DUKE COGEMA
STONE & WEBSTER

Document Control Desk
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852-2738

27 January 2005
DCS-NRC-000177

Subject: Docket Number 070-03098
Duke Cogema Stone & Webster
Mixed Oxide (MOX) Fuel Fabrication Facility
Construction Authorization Request Page Changes

References:
1) K. L. Ashe (DCS) letter to Document Control Desk (NRC), DCS-NRC-000168, dated 10 June 2004, *Construction Authorization Request and Environmental Report Change Pages*
2) P. S.Hastings (DCS) letter to Document Control Desk (NRC), DCS-NRC-000151, dated 28 July 2003, *Response to DSER Open Item CS-02*
3) P. S.Hastings (DCS) letter to Document Control Desk (NRC), DCS-NRC-000157, dated 29 September 2003, *Response to Request for Additional Information – Chemical Safety Open Items CS-09, AP-02, AP-08, and AP-09*
4) P. S.Hastings (DCS) letter to Document Control Desk (NRC), DCS-NRC-000158, dated 6 October 2003, *Response to Request for Additional Information – Chemical Safety Open Items CS-01 and CS-02*
5) P. S.Hastings (DCS) letter to Document Control Desk (NRC), DCS-NRC-000162, dated 10 October 2003, *Response to Request for Additional Information - DSER Open Items MP-01 (UO_2) and AP-03 (Titanium Fires)*
6) P. S.Hastings (DCS) letter to Document Control Desk (NRC), DCS-NRC-000165, dated 12 March 2004, *Response to Request for Additional Information - DSER Open Item AP-03 (Titanium Fires)*
7) R. L. Sweigart (DCS) letter to Document Control Desk (NRC), DCS-NRC-000174, dated 23 September 2004, *Response to Request for Additional Information*
8) R. L. Sweigart (DCS) letter to Document Control Desk (NRC), DCS-NRC-000175, dated 11 October 2004, *Response to Request for Additional Information*
9) R. C. Pierson (NRC) letter to K. L. Ashe (DCS), dated October 21, 2004, *June 10, 2004, Revised Construction Authorization Request – Depleted Uranium and the Mixed Oxide (MOX) Fuel Fabrication Facility Secured Warehouse*

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NMSS01

This letter provides change pages to the Duke COGEMA Stone & Webster (DCS), LLC, Construction Authorization Request (CAR) concerning the Mixed Oxide (MOX) Fuel Fabrication Facility. The enclosed change pages replace pages in the CAR as updated through Reference 1. The changes incorporate the revisions discussed in References 2 through 8. In addition, the changes restore the information associated with the fire event in the Secured Warehouse Building for storage of depleted uranium as requested in Reference 9.

The enclosed change pages do not contain information which is considered to be proprietary to DCS. Proprietary information is included in a separate letter. Enclosure 1 provides instructions for updating the CAR with the change pages. Enclosure 2 provides twenty-five copies of the CAR change pages.

If I can provide any additional information, please feel free to contact me at (980) 373-3787.

Sincerely,

Richard L. Sweigart
Vice President, Regulatory Affairs

RLS/KLA//MAM:gdh

Enclosures: (1) Construction Authorization Request January 2005 Update Instructions
(2) Change Pages to the Mixed Oxide Fuel Fabrication Facility Construction Authorization Request

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Enclosure 1
Construction Authorization Request
January 2005 Update Instructions

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Enclosure 2

Change Pages for Mixed Oxide Fuel Fabrication Facility Construction Authorization Request

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4.1.3 Project Services and Administration Manager

The Project Services and Administration Manager is responsible for managingdesign office security, document control, records management, and training functions. The minimum qualifications for this position are a Bachelors degree (or equivalent), four years of technical or programmatic management experience, and two years of nuclear industry experience.

4.1.4 Procurement Manager

The Procurement Manager is responsible for managing the procurement process for equipment and materials supporting the construction of the MFFF. This position is responsible for coordinating supplier evaluations, developing procurement packages, and obtaining legal input and review of contract terms and conditions. The minimum qualifications for this position are a Bachelors degree (or equivalent) and two years of related experience.

4.1.5 Environment, Safety, and Health Manager

The ES&H Manager is responsible for establishment of top-level project ES&H requirements and oversight of integration of ES&H requirements for nuclear safety, radiation protection, environmental protection, and industrial safety. This position works with line managers to ensure consistent interpretations of ES&H requirements, performs design reviews, and supports project change control reviews. The minimum qualifications for this position are a Bachelors degree (or equivalent) and four years of experience in ES&H or related disciplines.

4.1.6 MFFF Site Integration Manager

The MFFF Site Integration Manager is responsible for developing and maintaining SRS engineering and technical interfaces, including development and maintenance of work task agreements. During MFFF construction, this position will coordinate with SRS and other management personnel to support construction activities. The minimum qualifications for this position are a Bachelors degree (or equivalent) and two years of related experience.

4.1.7 MFFF Plant Operations and Startup Manager

The MFFF Plant Operations and Startup Manager is responsible during design for operability reviews. During construction, this position is responsible for development and qualification of operational processes, procedures, operational readiness and staff in preparation for startup testing and operations. The minimum qualifications for this position are a Bachelors degree (or equivalent) and four years of related experience. During the operations phase, this position is responsible for operation of the facility; therefore, responsibilities and qualifications for this position will be reestablished prior to initiation of facility operation.

4.1.8 MFFF Licensing & Safety Analysis Manager

The MFFF Licensing & Safety Analysis Manager is responsible for planning and execution of MOX Fuel Project licensing activities, including interfaces with regulatory agencies, and directs the development of the Integrated Safety Analysis. This function is responsible for the direct interface with the U.S. Nuclear Regulatory Commission (NRC) and support of project change control reviews. The minimum qualifications for this position are a Bachelors degree (or equivalent) and four years of experience in engineering, licensing, or operations of nuclear facilities.

4.1.9 MFFF Engineering Manager

The MFFF Engineering Manager is responsible for the MFFF process and facility design, including establishment of design requirements and development and maintenance of design control procedures; construction management and constructability reviews during design; and design support. He is responsible for directing the efforts of the following functions (described in more detail in the following sections): Facilities Design, Process Design, Manufacturing Design, Software Design, Procurement Engineering, Site Engineering, and Systems Engineering. The minimum qualifications for the MFFF Engineering Manager are a Bachelors degree (or equivalent) in engineering or science, four years of experience in the design of nuclear facilities, and three years of experience in engineering management. The minimum qualifications for managers implementing the functions directed by the MFFF Engineering Manager are a Bachelors degree (or equivalent) in engineering or science and four years of related experience, at least two of which must be in the design of nuclear facilities.

4.1.9.1 MFFF Facility Design Function

The MFFF Facility Design function is responsible for the design of the facility and site-related interfaces for the MFFF, including structural, mechanical, electrical, instrumentation and control, nuclear, and safeguards and security design disciplines.

4.1.9.2 MFFF Process Design Function

The MFFF Process Design function is responsible for the design of the MFFF aqueous polishing and mixed oxide processes and for the development of systems and equipment specifications.

4.1.9.3 MFFF Software Design Function

The MFFF Software Design function is responsible for the design of the software needed to operate the control systems for the MFFF.

4.1.9.4 MFFF Procurement Engineering Function

The MFFF Procurement Engineering function is responsible for developing the detailed design/build and fabrication procurement specifications for the MOX process and aqueous polishing equipment.

4.1.9.5 MFFF Manufacturing Design Function

The MFFF Manufacturing Design function is responsible for the development of detailed design drawings of the MOX process and aqueous polishing gloveboxes including internal equipment.

during operations. The Plant Manager would be responsible for the overall safety, operation, and maintenance of the MFFF in accordance with the NRC license. The Plant Manager will report to the President of DCS. The President will manage the affairs of the Corporation.

As the construction of systems is completed, the systems will undergo acceptance testing as necessary, followed by turnover from the construction organization to the operations organization. The turnover will include the physical systems and corresponding design information and records. Following turnover, the operations organization will be responsible for system maintenance and configuration management. The design basis for the facility is maintained during the transition from construction to operations through the configuration management system described in Section 15.2.

