material is dried and the oxalate material is transformed into PuO_2 in an oxidizing atmosphere of oxygen. The calcined PuO_2 material is canned and pneumatically transferred to the MP process area and stored in the PuO_2 buffer storage glovebox. When PuO_2 is needed, it is taken from the buffer storage glovebox by pneumatic transfer to the PuO_2 receiving/emptying glovebox for weighing and emptied onto a vibrating conveyor for transfer to the primary dosing unit. The primary dosing unit will blend the PuO_2 powder with UO_2 powder and recycled MOX scrap to make the “master blend.” The master blend is approximately 20 percent Pu. The master blend is loaded into jars (rated at 60 Kg & 80 Kg each) and sent to the jar storage and handling unit (JSHU). The JSHU is a glovebox that forms the backbone of the material handling equipment. The purpose of the JSHU is to store master blend jars, move powder between primary and secondary dosing units, auxiliary powder units that are used for sampling in the laboratory, homogenizing and pelletizing units, and scrap processing units, and to perform system maintenance. The JSHU contains storage areas and a material transport system made up of a motorized trolley on rails. It is driven by a motor connected to a pinion engaged with a rack and monitored by a position sensor with encoder.

When “master blend” MOX powder is needed, a jar is retrieved and sent to the ball milling glovebox for use in the Secondary Dosing Unit. In this step, the powder is micronized and the Pu content is adjusted to meet the final product specification. When secondary dosing is complete, the MOX product is moved to the homogenizing units that add pore-formers to control density, and a lubricant, such as zinc stearate. Once properly homogenized, the powder is transferred to hoppers that reside above the pelletizing presses. The powder is pre-measured and fed into the press dies. The MOX material is pressed under a high pressure hydraulic press to the needed compaction. Pressed “green” pellets are transferred to a notched conveyor and to molybdenum or “moly” boats. The moly boats are sent to a “green pellet storage area.” Green pellets in moly boats are transferred by overhead conveyor to the specific gravity control area for identification of boats and to the sintering furnace. The sintering furnace heats the pellets for a set time and temperature in a controlled atmosphere of argon and hydrogen. The sintered pellets are transferred by the same boats, through an airlock to the receiving gloveboxes. Nitrogen flow in the airlock serves to remove the argon/hydrogen gas from the system before transferring to the balance of the glovebox system. In the receiving gloveboxes they are transferred to a belt conveyor and transferred to a vibrating bowl and to a smooth conveyor in rows to feed a centerless grinder. Following grinding, the pellets are vacuum and laser de-dusted and transferred onto trays. Ten trays of pellets make one unit that includes a stainless steel top cover. The trays are transferred by “cartrack” to the second floor of MP building to the “Ground & Sorted Pellet Storage System.” The trays are unloaded onto a large conveyor where a robot transfers six pellets at a time to an in-line conveyor where they are visually and dimensionally inspected. Accepted pellets are re-loaded onto pellet trays and rejected pellets are taken to scrap storage. Accepted pellet trays are sent on a track to a stacker of 1-line trays. The column of pellets is pushed into the empty fuel rods. The empty fuel rods are obtained from a very large storage/transfer glovebox, designed for specifically for that purpose. Following filling with ground and sorted pellets, the rods are capped, welded and seal welded in a pressurized helium environment. They are decontaminated and inspected and sent through an airlock to a 32 rod tray loading station. This is the first production step that is outside of a glovebox (other than the sintering furnaces). The complete tray is sent by elevator to the 1st floor of the MP building. There a stacker/retriever stores the trays in racks. From the racks, rods are individually helium leak tested, laser dimensional checked and visually inspected by personnel. They are x-ray inspected and neutron counted to verify the Pu content of the MOX. After inspection they are again stored.

