7.0 FIRE PROTECTION

7.1 CONDUCT OF REVIEW

This chapter of the draft Safety Evaluation Report (DSER) contains the staff's review of fire protection described by the applicant in Chapter 7 of the Construction Authorization Request (CAR). The objective of this review is to verify whether the applicant's commitments and goals related to fire protection are adequate to meet or exceed the regulatory acceptance criteria referenced below. The review also verifies that the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) is adequately protected 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 CAR, other sections of the 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 Bases (see Chapter 5.0 of this DSER), the review of explosion protection aspects (see Chapter 8.0 of this DSER), and the review of other plant systems (see Chapter 11.0 of this DSER).

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

- Section 70.23(b) of 10 CFR states, as a prerequisite to construction approval, that the design bases of the PSSCs and the quality assurance program 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 MFFF design "provide for adequate protection against fires."

The review for this construction approval 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) as guidance in performing the review.

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

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 CAR described the applicant's commitment to assure that PSSCs as identified in the 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 developing 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 MFFF site improves the perception of protection against fires. It 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 CAR, the applicant committed to develop a fire protection program for the MFFF 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 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 MFFF 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.

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. An evaluation of how the applicant addressed these acceptance criteria at the MFFF site is discussed below.

7.1.2.1 Construction

Section 7.2.2 of the CAR stated that buildings where radioactive materials are used, handled or stored at the MFFF 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). Buildings that contain PSSCs are Type I construction (fire resistive) which have exterior bearing walls rated at least 3 hours, and interior bearing walls, trusses, beams, girders and columns rated at least 2 hours. In addition, buildings are protected from exterior fires by observing fire safety criteria recommended in NFPA 80A (Reference. 7.3.4). Staff finds the preliminary construction features at the MFFF are adequate to meet the baseline design criteria of 10 CFR 70.64 (a) for fire safety. The applicant designated some structures at the MFFF as PSSCs; they are discussed further in DSER Section 7.1.5.4.

7.1.2.2 Interior Surface

Section 7.2.2 of the CAR indicated that exposed interior walls or ceilings and any factory-installed facing material have a FM approved (Reference 7.3.3) or UL listed (Reference 7.3.5) flame spread rating of 25 or less, and a smoke developed rating of 50 or less in accordance with ASTM-E-84-98 (Reference 7.3.1). If carpets and rugs are used, they are tested in accordance with NFPA 253-1995 (Reference 7.3.4). Thus, staff is assured that interior finish materials do not contribute to fire or smoke development. The staff finds that the applicant's commitments satisfy the BDC of 10 CFR 70.64(a)(3).

7.1.2.3 Storage Racks

CAR Section 7.2.3.6 stated that racks for the storage of plutonium oxide, uranium oxide, or mixed oxide in powder, pellet or rod form are noncombustible. The applicant provides combustible loading controls to prevent the build up of combustibles in areas where storage racks are located. DSER Section 7.1.5.1 provides a discussion of combustible loading controls. Mechanical/structural properties of the racks are discussed in DSER Section 11.7. Limiting combustible materials in areas where special nuclear materials are stored reduces the intensity of potential fires if they occur. The staff finds the provisions for storage racks are acceptable because it meets the guidance of NUREG-1718 and satisfies the BDC of 10 CFR 70.64(a)(3).

7.1.2.4 Electrical Considerations

Section 11.5 of the CAR discussed the electrical systems at the MFFF. In addition, the applicant provided details on fire and electrical safety interfaces during a briefing to the ACRS (Reference 7.3.7). To prevent fires from initiating, the electrical systems at the MFFF are designed with the following considerations:

- Cables in redundant electrical trains are separated by rigid conduit, a distance of at least 150 feet (48.8 m), or Institute of Electrical and Electronics Engineers (IEEE) 384 (Reference 7.3.3) electrical separation criteria are applied.

- The main electrical trains (for ventilation and for the emergency control rooms) enter the MOX Fuel Fabrication Building (BMF) from different sides and on different floors of the MOX Processing Area.