4.4 INTERFACES

DCS is the licensee responsible for producing the detailed design of the MFFF and for operation of the facility. The management organization of DCS is discussed in Section 4.1. DCS establishes the interface points and requirements with SRS and ensures that the MFFF design is integrated appropriately into the SRS infrastructure.

The National Nuclear Security Administration (NNSA) facilitates the interface with DOE's Savannah River Operations Office (DOE-SR) and other SRS organizations such as the U.S. Forest Service, the SRS security contractor, and other service providers to DOE-SR such as South Carolina Electric & Gas (SCE&G). NNSA and DOE-SR also provide interfaces with respect to integration with SRS' emergency planning and response programs, worker training, and control of the SRS site (i.e., facilitating DCS' ability to remove or exclude personnel and property from the MFFF controlled area as necessary). In conjunction with NNSA and DOE-SR, the SRS Management and Operating (M&O) contractor is responsible for providing the utilities required to operate the MFFF and for receiving and treating the waste generated by the MFFF, and provides various support to DCS in areas such as site infrastructure, utilities, waste management, emergency services, site transportation, security, and training.

Interfaces between DCS and NNSA (along with DOE-SR) are controlled via DCS' contract with technical direction provided by the NNSA office in DOE Headquarters. The interfaces between DCS and the SRS M&O contractor are described through a Work Task Agreement (WTA) process administered by the NNSA (along with DOE-SR). Design-phase work task agreements are controlled, and are updated as appropriate for construction and operations. Interfaces subject to this process include various utilities, emergency services, waste management, and other infrastructure elements.

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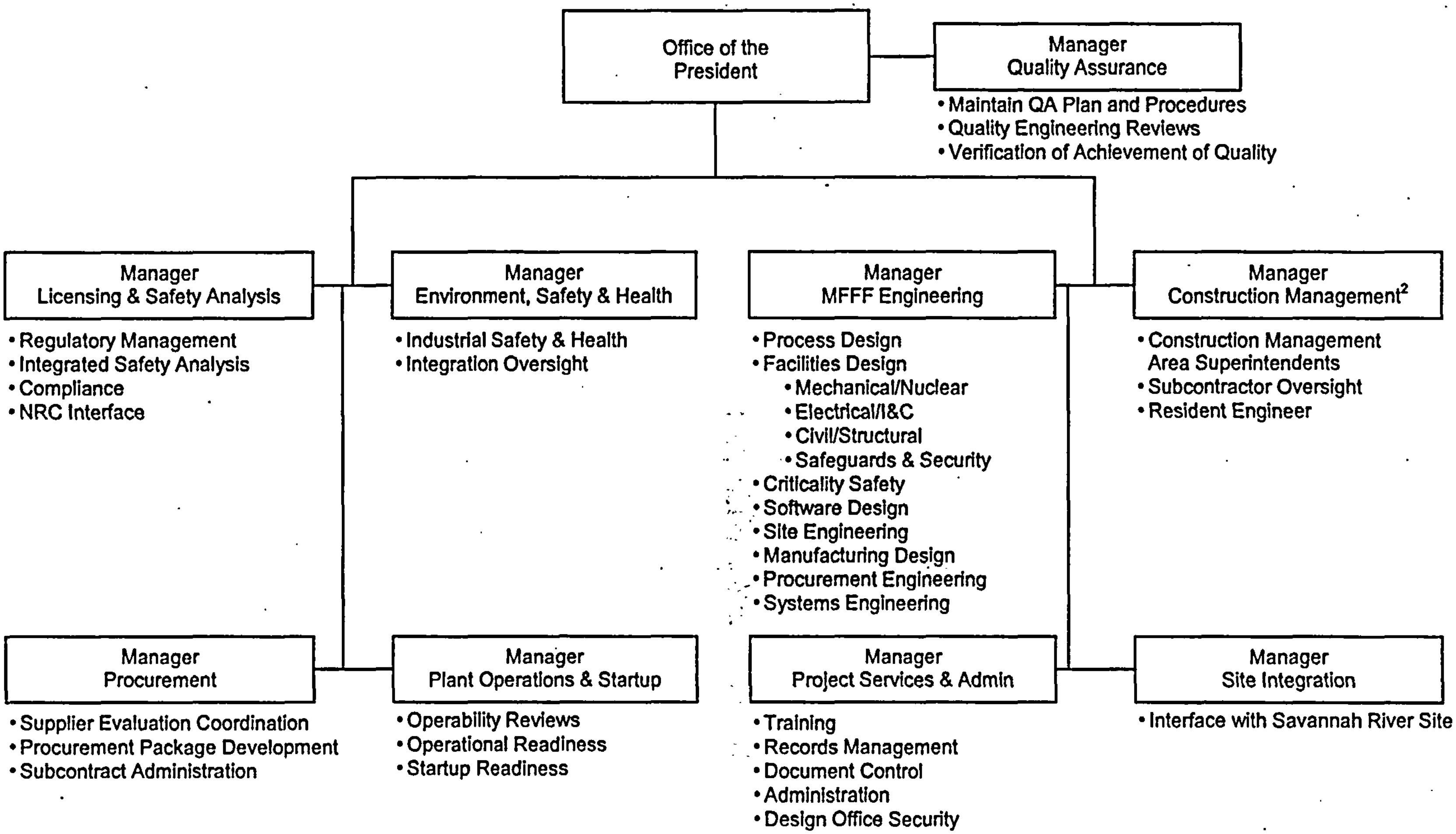

Figure 4-1. DCS Functional Organizational Structure During Design and Construction[1]

[1] Non-MFFF/non-safety functions not shown include: Lead Assembly, Fuel Qualification, Irradiation, Packaging & Transportation, Project Controls, and Outreach

[2] All functions provide support to Construction Manager during construction

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those containing flammable, explosive, and reactive chemicals. Fires are also hypothesized to occur in specific areas where fire accelerants may be present (e.g., combustible solvents). These areas are limited to specific vessels containing solvents in the AP Solvent Recovery Cycle and the AP Purification Cycle. Equipment hypothesized to operate at high temperatures also presents fire hazards. This equipment includes the following:

- Calcination furnace of the AP Oxalic Precipitation and Oxidation Unit
- Electrolyzers of the AP Dissolution Units
- Evaporators of the AP Acid Recovery Unit and the AP Oxalic Mother Liquor Recovery Unit
- Furnace of the MP Sintering Unit
- Welder of the MP Cladding and Decontamination Unit
- Grinder of the MP Grinding Unit
- Torches, heating plates, and evaporators found in the AP/MP laboratory.

In the absence of controls, these areas are more susceptible to an internal fire event than other areas due to their inclusion of at least one of the three elements necessary and sufficient for the development of a fire (i.e., fuel, oxygen, and applied heat). Additional information regarding the locations of fire hazards throughout the MFFF is presented in Chapter 7.

5.5.2.2.4 Unmitigated Event Consequences

Unmitigated event radiological consequences are established for each of the identified hazard events. These consequences are used to establish the need for the application of principal SSCs.

It is conservatively assumed that all of the material at risk within the fire area is involved in the fire. Fire areas are defined as areas that restrict the spread of fires such that they may be modeled as individually isolated areas. Fire areas are isolated through the use of fire barriers.

The radioactive material at risk within each fire area is provided in The site fire areas (defined in Chapter 7) and the radioactive material within each fire area listed in Table 5.5-3b provide the basis for this radiological consequence analysis. Chapter 7 also provides a general discussion of the criteria and justification for containing fires within the fire areas.

5.5.2.2.5 Unmitigated Event Likelihood

The likelihood of occurrence of unmitigated fire events was qualitatively and conservatively assessed. All unmitigated event likelihoods were assumed to be Not Unlikely. Consequently, no postulated fires resulting from internally generated failures were screened due to likelihood considerations.

5.5.2.2.6 Safety Evaluation

This section presents information on event grouping, safety strategies, principal SSCs, and safety function. The selection of event groupings for fire events is based on the potentially common

*Text removed under 10 CFR 2.390.

radiological prevention and mitigation features afforded by specific fire areas, confinement zones, and confinement types (e.g., 3013 canisters). Consequently, the following event groupings are identified:

- AP process cells
- AP/MP C3 glovebox areas
- C1 and/or C2 areas:
  - 3013 canister
  - 3013 transport cask
  - Fuel rod
  - MOX fuel transport cask
  - Waste container
  - Transfer container
  - Final C4 HEPA filter
- Outside the MOX Fuel Fabrication Building
- Facilitywide systems
- Facility.

