11.0 PLANT SYSTEMS
11.4 VENTILATION AND CONFINEMENT SYSTEMS

11.4.1 CONDUCT OF REVIEW

This chapter of the revised draft Safety Evaluation Report (DSER) contains the staff's review of ventilation and confinement systems described by the applicant in Chapter 11 of the revised Construction Authorization Request (CAR). The objective of this review is to determine whether the ventilation and confinement principal structures, systems, and components (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 ventilation and confinement systems by reviewing Chapter 11 of the revised CAR, other sections of the revised CAR and supplementary information provided by the applicant. The review of ventilation and confinement systems design bases and strategies was closely coordinated with the review of accident sequences described in the Safety Assessment of the Design Basis (see Chapter 5.0 of this revised DSER), and the review of other plant systems.

The staff reviewed how the information in the revised 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.

The review for this revised CAR issue focused on the design basis of ventilation and confinement systems, their components, and other related information. For ventilation and confinement 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, "Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility," (Reference 11.4.3.11) as guidance in performing the review.

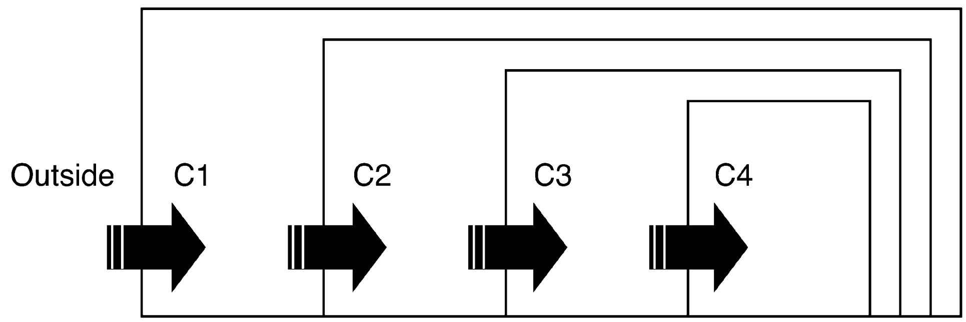
11.4.1.1 System Description

11.4.1.1.1 Functions and Major Components

In the revised CAR, the applicant proposed a ventilation and confinement system to confine radioactive materials within process areas and gloveboxes and to ensure minimum dispersal of radioactive materials during routine operations and under accident conditions. The system was intended to meet the recommendations in Regulatory Guide 3.12 (Reference 11.4.3.14) and consists of:

- Ventilation zones operated at pressure differentials designed such that air leakage occurs from areas of low radiation hazard into areas with the greater radiation hazard (Reference 11.4.3.11 and revised CAR Section 11.4.1.2). See Figure 11.4-1.

Figure 11.4-1, Ventilation Confinement Zones



- A system of filters assemblies consistent with American Society of Mechanical Engineers (ASME) N509 (Reference 11.4.3.5) consisting of high efficiency particulate air (HEPA) filters, prefilters, and two-stage spark arresters intended to remove radioactive materials from process areas and occupied areas during routine operations and under accident conditions (Reference 11.4.3.11 and revised CAR Section 11.4.9).

- A design in accordance with ASME N510 (Reference 11.4.3.6) to allow testing and in-service surveillance to ensure operability and required functional performance (Reference 11.4.3.11 and revised CAR Section 11.4.11).

- Redundancy of PSSCs to ensure that the performance requirements in 10 CFR 70.61 are met (Reference 11.4.3.11).

- Sufficient capacity and capability under routine operations. Under accident conditions involving fires, the proposed design has sufficient capacity to maintain air temperatures at the HEPA filters less than 450^{o}F and ensure that HEPA filters will remain operational. The applicant proposed to use dilution of hot air from a fire area with air from other areas to protect the HEPA filters (see revised DSER Section 7.1.5.5). The HEPA filters are capable of operating at temperatures up to 450^{o}F without severe degradation effects (Reference 11.4.3.11 and revised CAR Section 11.4.9).

- Under accident conditions, the applicant is proposing to only take credit for the final filtration assemblies and not HEPA filters located on gloveboxes or at confinement zone boundaries (Reference 11.4.3.11 and revised CAR Section 11.4.9). The applicant proposed to use a release factor of 1E-04 for the final filter assemblies in its accident safety analyses (revised CAR Sections 5.5.3.2 and 11.4.9). The applicant based its proposal on having redundant HEPA filter banks in each redundant filter assembly with HEPA filters that have been tested to have an efficiency for removal of 0.3 micron particles of at least 99.97 percent. After installation, the HEPA filter banks will be leak tested in accordance with ASME N510 (Reference 11.4.3.6) to ensure that leakage efficiency is at least 99.95 percent. Under severe conditions, the applicant considers that each bank of HEPAs will remove at least 99 percent of particulates and will provide an overall efficiency of 99.99 percent for the two combined banks.