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

- 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) qualified (i.e., ignition resistant and self-extinguishing).

- Emergency electrical power to PSSCs is routed in conduit.

- The normal and standby AC power systems are designed according to NFPA 70-1999 (Reference 7.3.4).

- Where electrical cables enter glovebox or decanning rooms, they are installed in solid stainless steel wireways or ducts (Reference 7.3.9.2, page 19).

These considerations also protect electrical systems from the effects of smoke and fire that initiate outside the electrical systems. Section 11.5 of the DSER evaluated the electrical systems at the MFFF. Staff indicates that electrical systems are robust and meet the performance requirements of 10 CFR 70.61. The applicant's electrical analyses provided reasonable assurance that the electrical PSSCs protect against the consequences of potential accidents and natural phenomena. Thus, the staff finds that the protection of electrical wiring is acceptable and adequate and that it satisfies the BDC of 10 CFR 70.64(a)(3).

7.1.2.5 Fire Alarm and Detection Systems

Section 7.2.3.2 of the CAR stated that the fire alarm systems are designed according to NFPA 72-1996 (Reference 7.3.4). The BMF detection systems are tied into a central alarm panel that is located in the Aqueous Polishing (AP) Control Room. The central fire alarm panel has a graphical display which assists the BMF operators identify and respond to alarms. Upon detection of a fire, audible and visual alarms are provided in the affected parts of the MFFF.

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. Smoke detection is provided in all fire areas of the BMF (Reference 7.3.9.3, Table 6). Detection systems are located throughout the MFFF in accordance with the principles of NFPA 72-1996. 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 CAR stated that detection systems in areas containing dispersible radioactive materials are identified as PSSCs for defense-in-depth reasons (see DSER Section 7.1.5.7). Each glove box is provided with a minimum of two detectors. Generally, smoke detectors are deployed. However, heat detectors are 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 the emergency power systems. The emergency power systems are PSSCs. See DSER Section 11.5 for details on the electrical power supply systems. The staff finds the provision for fire alarm and detection systems is acceptable because it ensures prompt notification of fires and satisfies the BDC of 10 CFR 70.64(a)(3).

7.1.2.6 Means of Egress Protection

The facility layout largely complies with the 1997 version of the Life Safety Code (Reference 7.3.4). According to 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 MFFF 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. There are two standby generators; each can 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 satisfy the BDC of 10 CFR 70.64(a)(3); therefore, they are adequate and acceptable.

7.1.2.7 Lightning Protection

The applicant designated the BMF and the Emergency Diesel Generator Building as PSSCs. 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) 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 and satisfies the BDC of 10 CFR 70.64(a)(3).

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 CAR describes the four confinement zones that are employed in the BMF; the staff's evaluation of their performance is provided in 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 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 ventilated by an independent ventilation system. The airlocks maintain a negative pressure with respect to the areas adjacent 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 ensures 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 provided an evaluation of the PSSC confinement systems in sections 11.4.1.4 and 7.1.5.5 of the 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. There are multiple separate filter housings and redundant trains of filter systems in separate fire areas. Also, no ignition sources and limited combustible materials are allowed within the filter housings or filter housing rooms.

7.1.2.8.2 Ventilation Ductwork and Dampers

The ductwork in the ventilation systems incorporates manual and automatic dampers and controls to distribute and regulate the movement of air. The ductwork is 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. The operation of the exhaust and supply dampers is pre-planned.

7.1.2.8.3 Filter Design and Protection

At the BMF, HEPA filters are 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). Entrance filters (spark arresters) and prefilters are located upstream of the HEPA filter exhaust plenums. Fire protection for the BMF final HEPA filter system is provided by air stream dilution and the use of spark arresters. Spark arresters prevent branding of the final filters by hot particles. The assemblies are designed and fabricated to the same temperature ratings as the duct materials in which they are installed.