Table 5.5-12 presents a mapping of hazard assessment events to their respective groups. The event representing the bounding unmitigated radiological consequence for each of the respective event groups is identified. It should be noted that hazard assessment events bounded by the event identified with the largest radiological consequence may require the same safety strategy and analogous principal SSCs to satisfy the performance requirements of 10 CFR §70.61. In this manner, fire events are ensured adequate protection.

The following sections describe the safety evaluation for the respective groupings of fire event groups. Tables 5.5-13a and 5.5-14 summarize the principal SSCs and the safety function for the facility worker, and the IOC and site worker, respectively. Table 5.5-13b summarizes the results of the evaluation for the protection of the environment. Principal SSCs listed in Table 5.5-13b are required only to make the event unlikely.

The FHA is part of the ISA and is an ongoing process during design. For a description of the relationship between the FHA and the ISA, see Chapter 7.

5.5.2.2.6.1 AP Process Cells

Fires are postulated in the AP process cells due to the presence of solvents and other chemicals with flash points that potentially could be exceeded. The AP process cell containing * in the largest radiological consequence and is thereby taken as the bounding fire event for this event group. Although this cell contains a fire was conservatively hypothesized to occur in this cell.

To reduce the risk to the IOC, site worker, facility worker, and the environment associated with the fire events within the AP process cells, a safety strategy utilizing prevention features is adopted. The principal SSC identified to implement this safety strategy is the use of process cell

*Text removed under 10 CFR 2.390.

the final C4 HEPA filters. Events associated with this event type are covered in the other event groups covered in this section.

To reduce the risk to the facility worker, site worker, the IOC, and the environment associated with the first event type in this event group, prevention features are utilized. The principal SSC identified to implement this safety strategy is combustible loading controls. Combustible loading controls are required to limit the quantities of combustibles in the filter area to ensure that the final C4 HEPA filters are not adversely impacted by a fire in the filter room.

The C3 confinement system provides defense-in-depth protection to mitigate the potential consequences for the IOC, the site worker, and the environment.

5.5.2.2.6.4 Outside the MOX Fuel Fabrication Building

Fires outside the MOX Fuel Fabrication Building, but on the MFFF site, could impact the MOX structures containing radioactive material. To reduce the risk to the IOC, site worker, facility worker, and the environment associated with these postulated events, a safety strategy utilizing mitigation features is adopted. The principal SSCs identified to implement this safety strategy are the MOX Fuel Fabrication Building structure, the Emergency Generator Building structure, the waste transfer line, and the Emergency Control Room Air-Conditioning System. The safety function of the MOX Fuel Fabrication Building structure and the Emergency Generator Building structure is to ensure that the structure is designed to withstand external fires and protect principal SSCs and support systems. [*Text removed under 10 CFR 2.390.] The safety function of the Emergency Control Room Air-Conditioning System is to ensure habitable conditions for operators.

5.5.2.2.6.5 Facilitywide Systems

Fires are postulated in facilitywide systems that contain or handle radioactive material. The bounding radiological consequence for this event is associated with the pneumatic pipe automatic transfer system.

To reduce the risk to the facility worker and environment associated with this event group, a safety strategy utilizing mitigation features is adopted. The principal SSCs identified to implement this safety strategy are facility worker action and combustible loading controls. The safety function of the facility worker action principal SSC is to ensure that facility workers take proper actions to limit radiological exposure as the result of fire. The safety function of the combustible loading controls is to limit the quantity of combustibles in a fire area containing a pneumatic system to ensure that this system is not adversely impacted by a fire.

Due to the low consequences of this event, no principal SSCs are required to protect the IOC and site worker. However, the C3 confinement system and the C2 confinement system passive boundary provide defense-in-depth protection for the IOC, site worker, and the environment.

5.5.2.2.6.6 Facility

Fires that may propagate from one fire area to another or that may encompass the entire facility have been postulated. To reduce the risk to the IOC, site worker, facility worker and the environment associated with these postulated events, a safety strategy utilizing prevention features is adopted. The principal SSC identified to implement this safety strategy is the fire barriers. The safety function of the fire barriers is to ensure that the fire is contained to a fire area. Additionally, as described in Chapter 7, fire suppression and detection systems are provided as necessary to provide defense-in-depth protection. It should be noted that as part of the fire protection program, combustibles are controlled to ensure the fire barrier ratings are adequate. Furthermore, fire propagation through the pneumatic transfer tubes is under evaluation, and IROFS will be added, as appropriate, to prevent the propagation of hot gas/vapor and smoke between interconnected gloveboxes.

In addition, facility worker action is identified as a principal SSC to protect the facility worker. The safety function of this principal SSC is to ensure that facility workers take proper actions to limit radiological exposure as the result of fire.

5.5.2.2.6.7 AP Electrolyzer

A titanium fire involving the AP Electrolyzer is postulated. The titanium fire is postulated to result in an energetic breach of the AP Electrolyzer and the dispersal of radioactive materials.

To reduce the risk to the facility worker, the IOC, the site worker, and the environment associated with this event, a safety strategy utilizing preventive features is adopted. The principal SSCs identified to implement this strategy are maintenance activity controls and the Process Safety Control Subsystem. The safety function of the maintenance activity controls is to isolate power from the electrolyzer when the electrolyzer is drained. The safety function of the Process Safety Control Subsystem is to monitor the electrolyzer for faults that could result in arcing or other imparting of electrical energy with the risk of titanium fire. In addition, the following are PSSCs associated with the electrolyzer for the prevention of titanium fires:

- Administrative controls associated with isolation of power to the electrolzer when the electrolyzer is drained
- Sintered silicon nitride barrier between anode and cathode
    - Physically separates cathode from anode in the nitric acid solution by serving as a dielectric barrier
- Polytetrafluroethylene insulator (PTFE)
    - Provides insulation/separation between the cathode and anode structures
    - Provides insulation/separation between the anode and the ground
- Guide sleeves
    - Insulation material used as guide sleeves between the anode and the titanium shell will be identified during the ISA process. The sleeves will be capable of withstanding the environmental conditions associated with being submerged in the electrolyzer fluid. If appropriate, a maintenance/change out frequency will be established.
- Electrolyzer structure
    - Seismically designed
    - Withstands turbulent flow and will not induce vibrations
    - Maintains geometry (geometrically safe for criticality purposes)

The C3 confinement system, the C4 confinement system, and the fire suppression and detection systems provide defense-in-depth protection to mitigate potential consequences to the IOC, the site worker and the environment.

5.5.2.2.7 Mitigated Event Consequences

Mitigated event consequences for the bounding radiological fire event are addressed in Section 5.5.3.

5.5.2.2.8 Mitigated Event Likelihoods

The likelihood of mitigated events is discussed in Section 5.5.4.

5.5.2.2.9 Comparison to 10 CFR §70.61 Requirements

The SA evaluates a comprehensive list of potential fire-related events. Based on the results of the bounding consequence analysis and the effective application of the principal SSCs identified in Section 5.5.2.2.6, the risks from fire-related events satisfy the performance requirements of 10 CFR §70.61.

5.5.2.3 Load Handling Events

5.5.2.3.1 General Description

A load handling hazard is postulated from the presence of lifting or hoisting equipment used during either normal operations or maintenance activities. A load handling event could occur when either the lifted load is dropped or the lifted load or the loading equipment impacts other nearby items containing radioactive materials.

A load handling event could have the following consequences:

- Possible damage to handled loads, resulting in dispersal of radioactive and/or chemical materials
- Possible damage to nearby equipment or structures, resulting in a loss of confinement and/or a loss of subcritical conditions
- Possible damage to process equipment or structures relied on for safety.

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The extent and magnitude of the damage depends on several variables, such as handling height, load weight, and load rigidity.

5.5.2.3.2 Causes

Causes identified for load handling events at the MFFF buildings include the following:

- Failure of handling equipment to lift or support the load
- Failure to follow designated load paths
- Toppling of loads.