- Monitoring instrumentation, alarms, and controls to ensure that pressure differentials in confinement zones are maintained, alternative power supplies are actuated when needed, and the consequences of accidents are mitigated (Reference 11.4.3.11 and revised CAR Sections 11.4.2, 11.4.3, 11.4.4, and 11.4.7).

- A design providing for a safe air supply to the emergency control rooms consisting of heaters, coolers, prefilters, HEPA filters, and acid gas/organic vapor cartridges to remove chemicals. This system will maintain a safe environment during emergencies for personnel and equipment (Reference 11.4.3.11 and revised CAR Section 11.4.2.6).

- A design that provides for removal and replacement of filters and other expected maintenance activities to minimize personnel exposures. The design allows for in-place testing of HEPAs in accordance with ASME N510 (Reference 11.4.3.6) to ensure that HEPAs have been properly installed and are undamaged.(Reference 11.4.3.11 and revised CAR Section 11.4.9.1)

- Gloveboxes that consist of welded stainless steel enclosures with windows, alone and in interconnected groups, that act as a primary barrier to confine hazardous (radioactive, toxic, or flammable) materials and to provide structural support capable of protecting process equipment during a postulated seismic event. Mixed Oxide Fuel Fabrication Facility (MFFF or the facility) personnel access to equipment inside the gloveboxes is provided through access holes in the glovebox windows fitted with gloves that maintain the confinement boundary. Gloveboxes that contain powder or pellet forms are inerted with nitrogen gas to eliminate adverse effects of atmospheric oxygen on the process or fuel. (Reference 11.4.3.11 and revised CAR Section 11.4.7).

- Glovebox window panels, viewing ports, or video cameras that give visual access to the gloveboxes. Light fixtures provide illumination and are generally located outside of the glovebox. The window panels are clear rectangular panels that fit into gasketed frames that cover specifically designed openings in the glovebox shell. The windows proposed by the applicant are polycarbonate (Lexan®) that may have lead-impregnated polymer sheets or lead-glass panels to provide additional radiation protection. The gasket material is Neoprene and the window panels range from small portholes to large 1 x 1.5 m [3.3 x 4.9 feet] polycarbonate panels that are 10 mm [0.39 inch.] thick. A panel of this size would weigh a maximum of 18 kg [40 lbs] not including frames, gaskets, glove hardware, gloves, or panel handling equipment. A panel of laminated safety glass of similar size would weigh approximately 36 kg [79 lbs] (Reference 11.4.3.11 and revised CAR Section 11.4.7).

- Gloveboxes that have pass-through connectors in glovebox shells that are used to bring process and utilities (such as air, electricity, and water) inside of the glovebox. These connectors are designed and tested to ensure glovebox pressure integrity stays within the maximum leakage criteria. At mechanical interfaces in the glovebox shells, pass-throughs are designed to allow motion generated outside of the glovebox to be transferred to equipment inside of the glovebox while maintaining confinement boundary leak tight criteria. Primary process equipment contains MOX product in various forms (i.e., powder, pellets, trays, and rods). These MOX forms are manufactured, transferred, stored, and maintained inside of gloveboxes (Reference 11.4.3.11 and revised CAR Section 11.4.7). Gloveboxes designated as PSSCs (Reference 11.4.3.11 and revised CAR Section 11.4.11.2) and relied upon to maintain confinement boundary:

- Use highly automated processes with hard-wired logic to avoid challenging the glovebox confinement.

- Provide seismic support of process equipment, resist impacts and potential load drops outside of the gloveboxes.

- Provide a stable base for barriers, stops, and guides that would prevent impact from equipment and material moving inside of the gloveboxes.

- Gloveboxes that are designed, fabricated, and welded in accordance with national codes and standards appropriate for their use (Reference 11.4.3.11 and revised CAR Section 11.4.7). The glovebox system uses continuously welded construction with the seams ground smooth, minimizes holdup of powder, minimizes leakage paths, and facilitates decontamination of equipment. Fabrication and welding codes include American National Standards Institute (ANSI) N690 (Reference 11.4.3.1) and American Welding Society (AWS) D1.1 (Reference 11.4.3.7).

- The ability to safely shutdown the primary process is facilitated by the seismic design for the glovebox and similar equipment and structural support members (Reference 11.4.3.11 and revised CAR Section 11.4.7). Equipment geometry and alignment must be maintained in order to maintain confinement. The glovebox 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 in accordance with ANSI N690 (Reference 11.4.3.1). 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," (Reference 11.4.3.13).

