7.0 FIRE PROTECTION

7.1 CONDUCT OF REVIEW

This chapter of the revised draft Safety Evaluation Report (DSER) contains the staff's review of fire protection issues described by the applicant in Chapter 7 of the revised Construction Authorization Request (CAR). The objective of this review is to determine whether the applicant's commitments and goals related to fire protection are adequate to meet the regulatory acceptance criteria referenced below. The review also determines whether the design of the proposed facility adequately protects against external and internal fires and whether the design bases of the principal structures, systems, and components (PSSCs) identified by the applicant adequately protect against natural phenomena and the consequences of potential accidents. The staff evaluated the information provided by the applicant for fire protection by reviewing Chapter 7 of the revised CAR, other sections of the revised CAR, and supplementary information provided by the applicant. The review of fire protection was closely coordinated with fire protection aspects of accident sequences described in the Safety Assessment of the Design Basis (see Chapter 5.0 of this revised DSER), the review of explosion protection aspects (see Chapter 8.0 of this revised DSER), and the review of other plant systems (see Chapter 11.0 of this revised DSER).

The staff reviewed how the fire protection 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 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 the baseline design criteria (BDC) and defense-in-depth practices be incorporated into the design of new facilities. With respect to fire protection, 10 CFR 70.64(a)(3) requires that the facility design "provide for adequate protection against fires."

The review discussed below focused on the design basis of fire protection systems, their components, and other related information. For fire protection systems, the staff reviewed information provided by the applicant for the safety function, system description, and safety assessment. The review also encompassed proposed design basis considerations such as redundancy, independence, reliability, and quality. The staff used Chapter 7.0 in NUREG-1718 (Reference 7.3.7.1) as guidance in performing the review.

Sections 7.1.1 through 7.1.4 of this revised DSER are the staff's evaluation of how the applicant addressed the fire protection acceptance criteria in NUREG-1718. Revised DSER Section 7.1.5 is the staff's evaluation of the design bases PSSCs related to fire protection.

7.1.1 Organization and Conduct of Operations

The organization and conduct of operations are the management measures that assure fire safety is administered appropriately at a licensed facility. Section 7.1 of the revised CAR described the applicant's commitment to assure that PSSCs as identified in the revised CAR are available and reliable; fire protection organizational responsibilities are defined; transient ignition sources and combustibles are controlled; and the facility maintains a readiness to extinguish or limit the consequences of a fire. The applicant committed to develop a fire protection program and administrative controls in order to meet organizational and operational guidance of NUREG-1718. The conclusion of the review is that the applicant's commitment to provide organization and conduct of operation at the facility site meets the regulatory acceptance criteria and fire protection baseline design criteria of 10 CFR Part 70.64(a)(3) for the construction approval stage. Therefore, it is acceptable. The following paragraphs provide more details on the applicant's plans for a fire protection program and administrative controls.

7.1.1.1 Fire Protection Program

In Section 7.1.1 of the revised CAR, the applicant committed to develop a fire protection program for the facility site. The applicant stated that the objectives of the fire protection program are to prevent fires from starting and to detect, control, and extinguish fires that do occur. The program establishes fire protection policies and identifies management and organizational responsibilities for the fire protection program. An effective fire protection program extends the concept of defense-in-depth to fire protection in areas with PSSCs.

7.1.1.2 Administrative Controls

Administrative controls establish procedures primarily for the storage, handling, and use of combustible materials and ignition sources. In Section 7.1.2 of the revised CAR, the applicant committed to develop procedures that govern the handling of transient combustibles in buildings containing PSSCs; permit systems that control ignition sources; formal periodic surveillance inspections; compensatory measures for detection and suppression systems; inspection and emergency action plans. The applicant committed to develop and implement testing, inspection, and maintenance procedures for facility fire protection systems and equipment. Systems that are designed and installed per National Fire Protection Association (NFPA) codes and standards are maintained according to NFPA requirements. The staff finds that the applicant's commitment to maintain all fire protection equipment, as recommended by NUREG-1718, increases the overall availability and reliability of fire protection equipment, and the performance of fire protection personnel. The applicant designated some administrative controls as fire safety PSSCs, which are discussed in Section 7.1.5 of the revised DSER.

7.1.2 Features and Systems

Plant fire protection features and systems include building construction, fire area determination, electrical installation, ventilation, detection and alarm, and suppression. Section 7.4 of NUREG 1718 provides acceptance criteria for fire protection features and systems. For the reasons set forth below, except for the items evaluated in revised DSER sub-sections 7.1.2.8.4 and 7.1.2.9, the staff finds that the applicant's proposed fire protection features and systems meet the 10 CFR 70.64(a)(3) baseline design criterion for fire protection.

7.1.2.1 Construction

Section 7.2.2 of the revised CAR stated that buildings where radioactive materials would be used, handled or stored at the facility are Type I or Type II construction. Thus, the structural members, including walls, columns, beams, girders, trusses, arches, floors, and roofs are of approved noncombustible or limited-combustible materials and will have fire resistance ratings as specified by NFPA 220-1995 (Reference 7.3.4.21). Buildings at the facility that contain PSSCs are Type I construction. Type I construction requires that exterior bearing walls are rated at least 3 hours, and interior bearing walls, trusses, beams, girders and columns are rated at least two hours.   The exterior walls of the MOX Fuel Fabrication Building (BMF) structure would not be load bearing, however, they would carry a minimum two hour fire rating in order to provide exposure protection. In addition, buildings are protected from exterior fires by observing fire safety criteria recommended in NFPA 80A (Reference. 7.3.4.17). Staff finds the preliminary construction features at the facility are adequate to meet the baseline design criteria of 10 CFR 70.64 (a)(3) for fire safety. The applicant designated some structures at the MFFF as PSSCs; they are discussed further in revised DSER Section 7.1.5.4. In addition to those buildings, the Secured Warehouse building (BSW) contains PSSCs because of the amount of depleted uranium it contains. (Open item CS-08 provides a discussion). Accordingly, the BSW would be Type I construction.