5.5.2.3.3 Specific Locations

Load handling events are hypothesized to occur both inside and outside of gloveboxes and in C2 areas where loads may be lifted or moved during both normal operations and potential maintenance activities. These events could also occur in the AP process cells. Finally, load handling events are also hypothesized to occur outside the

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5.5.2.3.4 Unmitigated Event Consequences

Unmitigated event radiological consequences have been established for load handling events identified in the hazard assessment. These consequences were used to establish the need for the application of principal SSCs.

5.5.2.3.5 Unmitigated Event Likelihood

The likelihood of occurrence of unmitigated load handling events was qualitatively and conservatively assessed: all unmitigated event likelihoods were assumed to be Not Unlikely. Consequently, no postulated internally generated failures were screened due to likelihood considerations.

5.5.2.3.6 Safety Evaluation

This section presents information on event grouping, safety strategies, principal SSCs, and safety function. The selection of the event groupings for load handling events is based on the confinement area and confinement type utilized, if applicable. Thus, within the C1 and/or C2 confinement areas, 3013 canisters, 3013 transport casks, fuel rods, MOX fuel transport casks, waste containers, transfer containers, and final C4 HEPA filters are identified as event groups. An additional event group has been identified to represent an impact that could potentially affect multiple confinement areas or types. The event group names are as follows:

- AP process cells
- AP/MP C3 glovebox areas
- C1 and/or C2 areas:
  - 3013 canister
  - 3013 transport cask

- Fuel rod
- MOX fuel transport cask
- Waste container
- Transfer container
- Final C4 HEPA filter

- C4 confinement
- Outside the MOX Fuel Fabrication Building
- Facilitywide.

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For each event group, the event representing the bounding unmitigated radiological consequence was identified. It should be noted that hazard assessment events bounded by the event identified with the largest radiological consequence may require the same safety strategy and analogous principal SSCs to satisfy the performance requirements of 10 CFR §70.61. In this manner, load handling events are ensured adequate protection.

The following sections describe the safety evaluation for the respective load handling event groups. Tables 5.5-16a and 5.5-17 summarize the results of the evaluation for the facility worker, and the IOC and site worker, respectively. Table 5.5-16b summarizes the results of the evaluation for the protection of the environment. Principal SSCs listed in Table 5.5-16b are required only to make the hypothesized event unlikely.

5.5.2.3.6.1 AP Process Cells

A load handling event is postulated within the AP process cells. The event with the bounding radiological consequences for this event group has been identified to occur within the AP cell containing [*Text removed under 10 CFR 2.390.] The resulting load handling event is postulated to result in a and subsequent release The vessels contained in this process cell are assumed to be impacted by either a lifting device or a lifted load causing their contents to drop/spill to the floor.

To reduce the risk to the site worker, the IOC, the facility worker, and the environment associated with this postulated event group, a safety strategy utilizing mitigation features is adopted. The principal SSCs identified to implement this safety strategy are the process cell for the facility worker and the process cell exhaust system for the site worker, the IOC, and the environment. The safety function of the process cell is to contain fluid leaks (e.g., through the use of drip trays) within the process cells. The safety function for the process cell exhaust system is to ensure that a negative pressure exists between the process cell areas and the C2 area and to ensure that the process cell exhaust is effectively filtered. Process cell entry controls are also identified as a principal SSC for the facility worker. The safety function of the process cell entry controls is to prevent the entry of personnel into process cells during normal operations, thus no load handling occurs in a process cell during normal operations. Additionally, process cell entry controls ensure that facility workers do not receive a radiological exposure in excess of limits while performing maintenance in the AP process cells.

The C2 confinement system passive boundary provides defense in depth protection for the IOC, the site worker, and the environment.

5.5.2.3.6.4 C4 Confinement

Load handling events are postulated within AP/MP gloveboxes without impacting the glovebox. These load handling events represent a set of off-normal conditions in which spills, leaks, etc., introduce radioactive material into the glovebox environment but do not result in a challenge to the static confinement of the glovebox. The event identified with the bounding radiological consequences involves the spill of unpolished plutonium powder inside a glovebox.

To reduce the risk to the site worker, the IOC, the facility worker, and the environment associated with this event group, a safety strategy utilizing mitigation features is adopted. The principal SSC identified to implement this safety strategy is the C4 confinement system. The safety function of the C4 confinement system is to ensure that C4 exhaust is effectively filtered. The C4 confinement system also functions to maintain a negative glovebox pressure differential between the glovebox and the interfacing system.

The C3 confinement system provides defense-in-depth protection to the IOC, the site worker, and the environment.

5.5.2.3.6.5 Outside the MOX Fuel Fabrication Building

A load handling event is postulated outside the MOX Fuel Fabrication Building. The bounding radiological event identified for this event group is a load handling event involving [*Text removed under 10 CFR 2.390.]

To reduce the risk to the IOC, the site worker, facility worker, and the environment, a safety strategy utilizing prevention features is adopted. The principal SSC identified to implement this safety strategy is the waste transfer line. The safety function of the waste transfer line is to ensure that it is protected from activities taking place outside the MOX Fuel Fabrication Building.

5.5.2.3.6.6 Facilitywide

This event group represents load handling events in which heavy loads or load handling equipment damages principal structures or primary confinement boundaries of the MOX Fuel Fabrication Building or causes damage to the confinement types discussed in Section 5.5.2.3.6.

To reduce the risk to the IOC, site worker, facility worker, and the environment associated with this postulated event, a safety strategy utilizing prevention features is adopted. The principal SSCs identified to implement this safety strategy are the MOX Fuel Fabrication Building structures and material handling controls. The safety function of the MOX Fuel Fabrication Building structures is to ensure that structures are qualified for load drops that could potentially impact radioactive material. The safety function of the material handling controls is to prevent load handling events that could breach primary confinements.

5.5.2.3.7 Mitigated Event Consequences

Mitigated event consequences for the bounding radiological load handling event are addressed in Section 5.5.3.

5.5.2.3.8 Mitigated Event Likelihood

The likelihood of mitigated events is discussed in Section 5.5.4.

5.5.2.3.9 Comparison to 10 CFR §70.61 Requirements

The SA evaluates a comprehensive list of load handling events. Based on the results of the bounding consequence analysis and the effective application of the principal SSCs identified in Section 5.5.2.3.6, the risks from load handling events satisfy the performance requirements of 10 CFR §70.61.

5.5.2.4 Explosion Events

5.5.2.4.1 General Discussion

Explosive events within the MFFF could result from the presence of potentially explosive mixtures [*Text removed under 10 CFR 2.390.] , steam over-pressurizations, and other potential over-pressurization events. These explosion/overpressurization events could either directly or indirectly involve radioactive material (i.e., an explosion may occur in a tank containing radioactive material or in a surrounding tank, which may impact the radioactive material). These events have the potential to release radioactive material and to damage nearby equipment relied on for safety. The major consequences of explosive events are as follows:

- Release of nuclear materials or chemicals to the environment
- Damage to a confinement boundary
- Damage to equipment contributing to dynamic confinement
- Loss of subcritical conditions
- Damage to civil structures
- Damage to other principal SSCs.

These explosion/overpressurization events are postulated to occur inside the MOX Fuel Fabrication Building from process operations, outside the MOX Fuel Fabrication Building from nearby support facilities and the storage of chemicals on the MFFF site, and from laboratory operations.

5.5.2.4.2 Causes

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5.5.2.4.6.2 Steam Explosion

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To reduce the risk to the IOC, site worker, facility worker, and the environment associated with this postulated explosion group, a safety strategy utilizing prevention features is adopted. The principal SSC identified to implement this safety strategy is the process safety control subsystem. The safety function of the process safety control subsystem is to ensure

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5.5.2.4.6.3 Radiolysis Induced Explosion

Within the MFFF processes, hydrogen is generated as a result of radiolysis of water or other hydrogenous materials. Radiolysis occurs mainly within the AP process where materials in process equipment are exposed to radiation fields and hydrogen is released. Radiolysis may also occur in other locations where waste and byproducts (e.g., contaminated organic waste or organic-additive-bearing scraps) are contained in closed containers. If not removed, the hydrogen can accumulate and present an explosion hazard.