- Ductwork is designed, fabricated, and tested in accordance with ASME B31.1, ASME N509, and U.S. Energy Research and Development Administration (ERDA) 76-21 (References 11.4.3.4, 11.4.3.5, and 11.4.3.10).

11.4.1.1.2 Control Concepts

As described in Sections 11.4.2.2.4, 11.4.2.3.4, 11.4.2.4.4, 11.4.2.5.4, 11.4.2.6.4, 11.4.2.7.4, 11.4.3.4, 11.4.4.4, and 11.4.7.1.4 of the revised CAR (Reference 11.4.3.11), the Ventilation and Confinement System provides for instrumentation and control systems to monitor and control the ventilation and confinement PSSCs. These instrumentation and controls include:

- Pressure instrumentation and controls to maintain proper negative pressures in each of the separate confinement zones. Negative pressures are established such that air flows from areas having a lower radiation hazard to areas having higher radiation hazard. These controls include pressure monitoring instrumentation and associated interlocks with individual confinement systems to ensure that the proper negative pressures are maintained. Fan controls are also provided to activate redundant fans, if needed, to ensure proper negative pressures.

- Manual and automatic damper controls to regulate air and gas flows within gloveboxes and confinement zones. These controls maintain proper confinement zone pressures and ensure proper air flows or isolation of gloveboxes in the event of glovebox breaks and isolation of fire areas in the event of fires. Tornado dampers are provided to ensure that overpressures do not occur in the event of tornadoes or high winds.

- Controls for the transfer of alternate power supplies. Switchgear controls ensure that standby, emergency, and uninterruptible power supplies are properly actuated if normal power supplies are lost.

- Instrumentation to measure differential pressures across filter banks to alert operators if filters need to be replaced.

- Variable-speed controls for fan operation to maintain proper pressure control in each confinement zone. Individual confinement systems are interlocked to ensure that air flows from zones of higher radiation hazard cannot flow to zones of lower radiation hazard.

- Air temperature instrumentation for fire protection and to ensure that area temperature requirements are properly maintained for habitability and for meeting equipment requirements. Air flow instrumentation is provided to ensure proper system operation.

- Nitrogen and dry air supply flow control is provided to ensure that proper confinement zone negative pressures are maintained.

- Sintering furnace instrumentation and controls to ensure that proper reducing conditions are maintained in the sintering furnace and that potential explosive or flammable conditions are detected and prevented. In the event of leakage from a sintering furnace seal, the staff calculated that a worker exposed to plutonium releases from a failed furnace seal would receive a dose less than 10 rem. This dose is less than the limit for intermediate consequence events in 10 CFR 70.61 for a facility worker (25 rem).

11.4.1.2 System Interfaces

Individual confinement zone ventilation systems are interconnected to ensure the proper negative pressures are maintained within confinement zones. Interlocks are provided to ensure that air flows from zones of higher radiation hazard cannot flow to zones of lower radiation hazard. The Ventilation and Confinement System also interfaces with the normal, standby, emergency, and uninterruptible power supplies so that systems can properly function in the event of power loss. Gloveboxes have functional and physical interfaces with the ventilation systems; electrical systems; air, gas, chilled water, and demineralized water systems; chemical processing systems; and fire suppression systems (Reference 11.4.3.11 and revised CAR Sections 11.4.1, 11.4.1.2.3, 11.4.2.2.4, 11.4.2.2.5, 11.4.2.3.4, 11.4.2.3.5, 11.4.2.4.4, 11.4.2.4.5, 11.4.2.5.4, 11.4.2.5.5, 11.4.2.6.4, 11.4.2.6.5, 11.4.2.7.4, 11.4.2.7.5, 11.4.3.5, 11.4.4.4, 11.4.4.5, 11.4.7.1.4, and 11.4.7.1.5).

11.4.1.3 Design Bases of the PSSCs

Design bases for the Ventilation and Confinement System PSSCs are discussed in Section 11.4.11 of the revised CAR. Based on the applicant’s safety assessment, PSSCs for the Ventilation and Confinement System are shown in Table 11.4-1.