7.1.2.2 Interior Surface

Section 7.2.2 of the revised CAR indicated that exposed interior walls or ceilings and any factory-installed facing material would have a Factory Mutual (FM) approved (Reference 7.3.2) or Underwriter's Laboratory (UL) listed (Reference 7.3.5.1) flame spread rating of 25 or less, and a smoke developed rating of 50 or less in accordance with American Society for Testing and Materials (ASTM)-E-84-98 (Reference 7.3.1.2). If carpets and rugs are used, they would be tested in accordance with NFPA 253-1995 (Reference 7.3.4.23). Thus, staff finds that interior finish materials would not contribute to fire or smoke development.

7.1.2.3 Storage Racks

Revised CAR Section 7.2.3.6 stated that racks for the storage of plutonium dioxide, uranium dioxide, or mixed oxide in powder, pellet or rod form would be noncombustible. The applicant provides combustible loading controls to prevent the build up of combustibles in areas where storage racks would be located. Revised DSER Section 7.1.5.1 provides a discussion of combustible loading controls. Mechanical/structural properties of the racks are discussed in revised DSER Section 11.7. Limiting combustible materials in areas where special nuclear materials would be stored reduces the intensity of potential fires if they occur. The staff finds the provisions for storage racks are acceptable because they meet the guidance of NUREG-1718.

7.1.2.4 Electrical Considerations

Section 11.5 of the revised CAR discussed the electrical systems proposed for use at the facility. In addition, the applicant provided details on fire and electrical safety interfaces during a briefing to the Advisory Committee on Reactor Safeguards (ACRS) (Reference 7.3.7.2). To prevent fires from initiating and to protect cables from fire exposure hazards, the electrical systems at the facility are designed with the following considerations:

- Cables in redundant electrical trains are separated per Institute of Electrical and Electronics Engineers (IEEE) 384 (Reference 7.3.3.2) electrical separation criteria.

- The main electrical trains (for ventilation and for the emergency control rooms) enter the BMF from different sides of the building (approximately 150 linear feet apart) but on the same floor. However, immediately after entering the building they are routed to separate floors of the MOX Processing (MP) area. (Reference 7.3.9.2)

- Other cables, backup power supplies, and equipment feeds are kept as far apart as practical and are routed separately to the extent practical.

- Cables supplying emergency electrical power to PSSCs are routed in conduit.

- Electrical faults do not initiate fires - when the breaker trips or the fuse blows, the electrical circuit is interrupted, which prevents damage to electrical components and wiring or cable insulation. Faults that would result in the inability of the system to perform its intended safety function are detected and removed.

- Electrical characteristics of equipment and/or power systems are monitored to assure adequate protection and operation.

- The number of trip devices that could shut down electrical systems that are relied on for safety under emergency condition is kept to a minimum.

- Exposed electrical cable is IEEE 383 (Reference 7.3.3.1) qualified (i.e., ignition resistant and self-extinguishing).

- The normal and standby alternating current (AC) power systems are designed according to NFPA 70-1999 (Reference 7.3.4.14).

- Where electrical cables enter glovebox or decanning rooms, they are installed in solid stainless steel wireways or ducts (revised CAR Section 7.2.3.1).

The applicant's proposed electrical features follow the applicable provisions of NFPA 70, IEEE 383, and IEEE 384 that provide reasonable assurance that electrical installations are free from fire hazards. As a result, automatic functioning of the detection, alarm, suppression, and barrier systems would be maintained; and electrical cables would not pose a source of fire hazard to other systems. Thus, the staff finds that the protection of electrical wiring from fire is acceptable and adequate.

7.1.2.5 Fire Alarm and Detection Systems

Section 7.2.3.2 of the revised CAR stated that the fire alarm systems are designed according to NFPA 72-1996 (Reference 7.3.4.15). The BMF detection systems are tied into a central alarm panel that would be located in the Aqueous Polishing (AP) Control Room. The central fire alarm panel has a graphical display which would assist the BMF operators in identifying and responding to alarms. Upon detection of a fire, audible and visual alarms would be provided in the affected parts of the BMF.

The alarm systems are capable of annunciating and differentiating fire conditions, supervisory indicators, or trouble signals. Alarm signals are transmitted to the monitored alarm center at the Savannah River Site (SRS) fire department and the AP Control Room. Initiating circuits are capable of transmitting an alarm under circuit fault conditions of single ground, open, or both.

Heat and smoke detectors supplement or can actuate fire-extinguishing systems, fire dampers and door closure devices. Detection systems would be located throughout the facility in accordance with the principles of NFPA 72-1996 (revised CAR Section 7.2.3.2). Automatic fire detection systems are selected on the basis of the fire hazard and their reliability in each area.

Section 7.5.3 of the revised CAR stated that detection systems in areas containing dispersible radioactive materials are identified as PSSCs for defense-in-depth reasons (see revised DSER Section 7.1.5.7). Each glove box is provided with a minimum of two detectors. Generally, smoke detectors would be deployed. But, heat detectors would be installed in gloveboxes prone to dusty conditions.

The primary power supply for fire detection/alarm system is the normal power system, which has two sources of offsite AC power. In the event that both sources of normal power are lost, the detection/alarm system can be powered by the standby AC power systems, and then by normal battery backup. See revised DSER Section 11.5 for details on the electrical power supply systems. The staff finds the provision for fire alarm and detection systems acceptable because it assures prompt detection and notification of fires.

7.1.2.6 Means of Egress Protection

The proposed facility layout largely complies with the 1997 version of the Life Safety Code (Reference 7.3.4.19). According to revised CAR Section 7.2.2, the means of egress are arranged and maintained to provide free and unobstructed lighted egress from all parts of the facility. Buildings at the facility are designed to provide means of egress that are adequate in number, location, and capacity for emergencies.

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Emergency lighting is provided for means of egress and for critical operations areas where manual operations must be performed during a power outage of normal AC power sources. Standby generators support the emergency egress lighting. The proposed design calls for two standby generators, each of which could operate continuously for 24 hours. The staff finds that the preliminary emergency lighting provisions provide the necessary illumination in the event power to normal lighting is interrupted. The provisions for means of egress and emergency lighting are adequate and acceptable.