To reduce the risk to the IOC, site worker, facility worker, and the environment associated with this postulated explosion group, a safety strategy utilizing prevention features is adopted. The principal SSCs identified to implement this safety strategy are the offgas treatment system and dilution air provided by the instrument air system. In addition, waste containers (utilized to transfer contaminated organic waste, organic-additive-bearing scraps in closed containers, and other liquid waste) are designated as principal SSCs for protection of the site worker, facility worker, and the environment. The safety function of the instrument air system is to provide sufficient scavenging air to dilute the hydrogen generated during radiolysis such that explosive concentrations of hydrogen do not occur. See Section 11.9 for additional details. The safety function of the offgas treatment system is to provide an exhaust path for the removal of this diluted hydrogen gas in process vessels. The safety function of the waste containers is to ensure that hydrogen buildup in excess of explosive limits does not occur while providing appropriate confinement of radioactive material.

5.5.2.4.6.4 HAN Explosion

Hydroxylamine nitrate (HAN) and nitric acid are used in the AP process to strip plutonium from the solvent after removal of americium, gallium, and other impurities at the extraction step. Hydrazine nitrate is used in conjunction with HAN to impede the HAN reaction with nitrous acid and consequently increase the HAN availability for the plutonium (IV) reduction. Within the AP process, the HAN/hydrazine nitrate and hydrazoic acid (a byproduct of the nitrous acid reaction with hydrazine nitrate) are destroyed in the purification cycle oxidation column, CLMN 6000, and recycling tanks, to prevent the propagation of these reactants, via the aqueous phase, to downstream process units and to the front end of the purification cycle (PULS2000). In addition to the HAN/hydrazine nitrate solution utilized in the AP process, HAN is present within the AP area in a storage tank containing hydroxylamine solution with nitric acid. This tank is used to feed HAN to the AP process.

The HAN interaction with nitrous acid can, under specific conditions discussed below, create an autocatalytic reaction that could result in an explosion and/or over-pressurization event. Control of systems containing both HAN and nitrous acid (i.e., such that nitrous acid concentration does not increase) may be performed either by:

- utilizing a reducing agent (e.g., hydrazine nitrate) that consumes nitrous acid at a rate faster than the rate at which it is being produced by HAN and metal catalyzed reactions, or
- maintaining the temperature, metal impurities, nitric acid concentration, and the HAN concentration within a specified regime for systems not containing hydrazine nitrate.

Another means of contending with HAN-nitrous acid reactions is to ensure that the system is designed for the conditions resulting from the non-autocatalytic reaction between HAN and nitrous acid.

The design basis values for concentrations and temperatures to preclude an autocatalytic reaction between HAN and nitric acid are:

Temperature	≤ 50 °C
HNO_3	≤ 6 M
HAN	≤ 2.5 M
N_2H_4	≥ 0.10 M
Pu	Not limited

A sensitivity analysis indicates the following regarding the above design basis values:

- The system is insensitive to nitrous acid from concentrations ranging from 1×10^{-4} to 1×10^{-2} M. That is, the system is stable for all credible nitrous acid concentrations in the aqueous phase.
- For fixed concentrations of HAN, hydrazine, and nitric acid (e.g., parameters taken at their respective design basis values), the system is stable up to a temperature of 68 °C.
- For fixed temperature, hydrazine concentration, and nitric acid concentrations at their respective design basis values, the system is stable for all HAN concentrations.
- For fixed temperature, nitric acid concentration and all HAN concentrations at their respective design basis values, the system is stable with a minimum of 0.001 M hydrazine utilizing a nitrous concentration of 1×10^{-4} M.

- For temperature and hydrazine concentration at their respective design basis values, the system is stable for all HAN concentrations as long as the nitric acid concentration is less than 7.3 M.

The principal SSCs that are implemented into the MFFF design to preclude the autocatalytic reaction of HAN with nitrous acid are represented by two cases:

- Process vessels containing HAN and hydrazine nitrate without addition of NO_x;
- Process vessles containing HAN and hydrazine nitrate with addition of NO_x.

Each of these cases is described below.

5.5.2.4.6.4.1 Process Vessels Containing HAN and Hydrazine Nitrate Without Addition of NO_X

In AP process vessels where HAN has been introduced to reduce the plutonium valence from IV to III (e.g., pulse column PULS3000 of the purification cycle), a preventative safety strategy is adopted to reduce the risk to the facility worker, site worker, public, and environment from an over-pressurization/explosion resulting from a potential autocatalytic HAN/nitric acid reaction. The principle SSCs to implement this safety strategy are the process safety control subsystem and chemical safety controls. The safety function of the process safety control subsystem is to ensure that the temperature of the solution containing HAN is limited to temperatures that are within safety limits. The safety function of the chemical safety controls is to ensure that the concentration of nitric acid, hydrazine, metal impurities and HAN introduced into the process is within the established design basis limits.

An additional concern in systems composed of HAN and nitric acid, is the possible concentration of HAN and nitric acid due to long term evaporation and/or depletion of hydrazine via radiolysis thereby changing the concentrations of the reagents. To preclude unacceptable changes in the reagent(s) concentrations the chemical safety control subsystem is implemented as a principal SSC. The safety function of the chemical safety control subsystem is to administratively ensure that the concentrations of HAN, nitric acid, and hydrazine are maintained within their respective safety limits by limiting the residence time of solutions containing HAN in contact with nitric acid and/or plutonium bearing solutions.

5.5.2.4.6.4.2 Process Vessels Containing HAN and Hydrazine Nitrate With Addition of NO_X

In the AP purification cycle, vessels designed to receive NO_x for reaction with hydrazine nitrate, HAN, and hydrazoic acid include the oxidation column KPA CLMN6000 and a recycling tank, KPA TK9500. Unlike other AP process vessels, these vessels are designed to eliminate hydrazine nitrate, HAN, and hydrazoic acid via reaction with excess nitrous acid produced from the introduction of NO_x. The temperature and pressure rise in these vessels as a result of these reactions is dependent on the concentrations of the reagents introduced into these vessels and the vent size of these vessels.

To reduce the risk of an over-pressurization/explosion event in these operations to the facility worker, site worker, IOC, and the environment, a preventative safety strategy is adopted. The principle SSCs utilized to implement this safety strategy are chemical safety control(s) and the off-gas treatment system. The safety function of chemical safety control is to limit the concentration of the HAN, hydrazine nitrate, nitric acid, and hydrazoic acid in the system ensuring the potential heat evolution and pressure increase do not exceed the design capabilities of the process vessel. The safety function of the off-gas treatment system is to provide an exhaust path for the removal of off-gases generated during the decomposition of these chemicals, which provides a means for heat transfer/pressure relief for affected process vessels.

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5.5.2.4.6.5 Hydrogen Peroxide Explosion

A solution of 10 wt % hydrogen peroxide is used in the dissolution units. Explosive vapors can be produced from concentrated solutions higher than 75 wt %. To reduce the risk to the facility worker, site worker, IOC, and the environment associated with this postulated explosion group, a safety strategy utilizing prevention features is adopted. The principal SSC identified to implement this safety strategy is chemical safety control. The safety function of chemical safety control is to ensure that explosive concentrations of hydrogen peroxide do not occur. Details of this event are presented in Section 8.5.

5.5.2.4.6.6 Solvent Explosion

Some units within the AP process are fed with solvent. The potential for explosions exists due to high process temperatures and the possible attainment of a flammable/explosive mixture in the gaseous phase due to excessive heating. Solvent explosions resulting from chemical interactions with strong oxidizers are discussed in the following section. Section 8.5 presents more details related to this event.

To reduce the risk to the facility worker, site worker, IOC, and the environment associated with this postulated event, a safety strategy utilizing prevention features is adopted. The principal SSCs identified to implement this safety strategy are the process safety control subsystem, process cell fire prevention features, and the offgas treatment system. The safety function of the process safety control subsystem is to ensure the temperature of the solutions containing solvents do not exceed the temperature at which the resulting gaseous phase becomes flammable. The safety function of the process cell fire prevention features is to ensure that fires in process cells are highly unlikely. The safety function of the offgas treatment system is to provide an exhaust path for the removal of gases in process vessels thereby ensuring that an explosive buildup of vapors does not occur.

5.5.2.4.6.7 TBP – Nitrate (Red Oils) Explosion

The acid-catalyzed hydrolysis of TBP and subsequent oxidation of the associated by-products introduces the risk of a runaway reaction and associated over-pressurization event. This risk exists in AP process units that may contain these by-products and reach high temperatures (e.g., acid recovery unit, oxalic mother liquors recovery unit, purification cycle and solvent recovery unit). These energetic reactions may involve TBP, nitric acid, plutonium nitrate TBP adduct, and TBP degradation products due to chemical reactions (nitration/oxidation/hydrolysis) and radiolysis. Runaway reactions involving TBP and nitric acid are referred to as "red-oil reactions."