Table 11.4-1 Confinement System Design Bases

PSSC	System Function	Controlling Parameters	Status
C4 Confinement System	Control releases of plutonium; Remain operable during fires; Maintain differential pressure between glovebox and C3 areas; Maintain negative glovebox pressure in small breaches;	C4 zone pressure maintained at negative pressure with respect to C3 zone during normal operation and transients; Redundant pressure sensors to maintain C4 pressures; Designed to maintain exhaust safety function assuming single active component failure; Final HEPA filter assembly release fraction: 1E-4 Final HEPA filter design temperature of 450 F; Two 100 percent capacity redundant assemblies of two HEPA filter banks prior to discharge; Two-stage spark arrestors and prefilters in each filtration assembly upstream of HEPA filters; Four 100 percent capacity fans in C4 discharge system; Manually activated fire-isolation valves between designated fire areas; High-capacity flow system (125 ft/min) in the event of glovebox breach to maintain negative pressure; In-place HEPA filter testing for final discharge filtration assemblies; System design in accordance with Regulatory Guide 3.12, except heat removal is by airflow dilution; HEPA filter design; HEPA filter housing design, construction and testing; and HEPA filter housing isolation dampers in accordance with ASME N509; HEPA filter design and testing; HEPA filter housing design and testing; ductwork and pipe flexible connections; and fan design, construction, and testing in accordance with ASME AG-1; Ductwork piping in accordance with ASME B31.3; “Bubble tight” isolation valve construction and testing; HEPA filter housing testing; and HEPA filter testing in accordance with ERDA 76-21; Filter testing in accordance with ASME N510 with each HEPA stage having a leakage efficiency of 99.95 percent; Piping, valves, and fittings associated with gloveboxes in accordance with ASME B31.3; Fan power from normal (non-PSSC), standby (non-PSSC), emergency (PSSC), and uninterruptible (PSSC) supplies; Remains operational during and after facility fires, tornadoes, and design basis earthquakes;	HEPA filter removal efficiency may be inadequate for severe accident conditions such as fires; HEPA filter soot loading capacity may be inadequate during fires

PSSC	System Function	Controlling Parameters	Status
C3 Confinement System	Control releases of plutonium; Remain operable during fires; Ensure 3013 canister storage area temperature; Provide cooling air to electrical rooms;	C3 zone pressure maintained at negative pressure with respect to atmosphere during normal operation and transients; HEPA filter release fraction: 1E-4; HEPA filter design temperature of 450 F; Designed to maintain exhaust safety function assuming single active component failure; Two 100 percent capacity redundant assemblies of two HEPA filter banks prior to discharge; Two-stage spark arrestors and prefilters in each filtration assembly upstream of HEPA filters; Two 100 percent capacity fans in C3 confinement system; Automatic and manual fire-rated dampers between designated fire areas; In-place HEPA filter testing for final discharge filtration assemblies; System design in accordance with Regulatory Guide 3.12, except heat removal is by airflow dilution; HEPA filter design; HEPA filter housing design, construction and testing; and HEPA filter housing isolation dampers in accordance with ASME N509; HEPA filter design and testing; HEPA filter housing design and testing; ductwork and pipe flexible connections; and fan design, construction, and testing in accordance with ASME AG-1; Sheet metal ductwork design, construction, and testing; "bubble tight" isolation damper construction and testing; HEPA filter housing testing; and HEPA filter testing in accordance with ERDA 76-21; Filter testing in accordance with ASME N510 with each HEPA stage having a leakage efficiency of 99.95 percent; Tornado dampers; Fan power from normal (non-PSSC), standby (non-PSSC), and emergency (PSSC) supplies; Provides emergency cooling capability for selected areas. Remains operational after facility fires, tornadoes, and design basis earthquakes;	HEPA filter removal efficiency may be inadequate for severe accident conditions such as fires; HEPA filter soot loading capacity may be inadequate during fires

PSSC	System Function	Controlling Parameters	Status
C2 Confinement Passive Barrier System	Control releases of plutonium	Two HEPA filter banks prior to discharge; Two-stage spark arrestors and prefilters in each filtration assembly; HEPA filter design temperature of 450 F; Automatic and manual fire-rated dampers between designated fire areas; In-place HEPA filter testing for final discharge filtration assemblies; System design in accordance with Regulatory Guide 3.12; HEPA filter design; HEPA filter housing design, construction and testing; and HEPA filter housing isolation dampers in accordance with ASME N509; HEPA filter design and testing; HEPA filter housing design and testing; ductwork and pipe flexible connections; and fan design, construction, and testing in accordance with ASME AG-1; Sheet metal ductwork design, construction, and testing; “bubble tight” isolation damper construction and testing; HEPA filter housing testing; and HEPA filter testing in accordance with ERDA 76-21; Filter testing in accordance with ASME N510 with each HEPA stage having a leakage efficiency of 99.95 percent; Tornado dampers; Final filters and downstream ductwork remain structurally intact during and after tornadoes and design basis earthquakes;	
Process Cell Exhaust Passive Barrier System	Control release of plutonium; Ensure equipment venting to prevent over-pressurization; Control of explosive vapors and hydrogen	HEPA filter release fraction: 1E-4; Two 100 percent capacity filtration stages (using electric heaters and two HEPA filter stages); Two-stage spark arrestors and prefilters in each final filtration assembly; HEPA filter design temperature of 450 F; System design in accordance with Regulatory Guide 3.12; HEPA filter design; HEPA filter housing design, construction and testing; and HEPA filter housing isolation dampers in accordance with ASME N509; HEPA filter design and testing; HEPA filter housing design and testing; ductwork and pipe flexible connections; and fan design, construction, and testing in accordance with ASME AG-1; Sheet metal ductwork design, construction, and testing; “bubble tight” isolation damper construction and testing; HEPA filter housing testing; and HEPA filter testing in accordance with ERDA 76-21; Filter testing in accordance with ASME N510 with each HEPA stage having a leakage efficiency of 99.95 percent; Final filters and downstream ductwork remain structurally intact during and after tornadoes and design basis earthquakes;	HEPA filter removal efficiency may be inadequate for severe accident conditions such as fires