7.1.2.8.4 Detection and Suppression Protection in the Ventilation Systems

Temperature detectors are provided 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. According to CAR Section 11.4.9, fire protection to the final HEPA filter systems will be provided by spark arresters and dilution of high temperature exhaust streams to prevent prolonged exposure to temperatures above the 400EF (204°C) maximum filter service temperature. The applicant's analyses determined that mixed airflows to the filters would not exceed 400EF (204°C) when a room temperature of 2300EF (1260°C) is assumed. The applicant provided supplemental information (Reference 7.3.9.1, RAI 146) that contains more details about its calculations.

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) to determine fire area boundaries. Section 7.2.3.1 of the 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; 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.). Construction details are in accordance with NFPA 221-1997 (Reference 7.3.4).

Openings in fire barriers are provided with appropriately rated fire doors with automatic fire closures, fire dampers, and fire-rated penetration seals. Fire doors are designed according to NFPA 80-1999 (Reference 7.3.4). The staff finds that the general selection of fire areas is appropriate for the hazards at the MFFF. The fire area selection minimizes the potential size of a fire. Therefore, it limits the fire exposure to equipment, material and personnel, and as a result, satisfies the fire protection BDC contained in 10 CFR Part 70.61(a)(3). The applicant designated fire barriers as PSSCs. The staff evaluated the design bases of fire barriers as in DSER Section 7.1.5.6.

7.1.2.10 Water Supply and Drainage

The MFFF design incorporates a water supply system in accordance with NFPA 801 requirements. Section 7.2.3.4 of the CAR stated that the fire protection water supply system consists of an underground loop around the MFFF 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.

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The design specifies that firewater is drained and collected.

The staff determined that the MFFF water supply system accommodates the requirements for automatic and manual suppression activities at the MFFF. It is based on defense-in-depth practices and satisfies the fire protection BCD of 10 CFR 70.64(a)(3).

7.1.2.11 Fire Suppression

A combination of automatic suppression systems, fire hose stations, exterior hydrants, and portable extinguishers provide suppression at the MFFF. 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 is handled (Reference 7.3.9.2, page 20). Where fissile materials are normally 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 DSER Section 7.1.5.7. The clean agent system will also be provided in areas of the MFFF that contain electrical and/or electronic equipment such as computer rooms, motor control centers and control rooms. Where needed, the clean agent system will 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).

According to Section 7.2.3.3 of the CAR, water-based suppression systems are provided within the corridors and stairwells of the MP and AP areas. 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 hallways, stairwells and offices of the Shipping and Receiving Area deploy wet-pipe sprinkler systems (discharge water when elevated temperatures are detected). Sprinklers are designed according to NFPA 13-1996 (Reference 7.3.4). All water-based systems will be periodically inspected, tested, and maintained in accordance with NFPA 25 (Reference 7.3.4).

Not all fire areas in the BMF are provided with 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 equipment in the areas such as the Rod Storage may be difficult to maintain operational due to ALARA concerns.

The standpipe and hose systems allow manual fire fighting capabilities throughout the MFFF. 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 (Reference 7.3.4).

Portable fire extinguishers are provided throughout the BMF and inside all buildings at the MFFF 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 are provided. Portable extinguishers are provided according to NFPA 10-1998 (Reference 7.3.4). Specially configured portable CO_2 bottles are provided in rooms with gloveboxes. These extinguishers can be quickly disconnected and attached to the glovebox to suppress fires within the glovebox without over-pressurizing the glovebox.

Packets of extinguishing powder are provided in gloveboxes and in the rooms where a zircaloy fire risk exists. In addition, zirconium swarf 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 extinguishers with quick disconnect fittings. According to CAR Section 7.2.3.2 and RAI Reference 7.3.9.4, page 15, both the SRS fire department and the facility fire brigade would respond to major fire fighting operations. Development and training of the facility fire brigade would follow NFPA 600-1996 (Reference 7.3.4) 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. The staff finds that the provisions for suppression are acceptable because they satisfy the baseline design criteria of 10 CFR 70.64(a)(3) and because they provide defense-in-depth.