To begin a MOX fuel assembly, rods are retrieved by the stacker/retriever and sent to a mockup assembly. The mockup assembly, once complete, is sent to final assembly. In final assembly, the fuel rods are pulled through the final assembly of grids and spacers. The lower and upper plates are attached and the assembly tilted vertically. A trolley on MP Level 2 will grip the assembly and transfer it to various inspection stations; air cleaning, dimensional inspection, and final visual inspection when lowered into a pit below MP Level 1. Following inspection, the assembly is transferred by the trolley to a temporary storage position so that it can be picked up by bridge crane to a vertical MOX fuel assembly vault. To ship the assemblies, they are retrieved from the storage vault, tilted three at a time on a special fixture, and pushed into a MOX Fresh Fuel Package (MFFP). Impact limiters are installed on the MFFP and an air-cart is used to transfer the MFFP to the MOX fuel truck bay. Once the MFFP is in the truck bay, it may be transferred by bridge crane to storage positions or loaded directly onto waiting trucks. MFFPs are loaded onto over-the-road trucks using the MOX fuel truck bay bridge crane.

11.7.1.1.2 Major Components

Major components include process equipment, fuel rods, transfer containers, welded process equipment, MOX fuel transport cask, MOX fresh fuel package, waste container, or a 3013 transport cask into the workplace or environment.

The applicant stated in CAR Section 5.0, that the material handling system may have a plutonium dispersal hazard if the static barrier of the primary confinement system is damaged due to a loss of confinement/dispersal of nuclear material event. In light of this hazard, the applicant has identified PSSCs as shown in Table 11.7-1. Table 11.7-1 below describes the events, the CAR-identified PSSCs, and hazard target for material handling equipment, “loss of confinement/dispersal of nuclear material event.”

Table 11.7-1, CAR-Identified PSSCs for Loss of Confinement/Dispersal of Nuclear Materials Events

Loss of Confinement/ Dispersal of Nuclear Material Events Related to Material Handling Equipment	Identified PSSC	For the protection of the...		
		Facility Worker	Site Worker*	Public*
Corrosion	Material Maintenance & Surveillance Program**	✔	-	-
	Qualification of fluid transfer systems	✔	-	-
Small breaches in glovebox boundary or backflow from utility lines	C4 confinement system	✔	-	-
Leaks of AP process vessels or pipes within process cells	Process Cell	✔	-	-
	Process Cell Entry Controls	✔	-	-
3013 Canister handling operations	3013 canister outer can opening device**	✔	✔	-
Rod handling operations	Material handling equipment**	✔	-	-
	Material handling controls**	✔	-	-
	Training and procedures	✔	-	-
Breaches in containers outside gloveboxes due to handling operations in C2 areas	3013 canister**	✔	✔	✔
	Transfer container**	✔	✔	✔
	Material handling controls**	✔	✔	✔
Breaches in containers outside gloveboxes due to handling operations in C3 areas	3013 canister**	✔	-	-
	Transfer container**	✔	-	-
	Training and procedures	✔	-	-
	Material handling controls**	✔	-	-
	C3 confinement system	-	✔	✔
***NOTE 1:** There are confinement systems or barriers that provide defense-in-depth protection for the site worker or the public for which no credit is technically being given due to the fact that the performance criteria is met without their use. ****NOTE 2:** These items are PSSCs specifically related to the material handling equipment DSER review in this Section.				

The applicant stated in CAR Section 5.0, that the material handling system may have a plutonium dispersal hazard if the static barrier of the primary confinement system is damaged and the plutonium is transferred to the workplace or environment due to a “load handling event.” In light of this hazard, the applicant identified PSSCs as shown in Table 11.7-2.