PSSC	System Function	Controlling Parameters	Status
Emergency Control Room Air-Conditioning System	Maintain habitable conditions in the event of accidents Maintain positive pressure with respect to surrounding areas	Dual air intakes with continuous monitoring for hazardous chemicals; One 100 percent capacity filtration stages (using prefilter stage, two HEPA filter stages, and chemical filters) for each control room air supply; One 100 percent capacity air handling unit per control room; One 100 percent capacity exhaust fan and one 100 percent capacity booster fan; HEPA filter design temperature of 450 F; Tornado dampers prevent over-pressurization; In-place HEPA filter testing for final discharge filtration assemblies; System design in accordance with Regulatory Guide 3.12; HEPA filter design; HEPA filter housing design, construction and testing; and HEPA filter housing isolation dampers in accordance with ASME N509; HEPA filter design and testing; HEPA filter housing design and testing; ductwork and pipe flexible connections; and fan design, construction, and testing in accordance with ASME AG-1; Sheet metal ductwork design, construction, and testing; “bubble tight” isolation damper construction and testing; HEPA filter housing testing; and HEPA filter testing in accordance with ERDA 76-21; Filter testing in accordance with ASME N510 with each HEPA stage having a leakage efficiency of 99.95 percent; Fan power from normal (non-PSSC), standby (non-PSSC), and emergency (PSSC) supplies; Remains operational during and after facility fires and after tornadoes and design basis earthquakes;	
Emergency Diesel Generator Ventilation System	Provide emergency generator ventilation	One 100 percent capacity air conditioning unit for each switchgear room; One 100 percent capacity roof ventilator for engine room cooling during standby (engine fan cools room during engine operation); Fan power from normal (non-PSSC), standby (non-PSSC), and emergency (PSSC) supplies; Remains operational after facility fires, tornadoes, and design basis earthquakes;	

PSSC	System Function	Controlling Parameters	Status
Offgas Treatment System	Control releases of plutonium	HEPA filter release fraction: 1E-4; HEPA filter design temperature of 450 F; Two 100 percent capacity redundant assemblies of two HEPA filter banks prior to discharge; Two-stage spark arrestors and prefilters in each filtration assembly upstream of HEPA filters; Two 100 percent capacity fans; Fire-rated dampers between fire areas; In-place HEPA filter testing for final discharge filtration assemblies; System design in accordance with Regulatory Guide 3.12; HEPA filter design; HEPA filter housing design, construction and testing; and HEPA filter housing isolation dampers in accordance with ASME N509; HEPA filter design and testing; HEPA filter housing design and testing; ductwork and pipe flexible connections; and fan design, construction, and testing in accordance with ASME AG-1; Sheet metal ductwork design, construction, and testing; “bubble tight” isolation damper construction and testing; HEPA filter housing testing; and HEPA filter testing in accordance with ERDA 76-21; Filter testing in accordance with ASME N510 with each HEPA stage having a leakage efficiency of 99.95 percent; Fan power from normal (non-PSSC), standby (non-PSSC), and emergency (PSSC) supplies; Remains operational during and after tornadoes and design basis earthquakes;	
Gloveboxes and Glovebox Pressure Controls	Maintain glovebox pressure	Gloveboxes are designed to remain functional during and after a design basis earthquake; Breach of confinement from load drops protected by automated processes;	
Sintering Furnace Confinement Boundary	Control releases of plutonium	Seals designed for peak operating temperature of 316°C; No damage is furnace is shutdown if overheating or low cooling flow conditions occur; Furnace shell and airlocks designed to withstand overpressures of 2.5 bar; Furnace shell leak tightness of 5E-5 leakage at 2.2 psi; Moisture carryover controls to prevent steam generation; Controls in place to minimize hydrogen hazards; Redundant pressure controls to maintain furnace pressure; Furnace designed to function during design basis earthquake;	
Tornado Dampers	Protect ventilation system from tornado effects	Resists design basis tornado effects; Remains operational after facility fires and design basis earthquakes;	