To reduce the risk to the facility worker, site worker, IOC, and the environment, a preventative safety strategy is adopted. To implement this preventative safety strategy, principal SSCs are established to control the rate of energy production from the exothermic chemical reactions and the amount of energy liberated from the system (e.g., heat transfer). By ensuring that the rate of energy generation does not exceed the rate of heat removal, such runaway reactions are prevented. The principal SSCs established to implement this safety strategy are the offgas treatment system, the process safety control subsystem, and chemical safety control. These

The Chapter 8 chemical consequence analysis includes releases of nitric acid at elevated temperatures from the AP process. Since these chemical releases are accompanied by a release of radioactive material, the previously discussed principal SSCs that protect the facility worker from radioactive material releases also provide protection for chemical releases. Thus, no additional principal SSCs are required for these events.

Dinitrogen tetroxide is stored in the Reagents Processing Building in liquefied form and passes through a vaporizer, also located in the Reagents Processing Building, where it is converted to gaseous nitrogen dioxide and other NOx gases prior to entry into the aqueous polishing area. Under normal operations, these gases are reacted with the hydrazine, HAN, and hydrazoic acid that are present with plutonium nitrate in the oxidation column of the Purification Cycle of the Aqueous Polishing process. If these gases or the unreacted nitrogen dioxide/dinitrogen tetroxide gases are released from the stack the consequences to all potential receptors are acceptable (no offgas treatment assumed).

However, if the process fails (e.g., the flow of plutonium nitrate with hydrazine, HAN, and hydrazoic acid is abnormally terminated to the oxidation column) and/or the nitrogen dioxide/dinitrogen tetroxide supplied to the oxidation column flows at an abnormally high rate, then there is the potential for chemical consequences associated with the release of these gases that may have come into contact with licensed materials to be unacceptable to the site worker. To reduce the risk to the site worker, a safety strategy utilizing mitigation features is adopted. The principal SSC identified to implement this safety strategy is the process safety control subsystem. The safety function of the process safety control subsystem is to ensure the flow of nitrogen dioxide/dinitrogen tetroxide is limited (e.g., by active flow controls) to the oxidation column such that chemical consequences to the site worker are acceptable.

Fires in the could result in unacceptable chemical consequence to the facility worker and the site worker. To reduce the risk to these receptors, a safety strategy utilizing mitigation features is adopted. The principal SSCs identified to implement this safety strategy are combustible loading controls and facility worker action. The safety function of the facility worker action principal SSC is to ensure that facility workers take proper actions to limit chemical consequences as a result of a fire. The safety function of combustible loading controls is to limit the quantity of combustibles in the secured warehouse to ensure that any fire that may occur will not encompass [*Text removed under 10 CFR 2.390.]

Any additional chemical impacts created by this event group are similar to those discussed in Sections 5.5.2.10.6.1 and 5.5.2.10.6.2. Table 5.5-24 summarizes the chemical event groupings, principal SSCs, and associated safety functions.

Although not required to limit the chemical consequences of a leak to satisfy the requirements of 10 CFR §70.61, leak detection is provided for the process cells.

5.5.2.10.7 Mitigated Event Consequences

The mitigated event consequences for these events are low (see Chapter 8 for a discussion of chemical consequences).

5.5.2.10.8 Mitigated Event Likelihoods

The likelihood of mitigated events is discussed in Section 5.5.4.

5.5.2.10.9 Comparison to 10 CFR §70.61 Requirements

The SA evaluates chemical-related events. Based on the results of the bounding consequence analysis and the effective application of the principal SSCs identified in Section 5.5.2.10.6, the risks from chemical-related events satisfy the performance requirements of 10 CFR §70.61.

5.5.2.11 Low Consequence Events

This section presents the events that have been screened from further evaluation due to the unmitigated radiological consequences satisfying the low dose limits (less than intermediate) established by 10 CFR §70.61.

Conservative unmitigated radiological consequences have been established for each of the events included in this screened category utilizing the methodology of Section 5.4.4. The unmitigated event consequences have been evaluated to be low to the IOC, site worker, facility worker, and the environment for each of the events considered in this section. Table 5.5-25 lists the events that have been screened based on low consequences.

Unmitigated quantitative consequences to the site worker and the IOC as a result of these events have been conservatively analyzed to fall clearly into the low category. The unmitigated dose consequences to the facility worker have been qualitatively determined to be low. The basis for this qualitative assessment is that many of these events involve one of the following:

- Small quantities of material at risk
- Material with a low specific activity (e.g., depleted uranium)
- Material not easily converted into respirable airborne particulate (i.e., small release fractions)
- Liquid–liquid interfaces where mass transfer rates are small
- Decay heat insufficient to result in radiological consequences.

Evaluations of events and consequences are limited to the time that the radwaste is under the responsibility of DCS. The scope of the analysis is terminated once DOE takes responsibility for

Table 5.5-13a. Fire Event - Summary of Principal SSCs - Facility Worker (continued)

Event Group	Principal SSC	Safety Function
C1 and/or C2 Areas - Transfer Container	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing transfer containers to ensure that the containers are not adversely impacted by a fire.
C1 and/or C2 Areas - Final C4 HEPA Filter	Combustible Loading Controls	Limit the quantity of combustibles in the filter area to ensure that the final C4 HEPA filters are not adversely impacted by a fire in the filter room.
Outside MOX Fuel Fabrication Building	MOX Fuel Fabrication Building Structure	Maintain structural integrity and prevent damage to internal SSCs from external fires.
	Emergency Generator Building Structure	Maintain structural integrity and prevent damage to internal SSCs from fires external to the structure.
	Emergency Control Room Air Conditioning System	Ensure habitable conditions for operators
		[*Text removed under 10 CFR 2.390.]
Facilitywide Systems	Facility Worker Action	Ensure that facility workers take proper actions to limit radiological exposure.
	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing a pneumatic system to ensure that this system is not adversely impacted by a fire.
Facility	Fire Barriers	Contain fires within a single fire area
	Facility Worker Action	Ensure that facility workers take proper actions to limit radiological exposure.
AP Electrolyzer	Maintenance Activity Controls	Isolation of power to the electrolyzer when the electrolyzer is drained
	Process Safety Control Subsystem	Monitor the electrolyzer for electrical faults that could result in arcing or other imparting of electrical energy with the risk of titanium fire
	Sintered silicon nitride barrier	Physically separate cathode from anode
	Polytetrafluroethylene insulator	Provide insulation/separation between anode and cathode and between anode and the ground
	Guide sleeves	Provide insulation between the anode and the shell
	Electrolyzer structure	Withstand turbulent flow, not induce vibrations

Table 5.5-13b. Summary of Principal SSCs for Environmental Protection From Fire Events

Event Group	Principal SSC	Safety Function
AP Process Cells	Process Cell Fire Prevention Features	Ensure that fires in the process cells are unlikely.
AP/MP C3 Glovebox Areas	C3/C4 Confinement Systems	Remain operable during design basis fire and effectively filter any release.
	Fire Barriers	Contain/limit fires to a single fire area
	Combustible Loading Controls [For Storage Gloveboxes ONLY]	Limit the quantity of combustibles in fire areas containing a storage glovebox such that any fire that may occur will not encompass a large fraction of the stored radiological material.
C1 and/or C2 Areas - 3013 Canister	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing 3013 canisters to ensure that the canisters are not adversely impacted by a fire.
C1 and/or C2 Areas - 3013 Transport Cask	3013 Transport Cask	Withstand the design basis fire without breaching.
	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing 3013 transport casks to ensure that the cask design basis fire is not exceeded.
C1 and/or C2 Areas - Fuel Rod	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing fuel rods to ensure that the fuel rods are not adversely impacted by a fire.
C1 and/or C2 Areas - MOX Fuel Transport Cask	MOX Fuel Transport Cask	Withstand the design basis fire without breaching.
	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing MOX fuel transport casks to ensure that the cask design basis fire is not exceeded.