Table 11.7-2, CAR-Identified PSSCs for Load Handling Events

Load Handling Events Related to Material Handling Equipment	Identified PSSC	For the protection of the...		
		Facility Worker	Site Worker*	Public*
AP Process Cells	Process Cell	✔	-	-
	Process Cell entry controls	✔	-	-
AP/MP C3 Glovebox Areas - All times	C3 confinement system	-	✔	✔
AP/MP C3 Glovebox Areas - normal operations	Material handling controls**	✔	-	-
	Material handling equipment**	✔	-	-
	Glovebox**	✔	-	-
AP/MP C3 Glovebox Areas - facility maintenance operations	Material handling controls**	✔	-	-
	Material handling equipment**	✔	-	-
	Glovebox**	✔	-	-
	Training and procedures	✔	-	-
C2 Areas/3013 Canister	3013 canister**	✔	✔	-
	Material handling controls**	✔	✔	-
C2 Areas/3013 Transport Cask	3013 transport cask**	✔	✔	-
	Material handling controls**	✔	✔	-
C2 Areas/Fuel Rod	Training and procedures	✔	-	-
C2 Areas/MOX Fuel Transport Cask	MOX fuel transport cask**	✔	-	-
	Material handling controls**	✔	-	-
C2 Areas/Waste Container	Training and procedures	✔	✔	-
C2 Areas/Transfer Container	Transfer container**	✔	✔	✔
	Material handling controls**	✔	✔	✔
C2 Areas/Final C4 HEPA Filter	Material handling controls**	✔	✔	-
C4 Confinement/Spill inside glovebox	C4 confinement system	✔	✔	-
C4 Confinement/Outside of MFFF Building	Waste transfer line	✔	✔	✔
C4 Confinement/Facilitywide	MOX FFF building structure	✔	✔	✔
	Material handling controls**	✔	✔	✔

*** NOTE 1:** There may be confinement systems or barriers that provide defense-in-depth protection for the site worker or the public for which no credit is technically being taken by DCS.
****NOTE 2:** These items are PSSCs specifically related to the material handling equipment DSER review in this Section.

The applicant stated in CAR Chapter 5, that the material handling system may have a load handling hazard from the presence of lifting or hoisting equipment used during normal operations or maintenance activities in the MFFF facility. A load handling event could occur when either a lifted load containing radioactive materials is dropped or the load or lifting equipment impacts equipment containing radioactive material. Heavy load drops and other load handling events, as specifically defined in NUREG-1718 and NUREG-0612, are discussed in the CAR Section 11.10 and are evaluated in Section 11.10 of this SER.

11.7.1.1.3 Control Concept

The MP and AP process control systems use a distributed processing control system strategy, with the manufacturing process translated into control algorithms for each process step. The systems include normal, protective, and safety control subsystems that ensure the final product conforms to manufacturing specifications and minimize plant waste and risk. The normal control subsystem controls the manufacturing process, the protective control subsystem maintains industrial safety (protects personnel) and protects equipment, and the safety control subsystem ensures safety limits will not be exceeded and that undesirable operational conditions are prevented or mitigated.

11.7.1.2 Design Bases for PSSCs

In the CAR the applicant identified the following material transport system PSSCs:

- 3013 canister.
- 3013 transport cask.
- 3013 canister outer can opening device.
- MOX fuel rod.
- Gloveboxes.
- Waste container.
- MOX fresh fuel transport cask.
- Transfer container.
- Material handling equipment.
- Material handling controls.

Note that not all material handling equipment will be designated as IROFS in the operating license stage of the MFFF SER review. Due to the nature of the systems with their large variations in equipment and their uses, no attempt has been made to list every individual item that is designated a PSSC. The material handling PSSCs are described in the context of their safety application such as: redundant brakes, with fail-safe design, on lifting equipment, structural oversizing of mechanical drive equipment, overspeed detection, mechanical stops, overtorque detection, electrical interlocks, component sizing, magnetic grippers, glovebox hoods, and shielding.

CAR Section 5.5.5.2 describes the general design basis commitments made by the applicant to meet the defense-in-depth requirements of 10 CFR 70.64(b) for PSSCs. DSER Section 5.1.4.5 discusses defense-in-depth.