7.1.2.7 Lightning Protection

The applicant designated the BMF and the Emergency Diesel Generator (BEG) Building as PSSC structures. Revised CAR Section 7.2.2 stated that PSSC structures are provided with lightning protection in accordance with the applicable provisions of NFPA 780-1997 (Reference 7.3.4.26). Lightning protection per NFPA 780 provides means of directing a lightning discharge to the earth without damage to the property. The staff finds that the provisions for lightning protection are adequate.

7.1.2.8 Ventilation System

The areas of the BMF that contain PSSCs are provided with ventilation systems that minimize the spread of fire and the products of combustion. Section 11.4 of the revised CAR describes the four confinement zones the BMF would contain; the staff's evaluation of this design feature is provided in revised DSER Section 11.4. Essentially, pressure gradients between the confinement zones ensure that leakage air flows from the zones of lowest contamination risk to zones of increasing contamination risk. During a fire, the main objective is to maintain differential pressure between the room of fire origin and the surrounding areas. Depending on whether gloveboxes or dispersible materials are present, the heating, ventilation, and air conditioning (HVAC) dampers to process rooms and process cells are operated to ensure that combustion products flow through the exhaust stacks of the gloveboxes, the process rooms or the process cells.

The BMF design incorporates airlocks that offer access to the process rooms. The airlocks are separated from the process rooms by fire barriers and are exhausted by the secondary confinement system. The airlocks have minimum-leakage doors and are maintained at a positive pressure with respect to the process room, thereby, reducing the spread of combustion products from the process room. In addition, the deliberate pressure cascade from the safe havens to the stairwells would ensure that the smoke infiltration is minimized during a fire in the MP or AP areas. The applicant's treatment of acceptance criteria for nuclear filter plenums is discussed below. The staff's evaluation of the PSSC confinement systems is provided in Sections 11.4.1.4 and 7.1.5.5 of the revised DSER.

7.1.2.8.1 Filter Plenum Construction and Protection

The final filter plenum enclosures are 2-hour fire rated construction with appropriate doors, and are located as far as practical from the postulated fires. The design calls for multiple separate filter housings and redundant trains of filter systems in separate fire areas. The filter housings are protected from ignition sources and only limited amounts of combustible materials would be allowed within the filter housings or filter housing rooms.

7.1.2.8.2 Ventilation Ductwork and Dampers

The proposed ductwork in the ventilation systems incorporates manual and automatic dampers and controls to distribute and regulate the movement of air. The ductwork would be welded stainless steel or welded galvanized pipe. Additional fire-rated protective features are provided when ductwork passes through a fire barrier into another fire area. The fire resistance of the dampers is suitable for the fire barriers they penetrate. Dampers are manually or automatically operated depending on the stage of fire development and/or location of the fire. As a result, the operation of the exhaust and supply dampers is pre-planned.

7.1.2.8.3 Filter Design and Protection

At the BMF, high efficiency particulate air (HEPA) filters would be used to prevent the release of radioactive materials. HEPA filters meet the requirements of American Society of Mechanical Engineers (ASME) AG-1 (Reference 7.3.8). The exhaust for the C3 and C4 confinement systems contain two sets of final filtration units. Each final filtration unit consists of a filter assembly housing, a two stage spark arrester, a pre-filter and two stages of HEPA filters. The spark arresters and the pre-filter are located upstream of the HEPA filter exhaust plenum. The first stage spark arrester is made of stainless steel wire mesh; it is designed to eliminate large burning embers that may pass through the duct work. The second stage spark arrester is non-combustible fiberglass and steel mesh designed to remove greater than 1.0 micron particles. The pre-filters are fiberglass media with metallic frames, while HEPA filters are fabricated of glass media with metallic frames and silicone gaskets. The filter housing assemblies are designed and fabricated to the same temperature ratings as the duct materials in which they are installed.

7.1.2.8.4 Protection of the Final HEPA Filters

Temperature detectors would be present in the ductwork upstream of each final filtration unit. Detectors alarm in the event of high temperature in the ductwork.

Automatic suppression is not provided in the final filter plenums as recommended in NUREG-1718. Instead, fire protection to the final HEPA filter systems would be provided by spark arresters, prefilters and dilution of high temperature exhaust streams to prevent prolonged exposure to temperatures above their maximum filter service temperature. Exhaust systems are designed to operate continuously, so that hot gases generated from one fire area will be diluted with air from unaffected fire areas. The pre-filters are rated for a continuous temperature of 400EF (204°C). HEPA filters are rated to 450°F (232°C). The applicant is performing analyses to demonstrate that maximum temperatures, soot and pressures are not exceeded during credible fires. The applicant has not completed the analysis; therefore, this is an open issue. See revised DSER Section 7.1.5.5. (Open Item FS-1.)

7.1.2.9 Fire Areas and Barriers

For facility design and operational purposes, the BMF is subdivided into fire areas. The applicant uses guidance from NFPA 801-1998 (Reference 7.3.4.27) to determine fire area boundaries. Section 7.2.3.1 of the revised CAR indicates that fire areas separate manufacturing from material storage areas; control or computer rooms from adjacent areas; emergency generators from each other; redundant trains of PSSCs as required; and electrical equipment or battery rooms from adjacent areas. There are over 350 fire areas at the BMF: 169 in the MP, 128 in the AP, 56 in the Shipping and Receiving Area. Fire areas are separated from other fire areas by non-combustible, reinforced concrete walls with a minimum 2-hour fire rating. Three-hour fire barriers separate some hazardous areas. Hourly ratings are based on American Society of Testing and Materials (ASTM) E-119 definitions (Reference 7.3.1.3). Construction details are in accordance with NFPA 221-1997 (Reference 7.3.4.22).