Table 5.5-13b. Summary of Principal SSCs for Environmental Protection From Fire Events (continued)

Event Group	Principal SSC	Safety Function
C1 and/or C2 Areas - Waste Container	None Required	N/A
C1 and/or C2 Areas - Transfer Container	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing transfer containers to ensure that the containers are not adversely impacted by a fire.
C1 and/or C2 Areas - Final C4 HEPA Filter	Combustible Loading Controls	Limit the quantity of combustibles in the filter area to ensure that the C4 final HEPA filters are not impacted by a filter room fire.
Outside MOX Fuel Fabrication Building	MOX Fuel Fabrication Building Structure	Maintain structural integrity and prevent damage to internal SSCs from external fires.
	Emergency Generator Building Structure	Maintain structural integrity and prevent damage to internal SSCs from fires external to the structure.
	Emergency Control Room Air Conditioning System	Ensure habitable conditions for operators
		[*Text removed under 10 CFR 2.390.]
Facility Wide Systems	Combustible Loading Controls	Limit the quantity of combustibles in areas containing the pneumatic transfer system to ensure this system is not adversely impacted
Facility	Fire Barriers	Contain fires within a single fire area
AP Electrolyzer	Maintenance Activity Controls	Isolation of power to the electrolyzer when the electrolyzer is drained
	Process Safety Control Subsystem	Monitor the electrolyzer for electrical faults that could result in arcing or other imparting of electrical energy with the risk of titanium fire
	Sintered silicon nitride barrier	Physically separate cathode from anode
	Polytetrafluroethylene insulator	Provide insulation/separation between anode and cathode and between anode and the ground
	Guide sleeves	Provide insulation between the anode and the shell
	Electrolyzer structure	Withstand turbulent flow, not induce vibrations

Table 5.5-14. Fire Event - Summary of Principal SSCs - IOC and Site Worker

Event Group	Principal SSC	Safety Function
AP Process Cells	Process Cell Fire Prevention Features	Ensure that fires in the process cells are highly unlikely
AP/MP C3 Glovebox Areas	C3/C4 Confinement Systems	Remain operable during design basis fire and effectively filter any release.
	Fire Barriers	Contain/limit fires to a single fire area
	Combustible Loading Controls [For Storage Gloveboxes ONLY]	Limit the quantity of combustibles in fire areas containing a storage glovebox such that any fire that may occur will not encompass a large fraction of the stored radiological material.
C1 and/or C2 Areas - 3013 Canister	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing 3013 canisters to ensure that the canisters are not adversely impacted by a fire.
C1 and/or C2 Areas - 3013 Transport Cask	3013 Transport Cask	Withstand the design basis fire without breaching.
	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing 3013 transport casks to ensure that the cask design basis fire is not exceeded.
C1 and/or C2 Areas - Fuel Rod	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing fuel rods to ensure that the fuel rods are not adversely impacted by a fire.
C1 and/or C2 Areas - MOX Fuel Transport Cask	MOX Fuel Transport Cask	Withstand the design basis fire without breaching.
	Combustible Loading Controls	Limit the quantity of combustibles in a fire area containing MOX fuel transport casks to ensure that the cask design basis fire is not exceeded.

Table 5.5-14. Fire Event - Summary of Principal SSCs - IOC and Site Worker (continued)

Event Group	Principal SSC	Safety Function
C1 and/or C2 Areas - Waste Container	None Required	N/A
C1 and/or C2 Areas - Transfer Container	Combustible Loading Controls[a]	Limit the quantity of combustibles ina fire area containing transfer containers to ensure that the containers are not adversely impacted by fire
C1 and/or C2 Areas - Final C4 HEPA Filter	Combustible Loading Controls	Limit the quantities of combustibles in the filter area to ensure that the C4 final HEPA filters are not impacted by a filter room fire.
Outside MOX Fuel Fabrication Building		[*Text removed under 10 CFR 2.390.]
	Emergency Control Room Air Conditioning System	Ensure habitable conditions for operators
	MOX Fuel Fabrication Building Structure	Maintain structural integrity and prevent damage to internal SSCs from external fires.
	Emergency Generator Building Structure	Maintain structural integrity and prevent damage to internal SSCs from fires external to the structure.
Facilitywide Systems	None Required	N/A
Facility	Fire Barriers	Contain fires within a single fire area
AP Electrolyzer	Maintenance Activity Controls	Isolation of power to the electrolyzer when the electrolyzer is drained
	Process Safety Control Subsystem	Monitor the electrolyzer for electrical faults that could result in arcing or other imparting of electrical energy with the risk of titanium fire
	Sintered silicon nitride barrier	Physically separate cathode from anode
	Polytetrafluroethylene insulator	Provide insulation/separation between anode and cathode and between anode and the ground
	Guide sleeves	Provide insulation between the anode and the shell
	Electrolyzer structure	Withstand turbulent flow, not induce vibrations

[a] Required for IOC only

Table 5.5-15. Mapping of Hazard Assessment Events to Load Handling Event Groups

Event Group	Event Description	Hazard Assessment Event
AP Process Cells	Load Handling Events within an AP Process Cell	AP-27*, AP-43
AP/MP C3 Glovebox Areas	Load Handling Events in C3b/glovebox areas	PT-10, GB-8, GB-9*
C1 and/or C2 Areas – 3013 Canister	Load Handling Events within the C2 areas involving 3013 canisters	RC-12*
C1 and/or C2 Areas - 3013 Transport Cask	Load Handling Events involving 3013 Transport Cask	RC-17*
C1 and/or C2 Areas – Fuel Rod	Load Handling Events in the C2 areas involving fuel rods.	AS-7*, AS-9*, RD-10
C1 and/or C2 Areas - MOX Fuel Transport Cask	Load Handling Event involving MOX Fuel Cask	AS-14*
C1 and/or C2 Areas - Waste Container	Loading Handling events in the C2 areas involving Waste Containers	AS-12*, MA-11, RC-15, WH-8
C1 and/or C2 Areas – Transfer Containers	Load Handling Events in the C2 areas involving Transfer Containers	FW-20*
C1 and/or C2 Areas - Final C4 HEPA Filter	Load Handling Events involving the final C4 HEPA filters	HV-15*
C4 Confinement	Leaks or spills within a glovebox	AP-36*, GB-10, RC-7
Outside MOX Fuel Fabrication Building	Load handling events occurring outside the AP/MP Buildings	SF-14*
Facilitywide	Load Handling Events that impact and damage the internal or external MFFF structure	FW-15*, FW-21, RC-13, HV-14, AS-8, RD-9, FW-17

* Hazard assessment event with bounding consequences for this event group.

Table 5.5-19. Principal SSCs and Associated Safety Functions for all Receptors for the Explosion Event Type (continued)

Explosion Group	Principal SSC	Safety Function
HAN Explosion [Process vessels containing HAN and hydrazine nitrate with NO_x addition]	Chemical Safety Control	Ensure concentrations of HAN, hydrazine nitrate, and hydrazoic acid are controlled to within safety limits
	Offgas Treatment System	Provide an exhaust path for the removal of gases in process vessels
Hydrogen Peroxide	Chemical Safety Control	Ensure that explosive concentrations of hydrogen peroxide do not occur
Solvent Explosion	Process Safety Control Subsystem	Ensure the temperature of solutions containing solvents is limited to temperatures within safety limits
	Process Cell Fire Prevention Features	Ensure that fires in process cells are highly unlikely
	Offgas Treatment System	Provide an exhaust path for the removal of gases in process vessels
TBP – Nitrate (Red Oil) Explosion	Offgas Treatment System	Provide an exhaust path for aqueous phase evaporative cooling in process vessels, thereby providing a mechanism for heat removal
		Provide venting of vessels/equipment that potentially contain TBP and its associated by-products to prevent over-pressurization in the case of excessive oxidation of TBP and/or its degradation products
	Process Safety Control Subsystem	Ensure the temperature of solutions containing organic is restricted to temperatures within safety limits in order to limit the rate of energy generation. Ensure that the design basis heatup rate is not exceeded Limit the residence time of organics in process vessels containing oxidizing agents and potentially exposed to high temperatures and in radiation fields

Table 5.5-19. Principal SSCs and Associated Safety Functions for all Receptors for the Explosion Event Type (continued)