7.1.2.12 Combustible and Pyrophoric Metals

When plutonium oxide is fully oxidized, it is not pyrophoric. Uranium oxide does not oxidize in an inert atmosphere, and oxidizes very slowly in air under process temperature conditions. Section 7.2.5 of the CAR indicates that for process reasons, some gloveboxes containing plutonium and uranium oxides are inerted with nitrogen. Thus, the preliminary design of the nitrogen systems provides defense-in-depth to the fire protection strategy because they limit the combustion of special nuclear materials.

Zirconium is stored and handled in accordance with NFPA 482-1996 (Reference 7.3.4). The applicant intends to use titanium for the electrolyzer circuit and associated equipment that could be exposed to silver(II) ions. Staff evaluated the handling of titanium in DSER Section 11.2.

The applicant did not identify fire events associated with the pyrophoric nature of some uranium and plutonium oxide powders as credible. This is discussed in DSER Sections 11.3.1.2.1 and 11.3.1.2.3.

7.1.2.13 Glovebox Protection

Gloveboxes provide physical and visual access to internal equipment, processes, and material. Glovebox details are in CAR Section 11.4.7.1 and the applicant's "Polycarbonate Report" (Reference 7.3.9.7). A typical glovebox is a large stainless steel enclosure-mounted on a structural stainless steel stand. Glovebox windows consist of rectangular fire resistant polycarbonate panels 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.

Each glove box is provided with a minimum of two detectors. Generally, smoke detectors will be deployed. However, if conditions such as dust prohibit their use, heat detectors will 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 applicant's proposed use of polycarbonate is not in compliance with the NFPA 801 requirements to use noncombustible materials. However, the applicant has attempted to demonstrate that an equivalent level of fire protection is achievable with the use of fire resistive polycarbonate. Compared to other plastic glovebox materials, polycarbonate is relatively difficult to sustain combustion or ignite. The applicant states that under seismic inertia loading and seismic deflection, polycarbonate is superior to non-combustible materials that are allowed by the code, such as glass. The MFFF provides additional fire protection features in the rooms containing gloveboxes, such as PSSC clean agent automatic suppression and manual CO_2 for glovebox injection, inert atmospheres for some gloveboxes with dispersible materials, and no ignition sources near the glovebox. The applicant designated glovebox fire protection features as PSSCs. See DSER Section 7.1.5.8. In addition, the applicant is examining bounding conditions and developing design basis criteria for the gloveboxes to assure that stated mechanical, (including high temperature non-fire-related failure), seismic, fire and other physical properties are valid for the range of expected use. (Non-fire-related failure of glovebox windows is discussed in Section 11.7.1 of this DSER.) The NRC considers this an open issue, because the design basis criteria and qualification standards for the gloveboxes have not been adequately resolved.

7.1.2.14 Flammable and Combustible Liquids and Gases

Chapter 8 of the CAR identified MFFF fire areas with the potential for large spills of flammable or combustible liquids. Section 7.2.2. of the CAR stated that flammable and combustible liquids are stored and handled in accordance with NFPA 30-1996 (Reference 7.3.4). 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 are placed in process cells. Process cells fire prevention features such as: eliminating ignition sources, earth grounding of vessels and pipes, combustible loading controls are implemented as PSSCs. (See DSER Section 7.1.5.3.) The Purification and Solvent Recovery cycles involve a solvent-diluent mixture, which is flammable. In addition to the PSSC process cell fire prevention features, the MFFF incorporates additional measures to limit fires:

- Welded equipment and pipes are connected to the offgas 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, reduce challenges to process cell PSSC, and satisfy the BDC of 10 CFR70.64.

Flammable and combustible gases are stored and handled in accordance with NFPA 50A-1999 and NFPA 55-1998 (Reference 7.3.4). Flammable gas generation, delivery systems and protection are evaluated in DSER Section 8.1.2.