Openings in fire barriers would have appropriately rated self-closing fire doors, fire dampers, and fire-rated penetration seals. Fire doors are designed according to NFPA 80-1999 (Reference 7.3.4.16). The staff finds that the general selection of fire areas is appropriate for the hazards at the BMF. The fire area selection minimizes the potential size of a fire. Therefore, it potentially limits the fire exposure to PSSC equipment, material and personnel. The applicant designated BMF and BEG fire barriers as PSSCs. Because of the quantity and type of combustibles found in the BMF, the applicant is reviewing the selection of the barriers to ensure that an adequate margin of safety can be provided. The margin of safety provided by PSSC barriers is considered an open issue. The staff's evaluation of fire barrier design bases is set forth in revised DSER Section 7.1.5.6. (Open Item FS-2.)

7.1.2.10 Water Supply and Drainage

The facility design incorporates a water supply system in accordance with NFPA 801 requirements. Section 7.2.3.4 of the revised CAR stated that the fire protection water supply system consists of an underground loop around the facility site, fire hydrants, fire pumps and two firewater storage tanks. One of the storage tanks is seismically qualified. The system is designed to handle the largest sprinkler demand plus 500 gpm (1893 liters per minute) for hose streams. The distribution systems are hydraulically designed to meet NFPA 13-1996, NFPA 14-1996, and NFPA 24-1995 (References 7.3.4.2, 7.3.4.3, and 7.3.4.6).

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The staff determined that the facility water supply system accommodates the requirements for automatic and manual suppression activities at the facility. The provisions for water capacity are based on defense-in-depth and industry practices; they are adequate.

7.1.2.11 Fire Suppression

A combination of automatic suppression systems, fire hose stations, exterior hydrants, and manual extinguishing devices would provide suppression at the facility. Automatic suppression is provided in areas where potentially significant fire loading is present.

Because of criticality concerns, water-based fire suppression systems are not planned in areas where fissile material would be handled (revised CAR Section 7.2.3.3.1). Where fissile materials would normally be present, clean agent suppression systems will be provided. In such cases, clean agent suppression is provided as a defense-in-depth PSSC to the fire barriers. Staff evaluated clean agent suppression as a PSSC in revised DSER Section 7.1.5.7. The clean agent system will also be provided in areas of the facility that contain electrical and/or electronic equipment such as computer rooms, motor control centers and control rooms. Where needed, the clean agent system would protect under floor areas as well. All clean agent systems will be designed, installed, and maintained according to NFPA 2001-1996 (Reference 7.3.4.28).

Otherwise, water based suppression is provided throughout the facility. To avoid possible ingress of water into areas where fissile material is handled, pre-action type sprinklers are used. Pre-action systems reduce the chance of accidental discharge by requiring independent actions for water discharge. The Secured Warehouse and Reagent Processing buildings would deploy wet-pipe sprinkler systems (discharge water when elevated temperatures are detected). The Truck Bays of the Shipping and Receiving Building would have an automatic deluge system (all sprinklers activate at once). Sprinklers are designed according to NFPA 13-1996. All water-based systems will be periodically inspected, tested, and maintained in accordance with NFPA 25 (Reference 7.3.4.7).

Not all fire areas in the BMF would have automatic suppression. Suppression is not provided in some airlocks, solvent cells, plenums, chases, and areas that are not normally occupied, have low combustible loading or no ignition sources. Plenums, chases and solvent cells are difficult to inspect on a routine basis. Similarly, automatic suppression features are not provided in areas such as Rod Storage, where they would be difficult to maintain operational due to ALARA concerns.

The standpipe and hose systems allow manual fire fighting capabilities throughout the proposed facility. Because of criticality concerns, a dry standpipe system instead of the normally pressurized wet standpipe system is provided in the MP and AP Areas. The standpipe systems are designed for Class II service, so that both fire department and fire brigade personnel can use them. The standpipe system is designed per NFPA 14-1996.

Portable fire extinguishers would be present throughout the BMF and inside all buildings at the facility so occupants could extinguish small fires. Extinguishers are selected and located according to fire hazards, and to their effectiveness. A combination of multipurpose dry chemical, metal-use and CO_2 extinguishers would be used. The use of portable extinguishers would be in accordance with NFPA 10-1998 (Reference 7.3.4.1). Specially configured portable CO_2 bottles would be present in rooms with gloveboxes. These portable bottles can be quickly connected to the glovebox to suppress fires within the glovebox without over-pressurizing the glovebox.

The design calls for packets of extinguishing powder to be present in gloveboxes and in the rooms where a zircaloy fire risk exists. In addition, zirconium swarfs are collected in covered metal containers and removed daily, stored, and disposed.

Based on the variety and redundancy of suppression features, the applicant does not place total reliance on a single fire suppression feature at the BMF. Standpipe and hose systems (which both facility-trained personnel and fire department can use) provide backup fire suppression to the automatic suppression systems. An additional back up suppression is the specially configured portable CO_2 bottles with quick disconnect fittings. According to revised CAR Section 7.3, the facility fire brigade would respond to fire fighting emergencies. Development and training of the facility fire brigade would follow NFPA 600-1996 (Reference 7.3.4.25) requirements.

Based on information provided to date, the staff finds that the fire suppression strategy provides diversity and defense-in-depth. Automatic and manual fire suppression controls the spread of fire, thereby, reducing the challenge to fire barriers.

7.1.2.12 Combustible and Pyrophoric Metals

When plutonium dioxide is fully oxidized, it is not pyrophoric. Uranium dioxide does not oxidize in an inert atmosphere, and oxidizes very slowly in air under process temperature conditions. Duke Cogema Stone & Webster (DCS) maintains that uranium dioxide is not combustible under process conditions (Reference 7.3.9.1, page 45). However, the Nuclear Regulatory Commission (NRC) Information Notice 92-14 (Reference 7.3.7.3) indicated that normally stable UO_2 may be pyrophoric or oxidize rapidly even at room temperatures when in very fine powder form. Section 7.2.5 of the revised CAR indicates that for process reasons, some gloveboxes containing plutonium and uranium dioxides are inerted with nitrogen. Thus, the nitrogen systems provide additional fire protection as they limit the potential combustion of special nuclear materials and ordinary combustible. Pyrophoricity of plutonium and uranium dioxides is discussed in revised DSER Section 11.3. (Open Item MP-1.)