The applicant has identified in the CAR the following design basis functions for the material handling equipment:

- Transfer of MOX fuel material and components from one point to another in the process. This is to be accomplished with the appropriate process throughput, positioning tolerance, mechanism reliability, and radiological shielding requirements.

- Maintain structural integrity and control of process containers to ensure that the confinement boundary is not breached.

- Function using fire barriers, as necessary, during transfer of material across process atmosphere or fire area boundaries.

- Function during maintenance operations to transfer tooling and spare parts within the glovebox system.

The applicant states in the CAR that the design basis of material handling PSSCs includes designing them to the following codes and standards:

- ANSI/AISC N690-1994, Specification for the Design, Fabrication, and Erection of Stell Safety-Related Structures for Nuclear Facilities for design of components required to maintain structural integrity;

- ASME B30.2-1996, Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist Overhead and Gantry Cranes for design of overhead cranes;

- CMAA-70-1994, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes for design of bridge cranes.

- ASME B30.16-1998, Overhead Hoists for design of hoisting equipment.

3013 Canister: The outer can is designed and qualified for a 9 m [30 ft] drop onto a flat, unyielding surface while remaining leak-tight, as discussed in DOE-STD-3013-2000, “Stabilization, Packaging, and Storage of Plutonium-Bearing Materials,” and meets the requirements of 10 CFR Part 71. The inner can is designed to remain leak-tight after a drop of 1.3 m [4 ft.] onto a flat unyielding surface. The outer and inner cans are designed to withstand pressures of 4927 kPa [699 psig] and 790 kPa [100 psig] and are hydrostatically tested prior to use at a pressure 1.5 times that of the design pressure. Both containers must be fabricated from ductile, corrosion resistant materials, such as 300 series stainless steel or better. Closure welding of the stainless steel must be done in such a way as to minimize the sensitization of stainless steel to stress corrosion cracking. Heat generation limits the mass of plutonium contained in the containers to less than or equal to 19 Watts [1.1 BTUs/minute]. Both of the containers are designed to hold the material for a maximum of 50 years. The DOE 3013 transport cask is a PSSC designed and qualified to protect the 3013 canister against transportation accidents. It will be certified to meet the free drop, crushing, and puncture requirements contained in 10 CFR 71.73.

Waste Transfer Containers: Waste transfer containers are designated as PSSCs that will be used to hold and ship MOX transuranic wastes. The waste transfer containers are designed, constructed, and qualified to meet the requirements of the U.S. Department of Transportation Specification 7A of the *Code of Federal Regulations, Title 49, Part 178, Section 178.350.*

Waste Drums: The waste drums are qualified to maintain their integrity from a 1 m [3.3 ft] drop. The drums are also provided with filters to prevent pressurization and prevent the release of wastes from the drum. While being stored, waste drums may be stacked above 1 m [3.3 ft]. The staff will review the handling controls for waste drums stacked above their design basis maximum drop height during the second (operation) phase of the MFFF license review. DCS intends to protect the worker from this hazard with worker actions, i.e, using respiratory protection and/or immediately evacuate the area. Based on the waste drum design basis criteria, the staff finds the waste drum design basis to be acceptable**.**

Fresh Fuel Casks: The fresh fuel casks will be qualified to meet the requirements of 10 CFR Part 71. The casks may be stacked in storage frames in the truck shipping bay. To accommodate the load, the frames will be designed for the full weight of the shipping package including seismic effects. Because this cask will not be used in the facility prior to being licensed by the NRC, and because the cask, if approved, will be handled in the proposed MFFF according to its certification, the staff finds this design to be acceptable.