The sintering furnaces in the MP Areas use hydrogen/argon atmospheres, while the calcining furnace in the AP Area uses an air/oxygen atmosphere. The fire safety measures for the sintering furnaces such as, inert-gas purge, automatic shutoffs are in accordance with NFPA 86C-1995 (Reference 7.3.4). Concerns regarding the adequacy of the overall safety provisions for the furnaces are discussed in DSER Section 11.3.

7.1.2.15 Special Hazards

BMF Battery rooms are separated from other areas by 3-hour fire walls, have automatic suppression, and provisions for ventilation and hydrogen gas detection. The fire protection features are adequate per NFPA 111-1996 (Reference 7.3.4) and IEEE 484-1996 (Reference 7.3.3) standards.

There are several laboratories in the BMF which are used 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). 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 DSER Section 8.0.

7.1.3 Manual Firefighting Capability

The applicant is performing a baseline needs assessment to determine the minimum necessary capabilities of the MFFF fire fighting forces. The applicant commits to provide an assessment of: 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 staff finds that commitments to manual fire fighting are adequate for the construction approval stage. The commitments satisfy the BDC of 10 CFR 70.64(a)(3).

7.1.4 Preliminary Fire Hazard Analysis (FHA)

The Preliminary FHA for the MFFF 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 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 MFFF 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 approval 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

As described in DSER Section 5.0, the applicant's safety assessment demonstrates that the MFFF PSSCs provide protection against hazards in accordance with the requirements of 10 CFR 70.61. The design bases of the PSSCs in this section ensure that adequate protection is provided against fires. The applicant provided fire safety design bases in CAR Sections 5.2.2.6, 7.5.3, and 11.4.11. This section describes the PSSCs and evaluates their corresponding design bases.

7.1.5.1 Combustible Loading Controls

The applicant identified combustible loading controls as a fire safety PSSC to protect plutonium found in the various confinement barriers in the C2 confinement areas of the BMF. (The confinement areas are described in Section 11.4 of this DSER.) The specific confinement barriers are: 3013 canisters, 3013 transport casks, fuel rods, MOX fuel transport casks, transfer containers, and the final C4 HEPA filters. The combustible loading control PSSC limits the quantity of combustibles in each fire area in order to ensure that the various confinement barriers are not adversely impacted by fire. In an RAI response (Reference 7.3.9.5, page 28), 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 PSSC combustible loading controls is the guidelines within NFPA 801. The administrative controls in NFPA 801 are the management measures and fire prevention procedures that limit unnecessary accumulation of combustibles in facilities handling radioactive materials. Based on industry experience, these measures 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 the design bases are acceptable, because they provide a reasonable assurance of protection against fires in accordance with 10 CFR Part 70.23(b).

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 10 CFR Part 73 (Reference 7.3.6), so they should withstand exposures to 1472^{o}F (800^{o}C) for 30 minutes.

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However, because of the combustible loading controls PSSC and the additional protection provided by automatic suppression, fires in the truck bays are expected to be small and quickly contained. A fire in the truck bay should not exceed criteria in 10 CFR Pat 71.73 and therefore should not challenge the transport cask confinement barriers. The staff concludes that the design bases for the confinement barriers of the MOX transport cask and the 3013 transport cask are acceptable, because they provide a reasonable assurance of protection against fires in accordance with 10 CFR Part 70.23(b).

7.1.5.3 AP Process Cell Fire Prevention Features

One of objectives 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 (Reference 7.3.9.3, page 27)

The applicant identified other fire prevention procedures in the process cells:

- Ventilator to prevent accumulations of vapors in the flammable range.
- A permit system to control ignition sources that may be introduced by welding, flame cutting, grazing, or soldering operations.
- Combustible loading controls.
- Prohibiting leak testing using open flames or combustion-generated smoke.
- Lighting protection for the MFFF buildings that are PSSCs.