Zirconium is stored and handled in accordance with NFPA 482-1996 (Reference 7.3.4.24). The applicant intends to use titanium for the electrolyzer circuit and associated equipment that could be exposed to silver(II) ions. Titanium exposed to hot sparks can ignite and burn. Staff has designated the handling of titanium as an open issue (AP-3) as discussed in the revised DSER Section 11.2.

7.1.2.13 Glovebox Protection

Gloveboxes provide physical and visual access to internal equipment, processes, and material. Glovebox details are in revised CAR Section 11.4.7.1 and the applicant's "Polycarbonate Report" (Reference 7.3.9.1). A typical glovebox is a large stainless steel enclosure-mounted on a structural stainless steel stand. Glovebox windows consist of rectangular polycarbonate panels (10 mm thick) that fit into frames in the glovebox walls and ceilings. Lead-impregnated polymer sheets or lead glass panels overlay windows where radiation shielding is required to reduce operator exposures.

Light fixtures are generally installed outside of the gloveboxes; and they provide illumination for the interior spaces through windows located in glovebox ceilings. The lenses of the fluorescent light fixtures are noncombustible.

The design of the proposed facility calls for each glovebox to be provided with a minimum of two detectors. Generally, smoke detectors would be deployed. However, if conditions such as dust limit their effectiveness, heat detectors would be installed. Actuation of the detectors transmits an alarm to the control room; operations utilizing hydraulic fluids are automatically shut down; the glovebox process fire doors are actuated to close; and operators can manually close the glovebox dampers if warranted.

The proposed facility design provides additional fire protection features in the process rooms containing gloveboxes, such as manual injection CO_2 for each glovebox, inert atmospheres for some gloveboxes with dispersible materials, fire doors between interconnected process gloveboxes, and minimal ignition sources near glovebox windows. Clean agent automatic suppression is also provided and designated a defense-in-depth principal SSC. (See revised DSER Section 7.1.5.7)

Fire areas are separated by fire barriers, which helps to prevent fires from spreading throughout the proposed facility. BMF fire barriers are rated a minimum of two hours and are designated PSSCs. All associated dampers and doors are fire rated for use in the barriers. To further reduce the fire risk, combustible loading controls are provided as a principal SSC for areas with gloveboxes that store radiological materials. This PSSC limits the amount of fixed and transient combustibles by design and through the use of administrative controls.

The applicant's proposed use of polycarbonate is not in compliance with the NFPA 801 requirements to use noncombustible materials. However, the applicant demonstrated that an acceptable level of fire protection is achievable with the use of polycarbonate. Compared to other plastic glovebox materials, polycarbonate is relatively difficult to sustain combustion or ignite (its reported flash point is 466°C, and the spontaneous ignition temperature is 577°C, as obtained by the ASTM D-1929-86 test method (Reference 7.3.1.1).

Based on the DCS Polycarbonate report, NRC considers polycarbonate to be a potential candidate material for use in glovebox window panels. Appendix B of the revised DSER discusses the resolution of concerns for the polycarbonate window material (FS-4).

7.1.2.14 Flammable and Combustible Liquids and Gases

Chapter 8 of the revised CAR identified facility fire areas with the potential for large spills of flammable or combustible liquids. Section 7.2.2 of the revised CAR stated that flammable and combustible liquids would be stored and handled in accordance with NFPA 30-1996 (Reference 7.3.4.8). Means for containing spills, such as dikes, and for drainage systems are provided for in accordance with NFPA 30. Most vessels containing flammable or combustible liquids would be placed in process cells. Process cells would have fire prevention features such as eliminating ignition sources, earth grounding of vessels and pipes, and combustible loading controls. (See revised DSER Section 7.1.5.3.) The Purification and Solvent Recovery cycles involve a solvent-diluent mixture, which is combustible. In addition to the PSSC process cell fire prevention features, the facility design incorporates additional measures to limit fires:

- Welded equipment and pipes are connected to the off-gas treatment system to preclude over-pressurization.

- Combustible chemicals are stored in welded tanks or equipment to avoid leakage.

- Chemicals are supplied through leak tight welded lines.

- Process temperature is maintained 5^{o}C less than the diluent's flashpoint.

- A minimum clearance is maintained from the tank bottoms for feed lines to preclude splashing or vapor formation.

- Off gases from process equipment are collected and adequately treated.

The NRC concludes that these additional protective features minimize the amount of fuel, and consequently the potential heat output of a fire initiating in the process cell. Therefore, these features provide defense-in-depth for fire protection, and reduce challenges to the process cell PSSC.

Flammable and combustible gases would be stored and handled in accordance with NFPA 50A-1999 and NFPA 55-1998 (References 7.3.4.11 and 7.3.4.12). Flammable gas generation, delivery systems and protection are evaluated in revised DSER Section 8.1.2.

The sintering furnaces in the MP areas would use hydrogen/argon atmospheres, while the calcining furnace in the AP area would use an air/oxygen atmosphere. The fire safety measures for the sintering furnaces such as inert-gas purge, and automatic shutoffs are in accordance with NFPA 86C-1995 (Reference 7.3.4.18). Concerns regarding the adequacy of the overall safety provisions for the furnaces are discussed in revised DSER Section 11.3.

7.1.2.15 Special Hazards

BMF battery rooms would be separated from other areas by 3-hour fire walls, have automatic suppression, and provisions for ventilation and hydrogen gas detection. The ventilation rate is a minimum of two air changes per hour, and the potential hydrogen accumulation is limited to less than 2% room volume. These requirements are adequate per NFPA 111-1996 (Reference 7.3.4.20) and IEEE 484-1996 (Reference 7.3.3.3) standards.