Material handling equipment designated as PSSCs are designed and qualified according to national codes and standards enabling them to perform their safety function during normal operations, upset conditions, and design basis events. The ability to safely shutdown the primary process is facilitated by the seismic design for the material handling equipment and structural support members. Equipment geometry and alignment must be maintained in order to have an orderly shutdown of the system. The system is designed to prevent physical interaction with confinement boundary elements or PSSCs under worst-case loading associated with normal, off-normal, accident, and design basis events according to the industry code ANSI/AISC N690-1994. The system will also be designed to meet the criteria provided in Regulatory Guide 1.100, Rev. 2, “Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants,” 1988 and IEEE Standard 344-1987, “IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.” Therefore, DCS, in its mechanical equipment seismic qualification program, has committed to include attached piping loads, thermal loads, and live loads, such as tank sloshing, and in addition, applied loads are required to meet or exceed accelerations corresponding to their installed locations. The staff has reviewed DCS’ commitment to these codes and standards and finds them to be equivalent to requirements for nuclear power generating stations and therefore are acceptable.

The seismic monitoring system is designed to satisfy the criteria provided in Regulatory Guide 3.17-1974, “Earthquake Instrumentation for Fuel Reprocessing Plants.” The design basis of the seismic monitoring system is that it provides sufficient data to evaluate the response of the confinement structure and other PSSCs to a seismic event and initiate a shutdown of process systems in the event of a high seismic event. The seismic system will meet the requirements of IEEE 603, “IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations,” 1998.

Evaluation of Capacity: The staff evaluated the information provided by DCS in their CAR regarding the capacity of the proposed material handling equipment. The material handling equipment is designed such that in the event of accident or off-normal condition, the equipment is designed to de-power or return to a shutdown condition. The throughput, or capacity, of the equipment peaks during normal operations or maintenance. The CAR describes the design of the equipment as being sized to handle the required throughput of shipping packages, containers, canisters, drums, casks, cans, powder, pellets, scrap, rods, and assemblies necessary for normal and off-normal operating conditions and maintenance. The CAR also discusses that the active systems, such as motors, power transmission systems and pass-throughs, carriers, actuators, end effectors, structural supports, sensors, and control systems will be based on the material throughput requirements for each process unit.

Capacities of the material handling equipment vary based on the operational through-put needed for the equipment, by the design and qualification of the equipment, and other specific design criteria. The material handling equipment designated as PSSCs must also retain their loads under all credible accidents and design basis natural phenomena events. Therefore, the capacity of these PSSCs may be greater than non-PSSCs. To accomplish these design requirements, equipment will be designed to maintain (1) clearance between equipment and the confinement boundary under all conditions, (2) to include physical stops to prevent uncontrolled motion of payloads from breaching containment in the event of over-travel or seismic conditions, (3) to ensure that actuating mechanisms, such as grippers, are designed to retain the payload under all conditions including loss-of-power and credible seismic events, and (4) to maintain appropriate margins of safety in hoisting equipment. Capacity of equipment is not directly discussed by design codes, however, the staff accepts that if PSSC equipment is built to the committed design codes it will be designed to handle all loads, events, and configurations while maintaining its safety function.

Material handling equipment intended to suspend loads from flexible cables are designed using codes for cranes, monorails, and hoists, that includes appropriate minimum factors of safety. Hoisting equipment identified as PSSCs further de-rate their capacities according to safety factors from NUREG-0554 applicable to single failure-proof cranes. Process equipment used during maintenance is further de-rated to 65 percent of capacity according to project-specific design criteria. Hoists will be designed in accordance with ASME B30.16, “Overhead Hoists.”

Material handling equipment that runs on fixed tracks are designed using structural design codes. Equipment classified as PSSCs are qualified in accordance with load combinations and acceptance criteria provided in ANSI/AISC N690 structural design code.