In addition, 2-hour fire barriers (evaluated in DSER Section 7.1.5.6) isolate process cells from each other.   Furthermore, all materials at risk are contained in sealed vessels and pipes and are isolated from any hazards inside the process cell. The design bases for AP process cell fire prevention are practices promoted in NFPA 801 and NFPA 30, which are based on industry experience. Together with observing fundamental safety measures of using appropriate storage, and minimizing exposure to air, ignition source controls provide a reasonable assurance of protection against fires in AP process cells in accordance with 10 CFR Part 70.23(b). Therefore, staff concludes that the design bases for AP fire prevention features are acceptable.

7.1.5.4 MOX Fuel Fabrication Structures

Fires that occur outside of the BMF could impact the radioactive material contained within. To reduce the risk to the public, site worker and facility workers, some MFFF structures are identified as PSSCs. They are the BMF structure, the Emergency Diesel Generator Building (BEG) structure, and the waste transfer line. The safety function of the BMF and BEG structures is to withstand external fires and protect the PSSCs and their support systems that these structures contain. The BMF and the BEG structures are designed to Type I per NFPA 220, which is the most fire resistive type. Type I construction has exterior bearing walls rated at least 3 hours, and interior bearing walls, trusses, beams, girders and columns rated at least two hours. In addition to Type I construction, CAR Section 11.1.3 states that the BMF has additional security measures consisting of reinforced concrete and engineered fill. This security barrier provides additional fire resistance to the BMF outer walls and roof.

The safety function of the waste transfer line is to prevent damage from external fires. The buried waste transfer line is double-walled stainless steel, designed to ANSI an ASME codes. It is located in a concrete trench, is routed away from heavy equipment areas, and is designed to withstand external forest fires.

Additionally, structures at the MFFF are protected from exterior fires by following guidelines in NFPA 80A for process facilities that are close to each other, or near bulk hazardous material storage. To minimize the risk of external fires from nearby buildings, automatic suppression is deployed within buildings at the MFFF site. MFFF onsite fire brigade and the SRS fire department are available to manually suppress external fires. Currently, the applicant is evaluating credible fire exposures from the Gas Storage Facility, transformers, HVAC and Process Chillers. According to Section 11.9.4 of the CAR, bulk gas storage areas will be protected in accordance with NFPA 50, 50A and 55 (Reference 7.3.4). Other external fires are postulated to occur due to nearby forests or vegetation.

The external fire walls of the BEG and the BMF structures are designed with a 3-hour rating according to NFPA 220 principles. Such design should withstand any credible external fires that could occur at the MFFF site. Similarly, a forest fire should not impact the protection of the waste transfer line. The structures provide a reasonable assurance of protection against external fires in accordance with 10 CFR Part 70.23(b).

7.1.5.5 C3 and C4 Confinement System

The applicant identified the C4 and C3 systems (DSER 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 fire to ensure that any potential releases caused by a fire are filtered. 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). 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 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 involve the glovebox gloves or windows, the C3 ventilation system is relied on to exhaust the products of combustion.

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 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 be available as part of the Hazard Analysis.

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 issue.

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.

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 (that is, interior walls are rated a minimum of 2-hours).
- Fire barriers are non-combustible, reinforced concrete.
- Fire doors between fire areas are self closing.
- Barriers have adequate penetration seals; a penetration seals 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 separate airlock ventilation system maintains the airlock at a negative pressure with respect to the secondary confinement area.
- Fire doors on gloveboxes automatically close upon fire detection.
- Transfer gloveboxes that pass through a fire barrier are equipped with fire doors that are rated at 2 hours; and

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

The applicant is reviewing the selection of the barriers to ensure that an adequate margin of safety can be provided. Therefore, the margin of safety of the fire barriers has not been adequately resolved and is considered an open issue. Additionally, the applicant is evaluating the propagation of hot gases through pneumatic transfer tubes. If this hazard poses a fire risk in the downstream fire area, then PSSCs such as sliding valves will be identified to isolate the pneumatic tube. Therefore, the propagation of hot gases through pneumatic transfer tubes has not been adequately resolved and is considered an open issue. The applicant committed to provide methodologies and input assumptions for determining fire barrier margins of safety and hot gas propagation during construction approval.