PSSC	System Function	Controlling Parameters	Status
Canisters, casks, and containers	Control releases of plutonium	Designed to standards to prevent releases under applicable handling and accident conditions;	
Supply Air System	Supply emergency cooling air to canister storage area and electrical rooms; Maintain confinement zone differential pressures	Provide supply air for emergency cooling; HEPA filter stages for static confinement; System design in accordance with Regulatory Guide 3.12; HEPA filter design; and isolation dampers in accordance with ASME N509; HEPA filter design and testing; ductwork and pipe flexible connections; and fan design, construction, and testing in accordance with ASME AG-1; Sheet metal ductwork design, construction, and testing; “bubble tight” isolation damper construction and testing; and HEPA filter testing in accordance with ERDA 76-21;	

The staff reviewed the above design bases for the Ventilation and Confinement System PSSCs to ensure that there is reasonable assurance of protection against natural phenomena and the consequences of potential accidents. The design bases are consistent with Regulatory Guide 3.12 (Reference 11.4.3.14) and other industry air cleaning standards such as ASME N509, (Reference 11.4.3.5), ASME N510 (Reference 11.4.3.6), and ASME AG-1 (Reference 11.4.3.3).

For natural phenomena hazards, the staff reviewed the proposed design bases consistent with Chapter 5 of the revised CAR, which discusses the analyses performed to show that the facility is adequately designed against natural phenomena with consideration of the most severe documented historical events for the Savannah River Site. The Ventilation and Confinement System gloveboxes, ductwork, and filter assemblies are designed to withstand the design basis earthquake. In addition, tornado dampers ensure that the effects of tornadoes, hurricanes, and high winds applicable to the proposed site do not degrade Ventilation and Confinement System PSSCs.

The Ventilation and Confinement System is designed to withstand fire and chemical effects. In-place testing and maintenance of HEPA filters are performed in accordance with ASME N509 (Reference 11.4.3.5) and ASME N510 (Reference 11.4.3.6). HEPA filters are designed to withstand pressure transients considering filter loadings and fan suction pressures. Filter replacement will be performed using bag-in, bag-out procedures to reduce the possibility of spreading contamination.

For potential accidents involving fires, staff reviewed the proposed design bases consistent with Chapters 5 and 7 of the revised CAR, which describe the analyses and design features applicable to fire protection. Design features of the Ventilation and Confinement System for fire protection include filter assembly redundancy, use of dilution to mitigate the high temperature effects of a fire, use of two-stage spark arrestors to prevent hot particles greater than 1 micron in size from contacting and starting fires on filters, and use of two redundant banks of HEPA filters in each filter assembly having a temperature rating of 450^{o}F and meeting UL 586 standards (Reference 11.4.3.9). The applicant considered the effects of fire on the Ventilation and Confinement System. The applicant assumed that fires are restricted to single fire areas and will not spread (Reference 11.4.3.11 and revised CAR Section 11.4.8). NRC staff reviewed the fire protection program and, as described in DSER Section 7.1.5.5, concluded that during fires temperatures at the HEPA filters can be maintained less than 400^{o}F and HEPA filters can be protected without severe temperature effects.

Under accident conditions, the applicant is proposing to only take credit for the final filtration assemblies and not HEPA filters located on gloveboxes or at confinement zone boundaries (Reference 11.4.3.11 and revised CAR Section 11.4.7.1.5). The applicant proposed to use a release factor of 1E-04 for the final filter assemblies in its accident safety analyses (revised CAR Sections 5.5.3.2 and 11.4.9). The applicant based its proposal on having redundant HEPA filter banks in each redundant filter assembly with HEPA filters that have been tested to have an efficiency for removal of 0.3 micron particles of at least 99.97 percent. After installation, the HEPA filter banks will be leak tested in accordance with ASME N510 (Reference 11.4.3.6) to ensure that leakage efficiency is at least 99.95 percent. Under severe conditions, the applicant considers that each bank of HEPAs will remove at least 99 percent of particulates and will provide an overall efficiency of 99.99 percent for the two combined banks. The staff, however, considers that a release factor for each filter assembly of no more than 1E-02 should be used under severe conditions such as a fire. Because the filter assembly contains two-stage spark arresters to minimize the possibility of hot embers contacting filters; prefilters to minimize HEPA filter dust loadings; and HEPA filters that meet UL 586 fire resistance standards (Reference 11.4.3.9) and can operate at temperatures up to 450°F, staff considers that the filtration assemblies can perform their intended function under conditions of fire. However, there have been facility fires that have damaged filters in ventilation systems, and because of the uncertainties in the environmental conditions that expose the HEPAs under potential fires and can degrade its performance, the staff considers that an increased release factor is needed. This is consistent with staff recommendations in NUREG/CR-6410 (Reference 11.4.3.12) that under severe conditions a particulate removal efficiency of 95 to 99 percent should be used for HEPA filter assemblies. Therefore, the staff has an open item related to the total assumed particulate release factor for accident analyses where severe environmental conditions are present.