Evaluation of Redundancy and Diversity: The CAR describes the passive design of the equipment to handle shipping packages, containers, canisters, drums, casks, cans, powder, pellets, scrap, rods, and assemblies necessary for normal and off-normal operating conditions and maintenance. The staff reviewed the system design basis including the provision of active systems, such as motors, power transmission systems and pass-throughs, carriers, actuators, end effectors, structural supports, sensors, and controls. Material handling equipment includes devices that suspend loads from flexible cables and material handling equipment that runs on fixed tracks. Some of this equipment is designed to work external to a glovebox and other equipment is designed to work internal to a glovebox environment. Redundancy and diversity in the design is accomplished by: various factors of safety, types of equipment, and by the layering of active and passive controls that protect the confinement boundary. The MFFF design for material handling equipment inside gloveboxes includes redundant brakes, with fail-safe design, on lifting equipment, structural oversizing of mechanical drive equipment, overspeed detection, mechanical stops, overtorque detection, electrical interlocks, and component sizing based on worst case loading combinations. Various containers and casks are also discussed in the MFFF design. Each of these containers or casks is designed for different applications and are certified under federal regulations prior to use. The staff has reviewed the applicant’s description of the material handling equipment and finds these systems to be diverse, on the basis of standard industry practices the staff finds the design to be acceptable. The staff notes that casks and canisters are likewise acceptable if they are used within their certification basis or if appropriate compensatory measures are made with consideration to the hazard to the facility and site worker, the public, and the environment.

Evaluation of Safe Shutdown: The staff evaluated the information provided by the applicant in their CAR regarding the ability to safely shutdown the proposed material handling equipment during normal, accident, and maintenance conditions. The staff notes that material handling equipment with a safety function will be identified as an IROFS following the completion of the ISA. The material handling equipment is designed such that in the event of accident or off-normal condition, the equipment is designed to de-power in a fail-safe condition. Emergency power is not provided to the material handling equipment. For example during a loss of power, hoist brakes passively activate and end effectors such as magnetic grippers passively fail to a “closed” or retain load condition. In this way, the design ensures that in any accident or off-normal condition, all system loads are maintained and the confinement boundaries are not challenged by dropped or unrestrained loads.

Evaluation of Welded Construction: The SRP for the material transport system specifically mentions tank and piping systems be of welded construction to the fullest extent possible. For the purposes of this review, this guidance is applied to gloveboxes (a material handling PSSC). Continuously welded construction means the seams are ground smooth, which facilitates cleaning and minimizes holdup of powder, pellets, dust, or debris. The specification of welded construction also minimizes leakage paths and facilitates decontamination of gloveboxes. Welding techniques will also be used to mount stainless steel casings to material handling support structures where necessary to minimize holdup of process byproducts. Various other steps will be taken in the design and construction of the equipment, such as re-entrant corners of relatively large radius and powder-handling channels will be of a sealed construction. Equipment will be designed and fabricated in accordance with national codes and standards appropriate for their use. These codes include ANSI/AISC N690-1994, “Specification for the Design, Fabrication, and Erection of Safety Related Steel Structures for Nuclear Facilities,” AWS D1.1-1998, “Structural Welding Code,” AWS D1.3-1998, “Structural Welding Code - Sheet Steel,” and AWS D9.1-1998, “Sheet Metal Welding Code.”   Of the four standards listed that will apply to the PSSCs of gloveboxes, AWS D9.1-1998, “Sheet Metal Welding Code,” the staff notes that this code is intended for joining various types of metal sheeting and is not intended for structural use. Based on the use of industry codes for the design and construction of welded material handling equipment, the staff finds this design basis to be acceptable.

Evaluation of Passive Features/Remote Operation: As discussed previously, the material handling equipment is designed such that in the event of accident or off-normal condition, the equipment is designed to de-power in a fail-safe condition. Emergency power is not provided to the material handling equipment. For example during a loss of power, hoist brakes passively activate and end effectors such as magnetic grippers passively fail to a “closed” or retain load condition. In this way, the design ensures that in any accident or off-normal condition, all system loads are maintained and the confinement boundaries are not challenged by dropped or unrestrained loads. The material handling equipment design also employs material handling equipment that is designed with engineered features to prevent active failures from impacting the glovebox walls. Based on the applicant’s commitment in its design basis for these passive engineered features, the staff finds that the design provides an adequate level of protection against active failures.