7.1.5.7 Suppression and Detection

Section 7.4.2 of the CAR stated that where dispersible fissile material is present, fire detection and suppression is provided as a PSSC for defense-in-depth to the fire barriers (which are PSSCs). PSSC detection/suppression systems further ensure that a propagating fire cannot result in an unacceptable release of radioactive material to the environment. 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 Reference 7.3.9.4 (page 14), the PSSC clean agent suppression systems will be installed as Seismic Category I. As Seismic Category I, these systems will 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 will be considered in their design and they will include 100% reserve.

A discussed in DSER Section 7.1.2.5, smoke detection systems are provided in all areas of the BMF. 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, staff concludes that fire detection/suppression systems provide defense in depth to the fire barriers to assure protection against fires in accordance with 10 CFR 70.23 (b).

7.1.5.8 Glovebox Fire Protection Features

In response to an RAI (Reference 7.3.9.4, page 54) the applicant has identified a PSSC, “glovebox fire protection features,” for events involving gloveboxes. This PSSC identifies some design features and operating controls, such as combustible loading and/or ignition source controls, that ensure fires involving glove boxes are unlikely to result in intermediate consequences to the environment. The applicant will provide additional details regarding glovebox fire protection features and the design basis in the safety assessment. The adequacy of the design basis for this PSSC remains open because it is not provided and, therefore, cannot meet criteria in 10 CR 70.23(b).

7.2 EVALUATION FINDINGS

In Section 7.5 of the CAR, the applicant provided design basis information for the fire protection systems that it identified as PSSCs for the proposed MFFF. Based on the staff's review of the CAR and supporting information provided by the applicant relevant to 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 DSER will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents, pending resolution of the following open items:

- The applicant did not provide sufficient justification that the C3 and C4 final HEPA filter could perform their safety function under fire/soot conditions. (DSER Section 7.1.5.5.) (FS-1)

- The applicant has not demonstrated that an adequate margin of safety has been provided for the fire barriers. (DSER Section 7.1.5.6.) (FS-2)

- The applicant is evaluating the pneumatic transfer tubes to determine if PSSCs will be required to prevent propagation of hot gases through the tubes. (DSER Section 7.1.5.6.) (FS-3)

- The design basis criteria and qualification criteria and qualification standards for the glove boxes are not sufficient to ensure that gloveboxes will be used in their expected performance range. (DSER Section 7.1.2.13) (FS-4)

- The applicant is developing design bases for the “glovebox fire protection features PSSC. (DSER Section 7.1.5.8.) (FS-5)

DCS has stated that it will provide additional information concerning open items identified by the staff as FS-1, 2, 3, 4 (Reference 7.3.11).

7.3 REFERENCES

7.3.1 American Society for Testing and Materials (ASTM):
ASTM-E-84, "Standard Test Method for Surface Burning Characteristics of Building Materials”
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 Institute of Electrical and Electronics Engineers, Inc. (IEEE)
Standard 383, “Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generation Stations”
Standard 384-92, “Standard Criteria for Independence of Class 1E Equipment and Circuits”
Standard 484-1996, “Recommended Practice for Installation Design and Installation of Vented-Led Acid Batteries for Stationary Applications.”