There would be several laboratories in the BMF to provide for physical and chemical analyses of samples from the AP or MP processes. Fire protection for laboratories is designed to meet NFPA 45-1996 (Reference 7.3.4.9). The isolation of these special hazards reduces the potential fire damage, while escape routes are safeguarded. Therefore, they enhance safety by reducing challenges to the PSSCs. However, concerns regarding general safety for the laboratories are discussed in revised DSER Section 8.0.

7.1.3 Manual Firefighting Capability

The applicant performed a baseline needs assessment which determined the minimum necessary capabilities of the facility fire fighting forces. The assessment evaluated the minimum staffing for the fire fighting forces, organization and coordination of onsite and offsite resources, personal protective and fire fighting equipment, and training and emergency planning. The assessment determined that an onsite emergency response team is required at the facility (revised CAR Section 7.3). The facility fire brigade will be developed in accordance with NFPA 600-1996. The staff finds that these plans for manual fire fighting are adequate for the construction approval stage.

7.1.4 Preliminary Fire Hazard Analysis (FHA)

The Preliminary FHA for the facility consists of a systematic analysis of the fire hazards, an identification of fire areas and evaluation of anticipated consequences given the features proposed to control the hazards.

The applicant provided a summary of the methodology and assumptions of the preliminary fire hazards analysis in Section 7.4.1 of the revised CAR. The preliminary FHA concluded that potential fires were typically small and did not propagate beyond the fire area of origin. The fire barriers could prevent facility wide fire spread. Furthermore, programs to maintain the fire barriers, and fire detection /suppression features increased the reliability of the fire barriers. Staff concludes that the preliminary FHA begins the process of documenting the adequacy of facility fire safety. It meets the regulatory acceptance criteria and fire protection baseline design criteria of 10 CFR Part 70.64(a)(3) for the construction authorization stage. Based on the applicant’s commitment to perform an FHA, staff finds the preliminary FHA is acceptable.

7.1.5 Design Bases of the PSSCs

In revised CAR Sections 5.5.2.2.6, 7.5.3, and 11.4.11, the applicant identified the design bases and safety functions of the PSSCs which are intended to provide adequate protection against fires. Pursuant to 10 CFR 70.23(b), this revised DSER documents the staff’s determination relative to whether those design bases provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

7.1.5.1 Combustible Loading Controls

Revised CAR Tables 5.5-13b, 5.5-13a and 5.5-14 identify combustible loading controls as a fire event group PSSC to protect:

- confinement barriers in the C1, C2 or C3 areas;
- radiological material storage gloveboxes;
- the pneumatic transfer system; and
- the secured warehouse.

The specific confinement barriers are: 3013 canisters, 3013 transport casks, fuel rods, MOX fuel transport casks, transfer containers, and the final C4 HEPA filters. Combustible loading controls are identified by the applicant as a PSSC for gloveboxes that store radiological material. For example, combustible loading controls would be provided for the sintered and green pellet glovebox stores, and the PuO_2 buffer storage area.

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The combustible loading control PSSC limits the quantity of combustibles in specific fire areas in order to ensure that the various confinement barriers, the facility wide system and large stores of radiological material would not be adversely impacted by fire. In revised CAR Section 5.6.2.2, the applicant identified combustible loading controls to include control of the fixed combustible loads by design, and control of transient combustibles by design and during operations. Transient combustible controls can be achieved through worker training, regular surveillance, and postings. Even when engineered features are relied on to mitigate potential fires, combustible loading controls are essential to limit the maximum fire growth rate. In addition to combustible loading controls, the applicant identified additional protective features for fire areas that contain the various plutonium confinement barriers. They are: (1) ignition source controls, (2) training of facility workers in manual suppression of incipient stage fires, (3) automatic fire detection in all areas having confinement barriers, (4) automatic fire suppression in some areas, and (5) the passive boundary of the C2 confinement system.

The design basis for the combustible loading controls identified by the applicant as PSSCs is the guidelines within NFPA 801. The administrative controls in NFPA 801 limit unnecessary accumulation of combustibles in facilities handling radioactive materials. Based on industry experience, these controls restrict the occurrence and development of fires. Thus, credible fires do not significantly impact primary confinement barriers. Staff concludes that PSSC combustible loading controls and their associated design bases are adequate, because they help to ensure that structures, systems, and components are not adversely impacted by fire.

7.1.5.2 Confinement Barriers

The applicant designated 3013 Transport cask and MOX Fuel Transport cask confinement barriers as PSSCs. The function of transport cask confinement barriers is to withstand the design basis fire without breaching. The transportation casks are designed to meet 10 CFR 71.73 requirements ***Text removed under 10 CFR 2.390.**

However, because of the combustible loading controls PSSC and the additional protection provided by automatic suppression, ***Text removed under 10 CFR 2.390.**

The staff concludes that the design bases for the confinement barriers of the MOX transport cask and the 3013 transport cask help to provide reasonable assurance of protection against the consequences of fires.

7.1.5.3 AP Process Cell Fire Prevention Features

One objective of a fire protection program is to prevent fires from starting. However, fires are postulated to occur in AP process cells due to the presence of solvents and other chemicals with “low” flash points. The applicant designated the AP process cell fire prevention features as PSSCs to ensure that fires in the process cells are highly unlikely. The safety strategy utilizes ignition source controls, such as:

- Elimination of ignition sources (including electrical equipment) within the AP process cells.
- Earth grounding of vessels and pipes to avoid static electricity.
- The use of controls to ensure that potential chemical reactions that may result in a fire are made highly unlikely
- Limiting combustible materials, and the process required combustible products.
- Maintaining temperatures to avoid generating flammable vapors.

In addition, the following are provided:

- Ventilation to prevent accumulations of vapors in the flammable range.
- Fire barriers rated at 2-hours or more (evaluated in revised DSER Section 7.1.5.6) to isolate process cells from each other and limit the effect of external fires.
- All materials at risk are contained in sealed vessels and pipes and are isolated from any hazards inside the process cell, and
- Lightning protection.

Furthermore, the applicant identified procedures that apply to process cells:

- permit systems to control ignition sources; and
- procedures to prohibit leak testing using open flames or combustion-generated smoke.