For most operations the process control system is designed to control the material handling equipment during normal process conditions. In the event of an off-normal or accident condition, additional control system elements are capable of overriding the normal process controllers to mitigate the potential hazardous condition. This equipment and functions are described in further detail in Section 11.6 of this SER. During maintenance, process equipment and controllers are de-energized and equipment may be selectively energized under manual control of MFFF personnel engaged in the maintenance activities. Based on the control system design being for remote operation of process equipment, the staff finds this design for remote operation to be acceptable.

Evaluation of Radiation Safety: The staff review and evaluation of the radiation safety program is discussed in detail in Section 6.0 of this SER. In general, the design basis for the material handling equipment hardware for radiation safety is as follows: use of design configurations to minimize powder/dust or debris; mounting of stainless steel casings on structural supports to prevent powder/dust retention; easy visibility and accessibility of parts for cleaning, use of sealed bearings or leak-free coupling mechanisms, use of appropriate surface quality or coatings; surface qualities of N6 or better for inner components and N4 or better for material in contact with powder; lubricant use is limited to extent practical; continuous and smoothly ground internal welds; re-entrant corners of large relative radius; and sealed powder handling channels. These “N” surface qualities are defined in ISO 1302. The American standard related to these surface finishes is ASME B46.1. A surface finish of N4 relates to the average distance between the median line of the surface profile and its peaks and troughs of approximately 8 micro-inches. It is also called a “ground finish.” A N6 surface finish is a “smooth turned” finish of approximately 32 micro-inches roughness. Based on its commitments to industry standards for surface finish and the general equipment design for minimization of powder holdup in equipment, the staff finds these provisions to be acceptable.

Evaluation of Corrosion Resistance: The material handling equipment proposed by the applicant are to be made primarily of stainless steel with the appropriate surface finishes to resist corrosion. The corrosion of carbon steel parts that cannot be painted will be prevented by a glovebox environment of nitrogen or dry air. For other areas, components may be coated or painted for corrosion resistance and ease of decontamination. Outside gloveboxes, painting systems will be used for materials located in C3b rooms to facilitate decontamination. In addition, the material condition of the equipment will be monitored by the material maintenance and surveillance programs. On the basis of industry codes and standards that specify system design accounting for corrosion as a standard industrial practice, the staff finds the design to be acceptable.

Evaluation of Personnel Protection: NRC NUREG-1718, Section 11.4.7.2, states that the need for hoods, gloveboxes, and shielding for personnel protection should be evaluated. These systems are generally required for processing operations involving more than gram quantities of plutonium or general operations involving 50 micrograms or more or plutonium in respirable form. In its clarification letter to its original response to NRC’s request for additional information (RAI), dated December 5, 2001, the applicant stated that the equipment that meets the stated conditions are all located in process cells. Process cells contain equipment that handles radioactive materials in chemical solutions; that equipment being of a fully welded construction and not requiring routine maintenance. Equipment containing radioactive materials in the powder (MP) process is contained in gloveboxes in process rooms that provide equivalent confinement to fully welded equipment in process cells. As part of the review of the accident scenarios for gloveboxes, the staff found that both fire and impact events with gloveboxes were analyzed. However, DCS did not postulate or analyze an accident scenario related to a high temperature non-fire-related failure of gloveboxes. Qualification of gloveboxes is an open item (designated as FS-4) and is discussed in Section 7 of this DSER.

11.7.2 EVALUATION FINDINGS

In Chapter 11.7 of the CAR, DCS provided design basis information for the material transport systems that it identified as PSSCs for the proposed MFFF. Based on the staff's review of the CAR and supporting information provided by the applicant relevant to the material transport systems, the staff finds that DCS has met the defense-in-depth requirements stated 10 CFR 70.64(b). The staff concludes, pursuant to 10 CFR 70.23(b), that the design bases of the PSSCs evaluated in this DSER section will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

11.7.3 REFERENCES

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