NRC staff also reviewed a soot generation analysis performed by the applicant to ensure that filter loadings during a fire would not adversely affect filter integrity. Under accident conditions involving fires, the proposed design may have inadequate capacity to remove soot loadings. Using the Ballinger correlation (see Reference 11.4.3.8), the applicant computed a maximum HEPA filter loading of 4.08 kg/filter at a differential pressure of 10.5 in. water gauge (WG). The largest fire loading was computed to be 3.5 kg/filter. Using the Ballinger correlation, the staff computed a maximum HEPA filter loading of 1.2 kg/filter for the proposed 1500 cubic feet per minute (CFM) sized HEPA filter at a 10 in. WG differential pressure (a differential pressure of 10 in. WG is the highest recommended loading for nuclear-grade HEPA filters). Therefore, the applicant's assumed soot loading capacity may be inadequate. Excessive HEPA filter soot loadings can result in damaged or ruptured filters and excessive releases to radioactive material. Therefore, the staff has an open item related to the soot generation analysis applicable to fire accidents.

The staff reviewed the design bases of the Ventilation and Confinement System to ensure that it provides adequate protection against chemical risks produced from licensed material, facility conditions that affect the safety of licensed material, and hazardous chemicals produced from licensed material. Gloveboxes are constructed welded stainless steel to resist the corrosive effects of chemicals used in aqueous polishing and MOX fuel fabrication processes. In addition, ductwork and filter assemblies upstream of the final filters are stainless steel, and filter materials will be designed to also withstand the chemical effects resulting from normal operations. As indicated above, during fires, HEPA filters may be unable to remove greater than 99.99 percent of particulates and may become overloaded with soot. Accident analyses are further discussed in Chapter 5 of the revised CAR. Chemical safety is discussed in Chapter 8 of the revised CAR.

The staff reviewed the design bases of the Ventilation and Confinement System to ensure that it provides for emergency capability to control the release of licensed material during normal operations and under postulated accident conditions. Release of licensed material is controlled by the use of redundant HEPA filter banks in redundant filter assemblies. Individual HEPA filters are tested to ensure that individual HEPA filters are capable of removing at least 99.97 percent of 0.3 micron particles. Following installation, PSSC HEPA filters are in-place tested in accordance with ASME N510 (Reference 11.4.3.6) to ensure that leakage around filter banks is less than 0.05 percent.

The staff reviewed the design bases of the Ventilation and Confinement System with respect to electrical power supply. The C4 confinement system is supplied by normal, standby, emergency, and uninterruptible power supplies. The C3 exhaust system, the emergency control room, and emergency diesel generator systems are supplied by normal, standby, and emergency power supplies. The C2, and process cell exhaust confinement systems and the supply air system are supplied by normal and standby power supplies. These diverse power supply systems will ensure continued operation of Ventilation and Confinement System PSSCs. Staff's review of the electrical systems is provided in DSER Section 11.5.

The staff reviewed the proposed design bases of Ventilation and Confinement System PSSCs to ensure that it provides for adequate inspection, testing, and maintenance to ensure availability and reliability to perform their function when needed. Redundant filter assemblies are provided so that single filter assemblies can be taken offline for maintenance, testing, and replacement of filters. Dampers can be used to isolate individual filter assemblies and fans. The filter assembly design includes provisions for in-place testing of HEPA filters in accordance with ASME N510 (Reference 11.4.3.6). Filter assemblies use bag-in/bag-out designs for filter replacement to minimize the possibility of spreading contamination.

The staff reviewed the proposed design bases of the Ventilation and Confinement System to ensure that it provides for criticality control and adherence to the double contingency principle. Based on experience from the MELOX site, the applicant assumed that up to 3 kg of PuO_2 could exist in the glovebox HEPA filter located in the pellet grinding glovebox, where material becomes airborne at a rate of 0.3 grams per hour, and assuming that the HEPA filters are replaced at 450 day intervals. This amount would be subcritical, as 3 kg of PuO_2 is substantially less than the minimum critical mass. ANSI/ANS-8.1 (Reference 11.4.3.2) contains single-parameter (*i.e.*, always safe) subcritical limits for $^{239}PuO_2$ containing not more than 1.5 wt. percent water. At full density, the subcritical limit is 10.2 kg; at half density, the subcritical limit is 27 kg. This would bound the worst-case conditions that could be found in the HEPA filters, because the ANSI limits conservatively assume the plutonium is all ^{239}Pu (MOX plutonium will have at least 4 wt. percent ^{240}Pu), and the maximum density for unsintered PuO_2 powder (according to revised CAR Table 6-2) falls within the density range covered by the limits in ANSI/ANS-8.1 (Reference 11.4.3.2).