The design bases for AP process cell fire prevention are practices promoted in NFPA 801 and NFPA 30, which are based on industry experience, and rely on the use of fundamental safety measures and controls regarding storage, exposure, ignition sources, combustibles, and separation. The staff concludes that the design bases for AP fire prevention features provide reasonable protection against fire initiation and development.

7.1.5.4 MOX Fuel Fabrication Structures

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7.1.5.5 C3 and C4 Confinement Systems

The applicant identified the C4 and C3 systems (revised CAR Section 11.4) as PSSCs that are designed to limit the release of radioactive materials to the environment. These systems are designed to remain operational during a design basis fire to ensure that any potential releases caused by a fire are filtered. Additionally, the design function of the C4 confinement system is to ensure that the final C4 HEPA filters are not impacted by fire. The design basis is Regulatory Guide 3.12 (Reference 7.3.7.4). The design does not incorporate automatic suppression features to cool hot gas in the exhaust streams as recommended by NUREG-1718 or other industry guidance such as from the Department of Energy (DOE) (Reference 7.3.6). Instead, as an equivalent design to Regulatory Guide 3.12 (Section 8.e), it cools the hot gas from a fire by mixing it with air from rooms that are not involved in the fire. If the fire is large enough to exceed set thresholds in the final filtration units or exhaust, the C3 and/or C4 systems may be isolated.

The continuous temperature rating of the pre-filters is a nominal 400°F (204°C). HEPA filters are fabricated of glass media with metallic frames and silicone gaskets. The continuous service rating is 450°F (232°C). Preliminary analyses indicated that the exhaust flow dilution would reduce extremely high room temperatures of 2300°F (1260°C) to less than 400°F (204°C) in the final filter plenum. Thus, the final C3 and C4 HEPA filters are not affected by the maximum temperatures anticipated to result from credible fires within the BMF. However, additional analyses performed by staff indicated that the soot reaching the C3 HEPA filter system did exceed the capacity of the HEPA filters. Also, the applicant did not provide the soot loading analysis for the C4 final filter. The applicant is currently performing a soot loading analysis for the C4 final filter and redoing the soot analysis for the C3 final filters. The analyses will need to be submitted to the NRC staff as part of the revised CAR review.

Therefore, the ability of the final C4 and C3 HEPA filters to perform their safety function when considering soot loading, has not been adequately demonstrated and is considered an open item. (Open Item FS-1.)

7.1.5.6 Fire Barriers

The BMF fire barrier systems (including walls, doors, fire dampers and penetration seals) are PSSC that prevent fires from spreading from one fire area to another. In addition, the applicant has identified fire barriers as PSSCs to ensure that facility-wide systems that contain or handle radioactive materials, such as pneumatic transfer tubes do not spread fire. The design basis for fire barriers is NFPA 801, NFPA 221, NFPA 80, and UL 555-1995 (Reference 7.3.5.2).

To minimize the potential for fire spread between fire areas, the applicant implemented the following measures:

- Fire barriers within the MOX Fuel Fabrication Building are designated PSSCs.
- Detection and suppression systems in areas with significant quantities of dispersible radioactive material are designated defense-in-depth PSSCs to provide a diverse means of mitigating risks.
- Buildings containing PSSCs are designed as Type I construction. In addition, fire barriers in those structures are rated a minimum of two hours.
- Fire barriers are non-combustible, reinforced concrete.
- Fire doors between fire areas are normally closed or self closing.
- Barriers have adequate penetration seals; a penetration seal tracking program will record pertinent information regarding the emplacement and modification of fire barrier penetration seals.
- Airlocks are provided at the doors between secondary and tertiary confinement areas. The airlock is maintained at a positive pressure with respect to the secondary confinement area.
- Fire doors on gloveboxes are normally closed or close upon fire detection. Automatic closure is inhibited momentarily during operations when the collision zone is not clear.
- Transfer gloveboxes that pass through a fire barrier are equipped with fire doors that are rated at 2 hours;

- Fire dampers to the supply and exhaust systems are manually or automatically closed, as necessary to maintain the effectiveness of fire barriers; and

- Combustible loading controls as a PSSC to reduce the potential spread of hot gases through pneumatic transfer tubes. (See revised DSER Section 7.1.5.1)

The applicant is reviewing the selection of the barriers to ensure that an adequate margin of safety can be provided. After accounting for all combustibles within a fire area, and using reasonable estimates of fire growth, the applicant's calculations show that in a few cases, the room temperatures could exceed temperatures that the barriers are qualified to withstand. That is, the barriers are qualified to the ASTM E-119 standard time-temperature curve. DCS predicted a peak room temperature of about 1100°F for FA-MP-142 at four minutes, while the standard curve temperature is around 800°F (Reference 7.3.9.4). DCS agreed to re-evaluate those scenarios where room temperatures could exceed the ASTM time-temperature profile to determine if fire barrier members could fail due to thermal shock or stress. DCS will revise its severity calculation methodology and assumptions to evaluate maximum temperature impacts on fire barriers. Therefore, the margin of safety of the fire barriers has not been adequately resolved and is considered an open issue. (Open Issue FS-2.)

7.1.5.7 Suppression and Detection

Sections 7.4.2 and 7.5.3 of the revised CAR stated that where dispersible fissile material is present, fire detection and suppression is provided as a PSSC. PSSC detection/suppression systems further ensure that a propagating fire cannot result in an unacceptable release of radioactive material to the environment and therefore, provide defense-in-depth. Because of criticality concerns when using water, clean agent suppression is provided. However, clean agent suppression is not credited in the Safety Assessment or the Preliminary FHA. According to revised CAR Section 7.5.3, the PSSC clean agent suppression systems are designed to be operable after an earthquake. Therefore, if a post-seismic fire were to occur in fire areas containing radioactive materials, post-seismic fire fighting capability will be available. All clean agent systems will be designed, installed and maintained according to NFPA 2001-1996. To assure the reliability of the clean agent suppression system, the effect of ventilation and agent soak time will be considered in their design. They will include 100% reserve. The reserve is not automatically connected. Instead, the facility fire brigade manually connects the reserve capacity when needed.