7.3.4 National Fire Protection Association, Inc. (NFPA) Standards

Standard 10, "Standard for Portable Fire Extinguishers”
Standard 13, "Standard for the Installation of Sprinkler Systems”
Standard 14, "Standard for the Installation of Standpipes and Hose Systems”
Standard 20, "Standard for the Installation of Centrifugal Fire Pumps”
Standard 22, “Water Tanks for Private Fire Protection”
Standard 24, "Standard for the Installation of Private Service Mains and their Appurtenances”
Standard 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems”
Standard 31, "Standards for Installation of Oil Burning Equipment”
Standard 45, "Standard for Fire Protection for Laboratories Using Chemicals”
Standard 50, "Standard for Bulk Oxygen Systems at Consumer Sites”
Standard 50A, "Standard for Gaseous Hydrogen Systems at Consumer Sites”
Standard 51, "Standard for Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes”
Standard 55, "Standard for Compressed and Liquefied Gases in Portable Cylinders”
Standard 58, "Standard for Storage and Handling of Liquefied Petroleum Gases”
Standard 69, "Standard on Explosion Prevention Systems”
Standard 70, "National Electric Code”
Standard 72, "National Fire Alarm Code”
Standard 80, "Standard for Fire Doors and Fire Windows”
Standard 80A, "Recommended Practice for Protection of Buildings from Exterior Fire Exposures”
Standard 86C,”Industrial Furnaces Using a Special Processing Atmosphere”
Standard 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems”
Standard 101, "Life Safety Code”
Standard 111, “Stored Electrical Energy Emergency and Standby Power Systems”
Standard 220, "Standard on Types of Building Construction”
Standard 221, “Fire Walls and Fire Barrier Walls”
Standard 251, "Standard Methods of Tests of Fire Endurance of Building Construction and Materials”
Standard 253, "Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source"
Standard 482, “Production, Processing, Handling and Storage of Zirconium”
Standard 600, "Standard on Industrial Fire Brigades”
Standard 780, "Lightning Protection Code”
Standard 801, "Standards for Facilities Handling Radioactive Material”
Standard 2001, "Standard on Clean Agent Extinguishing Systems”

7.3.5 Underwriters Laboratories (UL), Inc.
UL Building Materials Directory
UL Fire Protection Equipment Directory
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.
Draft DOE-STD-5XXX-99, "Stabilization, Packaging, and Storage of Plutonium-Bearing Materials”, Washington, DC. March 1999.

7.3.7 U.S. Nuclear Regulatory Commission (NRC)

Briefing to the Advisory Committee on Reactor Safety (ACRS) on the MFFF, “Electrical and Instrument and Control Systems Overview,” April 10, 2002.
Code of Federal Regulations, *Title 10, Energy*, Part 71, “Packaging and Transportation of Radioactive Materials.”
"Domestic Licensing of Special Nuclear Material (10 CFR Part 70)," Federal Register: Vol. 64, No. 146. pages 41338-41357. July 30, 1999.
NUREG-1718, “Standard Review Plan for the Review of an Application for a Mixed Oxide Fuel Fabrication Facility.”
Regulatory Guide 3.12, “General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.” August, 1973.

7.3.8 American Society of Mechanical Engineers (ASME).
ASME-AG-1, "Code on Nuclear Air and Gas Treatment”

7.3.9 Duke Cogema Stone & Webster

7.3.9.1 Hastings, P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission, RE Response to Request for Additional Information (DCS-NRC-000060), August 31, 2001.

7.3.9.2 Hastings, P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory, RE Clarification of Responses to NRC Request for Additional Information, Enclosure A: Fire Protection (DCS-NRC-000074), December 5, 2001,

7.3.9.3 Hastings, P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission RE Clarification of Responses to NRC Request for Additional Information, DCS-NRC-000083, February 11, 2002

7.3.9.4 Hastings, P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission, RE Clarification of Responses to NRC Request for Additional Information (DCS-NRC-000085), March 8, 2002.

7.3.9.5 Hastings, P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission, RE Clarification of Responses to NRC Request for Additional Information, January 7, 2002.

7.3.9.6 Hastings, P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission, RE Clarification of Responses to NRC Request for Additional Information (DCS-NRC-000092), April 23, 2002.

7.3.9.7 Hastings P., Duke Cogema Stone & Webster, letter to U.S. Nuclear Regulatory Commission, RE Choice of MFFF Process Glovebox Window Material (DCS-NRC-000030), December 15, 2000

7.3.10 American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHARE)
“Design Guide for Department of Energy Nuclear Facilities,” Atlanta, Georgia. 1993.