The moisture level of powder is limited to 1 wt. percent water, according to revised CAR Table 6-2 and revised CAR Section 6.3.4.3.2.6. The MOX process gloveboxes are under an inert atmosphere, and this quantity of water (approximately 10 percent by volume) would be readily noticeable to operators. The amount of organic additives in the final blend is neutronically equivalent to 2 wt. percent water (discussed in revised CAR Section 6.3.4.3.2.6). Although this slightly exceeds the bounding moderation level assumed in the ANSI/ANS-8.1 (Reference 11.4.3.2) limits, this would not be sufficient moderation to exceed the subcritical mass limits. In addition, the PuO_2 would be spread over the surface of the filter medium, and would not be accumulated in a spherical geometry. Therefore, application of the subcritical limits in ANSI/ANS-8.1 (Reference 11.4.3.2) are considered appropriate.

The only remaining source of water would be the possible intrusion of condensation via the ventilation system; however, the ventilation system is designed as a dry system and, therefore, condensation would not be present. Moreover, the ventilation system complies with the double contingency principle, because of the design which incorporates multiple confinement zones before accumulation outside the ventilation system is possible. It would require multiple upset conditions to accumulate an unsafe mass of plutonium oxides outside the process gloveboxes through airborne migration. Therefore, the staff has reasonable assurance that the ventilation system will be critically safe. ANSI/ANS-8.1 (Reference 11.4.3.2). Staff's review of nuclear criticality safety is provided in DSER Section 6.

The staff reviewed the proposed design bases of the Ventilation and Confinement System to ensure that it provides for instrumentation and control systems to monitor and control the ventilation and confinement PSSCs. These instrumentation and controls include pressure instrumentation and controls to maintain proper negative pressures in each of the separate confinement zones; manual and automatic damper controls to regulate air and gas flows within gloveboxes and confinement zones; controls for the transfer of alternate power supplies; instrumentation to measure differential pressures across filter banks; variable-speed controls for fan operation; air temperature and airflow instrumentation; and nitrogen and dry air supply controls. Staff's review of instrumentation and control systems is provided in DSER Section 11.6.

11.4.2 EVALUATION FINDINGS

In Section 11.4 of the revised CAR, DCS provided design basis information for the ventilation and confinement systems that it identified as PSSCs for the proposed facility. Based on the staff's review of the revised CAR and supporting information provided by the applicant relevant to the ventilation and confinement systems, the staff finds that due to the open items discussed above and listed below, the staff cannot conclude, pursuant to 10 CFR 70.23(b), that the design bases of the PSSCs identified by the applicant will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

The open item in this section of the DSER is as follows:

- The HEPA filter removal efficiency for severe accidents such as fires should be 99 percent, not 99.99 percent as the applicant has assumed. (revised CAR Section 11.4.1.3)(VS-1)

The following open items in Sections 7 is related to Section 11.4, Ventilation and Confinement:

- The soot analysis indicates that HEPA filters may be overloaded during fires and the ventilation system design capacity may be inadequate. (revised CAR Sections 7.1.5.5 and 11.4.1.3) (FS-1)

DCS provided additional information concerning open item identified by the staff as VS-1 (Reference 11.4.3.15). Because the information was provided recently, the staff has not completed its review.

11.4.3 REFERENCES

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11.4.3.4. _____. Standard ASME B31.3, “Process Piping.” ASME: New York, NY. 1998.

11.4.3.5. _____. Standard ANSI/ASME N509, “Nuclear Power Plant Air Cleaning Units and Components.” ASME: New York, NY. 1980.

11.4.3.6. _____. Standard ANSI/ASME N510, “Testing of Nuclear Air-Cleaning Systems.” ASME: New York, NY. 1980.

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11.4.3.8. Ballinger, M.Y., et al., “Aerosols Released in Accidents in Reprocessing Plants.” Nuclear Technology, Vol. 81, May 1988.

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11.4.3.11. U.S. Nuclear Regulatory Commission (U.S.) (NRC). NUREG-1718, “Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility.” NRC: Washington, D.C. 2000.

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11.4.3.14. ______. Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.” NRC: Washington, D.C. 1973.

11.4.3.15 Hastings, P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission, RE Construction Authorization Request Change Pages, April 10, 2003.

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