A discussed in revised DSER Section 7.1.2.5, smoke detection systems would be present in all areas of the BMF. Fire detection and alarm systems are designed per NFPA 72-1996. Heat or smoke detectors are provided in gloveboxes. Detection systems in these locations are designated PSSCs. Detection and clean agent suppression systems allow initiating fires to be quickly detected and controlled. As PSSCs they reduce the impact of fire, so fire barriers can be more effective. Thus, the staff concludes that fire detection/suppression systems provide defense in depth to the fire barriers to help assure protection against fires.

7.2 EVALUATION FINDINGS

In Section 7.5 of the revised CAR, the applicant provided design basis information for the fire protection systems that were identified as PSSCs for the proposed MOX facility. Based on the staff's review of the revised CAR and supporting information provided by the applicant relevant to fire protection systems, the staff finds that, due to the open items discussed above and listed below, DCS has not met the BDC set forth in 10 CFR 70.64(a)(3). Further, until the open items are closed, the staff cannot conclude, pursuant to 10 CFR 70.23(b), that the design bases of the PSSCs evaluated in this revised DSER will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents. The following open items are pending resolution:

- The ability of the final C4 and C3 HEPA filters to perform their safety function when considering soot loading, has not been adequately demonstrated. (Revised DSER Section 7.1.5.5.) (FS-1)

- The margin of safety of the fire barriers has not been adequately resolved. (Revised DSER Section 7.1.5.6.) (FS-2)

DCS provided additional information concerning open item identified by the staff as FS-1 (Reference 7.3.9.3). Because the information was provided recently, the staff has not completed its review.

Regarding FS-2, DCS will provide additional severity analyses (Reference 7.3.7.5).

7.3 REFERENCES

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7.3.1.3 _____. ASTM-E-119, "Standard Test Methods for Fire Test of Building Construction and Materials.” 1995.

7.3.2 Factory Mutual Research Corporation (FM), "Factory Mutual System Approval Guide Equipment, Materials, Services, and Conservation of Property. “

7.3.3.1 Institute of Electrical and Electronics Engineers, Inc. (IEEE). IEEE Standard 383, “Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generation Stations.”

7.3.3.2 _____. Standard 384-92, “Standard Criteria for Independence of Class 1E Equipment and Circuits.”

7.3.3.3 _____. Standard 484-1996, “Recommended Practice for Installation Design and Installation of Vented-Lead Acid Batteries for Stationary Applications.”

7.3.4.1 National Fire Protection Association, Inc. (NFPA) Standards. NFPA Standard 10, "Standard for Portable Fire Extinguishers.”

7.3.4.2 _____. Standard 13, "Standard for the Installation of Sprinkler Systems.”

7.3.4.3 _____. Standard 14, "Standard for the Installation of Standpipes and Hose Systems.”

7.3.4.4 _____. Standard 20, "Standard for the Installation of Centrifugal Fire Pumps.”

7.3.4.5 _____. Standard 22, “Water Tanks for Private Fire Protection.”

7.3.4.6 _____. Standard 24, "Standard for the Installation of Private Service Mains and their Appurtenances.”

7.3.4.7 _____. Standard 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.”

7.3.4.8 _____. Standard 30, “Flammable and Combustible Liquids Code.”

7.3.4.9 _____. Standard 45, "Standard for Fire Protection for Laboratories Using Chemicals.”

7.3.4.10_____. Standard 50, "Standard for Bulk Oxygen Systems at Consumer Sites.”

7.3.4.11_____. Standard 50A, "Standard for Gaseous Hydrogen Systems at Consumer Sites.”

7.3.4.12_____. Standard 55, "Standard for Compressed and Liquefied Gases in Portable Cylinders.”

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7.3.4.14_____. Standard 70, "National Electric Code.”

7.3.4.15_____. Standard 72, "National Fire Alarm Code.”

7.3.4.16_____. Standard 80, "Standard for Fire Doors and Fire Windows.”

7.3.4.17_____. Standard 80A, "Recommended Practice for Protection of Buildings from Exterior Fire Exposures.”

7.3.4.18_____. Standard 86C, ”Industrial Furnaces Using a Special Processing Atmosphere.”

7.3.4.19_____. Standard 101, "Life Safety Code.”

7.3.4.20_____.Standard 111, “Stored Electrical Energy Emergency and Standby Power Systems.”

7.3.4.21_____. Standard 220, "Standard on Types of Building Construction.”

7.3.4.22_____. Standard 221, “Fire Walls and Fire Barrier Walls.”

7.3.4.23_____. Standard 253, "Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source."

7.3.4.24_____. Standard 482, “Production, Processing, Handling and Storage of Zirconium.”

7.3.4.25_____. Standard 600, "Standard on Industrial Fire Brigades.”

7.3.4.26_____. Standard 780, "Lightning Protection Code.”

7.3.4.27_____. Standard 801, "Standards for Facilities Handling Radioactive Material.”

7.3.4.28_____.Standard 2001, "Standard on Clean Agent Extinguishing Systems."

7.3.5.1 Underwriters Laboratories (UL), Inc. UL Building Materials Directory.

7.3.5.2 _____. Standard 555, "Standard for Fire Dampers and Ceiling Dampers."

7.3.6 U.S. Department of Energy (DOE). DOE-STD-1066-97, "Fire Protection Design Criteria", Washington, DC. March 1997.

7.3.7.1 NUREG-1718, "Standard Review Plan for the Review of an Application for a Mixed Oxide Fuel Fabrication Facility," August 2000.

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7.3.7.4 Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants." August 1973.

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7.3.9.2 Hastings P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission, RE Evaluation of the Draft Safety Evaluation Report (DSER) on Construction of a Mixed Oxide Fuel Fabrication Facility," 09 July 2002.

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

7.3.9.4 MOX Fuel Fabrication Facility (MFFF) Fire Severity Calculation," NRC Technical Exchange, 6 February 2003.