Explosion Group	Principal SSC	Safety Function
TBP – Nitrate (Red Oil) Explosion (continued)	Chemical Safety Control	Ensure a diluent is used that does not contain cyclic chain hydrocarbons
AP Vessel Over-Pressurization	Fluid Transport Systems	Ensure that vessels, tanks, and piping are designed to prevent process deviations from creating over-pressurization events
	Offgas Treatment System	Provide an exhaust path for the removal of gases in process vessels
	Chemical Safety Control	Ensure control of the chemical makeup of the reagents and ensure segregation/ separation of vessels/components from incompatible chemicals
Pressure Vessel Over-Pressurization	Pressure Vessel Controls	Ensure primary confinements are protected from the impact of pressure vessel failures (bulk gas, breathing air, service air and instrument air systems)
Hydrazoic Acid Explosion	Chemical Safety Control	Ensure the proper concentration of hydrazine nitrate is introduced into the system Ensure that hydrazoic acid is not accumulated in the process or propagated to units that might lead to explosive conditions
	Process Safety Control Subsystem	Ensure the temperature of solutions potentially containing hydrazoic acid is limited to prevent an explosive concentration of hydrazoic acid from developing

Table 5.5-24. Principal SSCs and their Safety Functions for the Chemical Event Type

Event Group	Principal SSCs	Safety Function
Events involving only hazardous chemicals not produced from licensed material	Emergency Control Room Air Conditioning System	Ensure habitable conditions for operators
Events involving only hazardous chemicals produced from licensed material	Process Cell Entry Controls	Prevent the entry of personnel into process cells during normal operations
		Ensure that workers do not receive a chemical consequence in excess of limits while performing maintenance in the AP process cells
	Facility Worker Action	Ensure that facility workers take proper actions to limit chemical consequences for leaks occurring in C3 ventilated areas
	C4 Confinement System	Contain a chemical release within a glovebox and provide an exhaust path for removal of the chemical vapors
Events involving hazardous chemicals and radioactive material	See SSCs proposed for other event types	N/A
	Process Safety Control Subsystem	Ensure the flow rate of nitrogen dioxide/ dinitrogen tetroxide is limited to the oxidation column of the purification cycle
	Combustible Loading Controls	Limit the quantity of combustibles in the secured warehouse to ensure that any fire that may occur will not encompass [*Text removed under 10 CFR 2.390.]
	Facility Worker Action	Ensure that facility workers take proper actions to limit chemical consequences [*Text removed under 10 CFR 2.390.]

Table 5.5-25. Low Consequence Screened Hazard Assessment Events

Loss of Confinement Events	Fire Events	Load Handling Events
AP-21	MA-3	FW-16
AP-46	RC-2	RC-11
AS-3		SF-13
AS-4		
FW-7		
FW-8		
FW-12		
GH-14		
HV-3		
HV-4		
HV-6		
HV-10		
HV-11		
RC-6		
RD-4		
RD-5		

Table 5.6-1. MFFF Principal SSCs (continued)

Principal SSC	**Safety Function**	**SA Design Basis Reference**
Combustible Loading Controls*	Limit the quantities of combustibles in the filter area to ensure that the C4 final HEPA filters are not adversely impacted by a filter room fire	5.6.2.2
	Limit the quantity of combustibles in fire areas containing a storage glovebox and the secured warehouse such that any fire that may occur will not encompass a large fraction of the stored radiological material.	
	Limit the quantity of combustibles in a fire area containing 3013 canisters to ensure that the canisters are not adversely impacted by a fire	
	Limit the quantity of combustibles in a fire area containing 3013 transport casks to ensure that the cask design basis fire is not exceeded	
	Limit the quantity of combustibles in a fire area containing fuel rods to ensure that the fuel rods are not adversely impacted by a fire	
	Limit the quantity of combustibles in a fire area containing MOX fuel transport casks to ensure that the cask design basis fire is not exceeded	
	Limit the quantity of combustibles in a fire area containing transfer containers to ensure that the containers are not adversely impacted by a fire	
	Limit the quantity of combustibles in areas containing the pneumatic transfer system to ensure this system is not adversely impacted	
Criticality Control	Prevent criticality events	6.4
Double-Walled Pipe	Prevent leaks from pipes containing process fluids from leaking into C3 areas	11.8.7
Electrolyzer structure	Withstand turbulent flow, not induce vibrations	5.5.2

Table 5.6-1. MFFF Principal SSCs (continued)

Principal SSC	Safety Function	SA Design Basis Reference
Emergency AC Power System	Provide AC power to emergency DC system battery charger	11.5.7
	Provide AC power to emergency diesel generator fuel oil system	
	Provide AC power to high depressurization exhaust system	
	Provide AC power to C4 confinement system	
	Provide AC power to emergency control room air-conditioning system	
	Provide AC power to emergency diesel generator ventilation system	
	Provide AC power to emergency control system	
	Provide AC power to seismic monitoring system and seismic isolation valves	
	Provide AC power to Process Cell Exhaust System	
Emergency Control Room Air-Conditioning System	Ensure habitable conditions for operators	11.4.11
Emergency Control System	Provide controls for high depressurization exhaust system	11.6.7
	Provide controls for C4 confinement system	
	Provide controls for emergency control room air-conditioning system	
	Provide controls for emergency AC system	
	Provide controls for emergency DC system	
	Provide controls for emergency generator ventilation system	
	Provide controls for emergency diesel generator fuel oil system	
	Shut down process on loss of power	
	Shut down and isolate process and systems, as necessary, in response to an earthquake	
	Provide controls for Process Cell Exhaust System	

Table 5.6-1: MFFF Principal SSCs (continued)

Principal SSC	Safety Function	SA Design Basis Reference
Emergency DC Power System	Provide DC power for high depressurization exhaust system	11.5.7
	Provide DC power for C4 confinement system	
	Provide DC power for emergency AC power system controls	
	Provide DC power for emergency control room air-conditioning system	
	Provide DC power for emergency control system	
	Provide DC power for emergency generator ventilation system	
	Provide DC power to Process Cell Exhaust System	
Emergency Generator Building Structure	Maintain structural integrity and prevent damage to internal SSCs from external fires, external explosions, earthquakes, extreme winds, tornadoes, missiles, rain, and snow and ice loadings	11.1.7
Emergency Generator Ventilation System	Provide emergency diesel generator ventilation	11.4.11
Emergency Diesel Generator Fuel Oil System	Provide emergency diesel generator fuel oil for the emergency diesels	11.5
Facility Worker Action*	Ensure that facility worker takes proper action to limit chemical and radiological exposure	5.6.2.6
Facility Worker Controls*	Ensure that facility workers take proper actions prior to bag-out operations to limit radiological exposure.	5.6.2.9
	Ensure that facility workers take proper actions during maintenance activities to limit radiological exposure.	5.6.2.9
Fire Barriers	Contain fires within a single fire area	7.5.3
Fire Detection and Suppression	Support fire barriers as necessary	7.5.3

Table 5.6-1. MFFF Principal SSCs (continued)

Principal SSC	Safety Function	SA Design Basis Reference
Fluid Transport Systems	Ensure that vessels, tanks, and piping are designed to prevent process deviations from creating over-pressurization events	11.8.7
	Withstand as necessary the effects of the DBE such that confinement of radionuclides is maintained	11.8.7
Glovebox	Maintain confinement integrity for design basis impacts	11.4.11
Glovebox Pressure Controls	Maintain glovebox pressure within design limits	11.4.11
Guide Sleeves	Provide insulation between anode and shell	5.5.2
Hazardous Material Delivery Controls*	Ensure that the quantity of delivered hazardous material and its proximity to the MOX Fuel Fabrication Building structure, Emergency Generator Building structure, and the [*Text removed under 10 CFR 2.390.] controlled to within the bounds of the values used to demonstrate that the consequences of outside explosions are acceptable.	5.6.2.8
Instrument Air System (Scavenging Air)	Provide sufficient scavenging airflow to dilute the hydrogen produced by radiolysis such that an explosive condition does not occur	11.9.5
Laboratory Material Controls*	Minimize quantities of hazardous chemicals in the laboratory	5.6.2.7
	Minimize quantities of radioactive materials in the laboratory	5.6.2.7
Maintenance Activity Controls	Isolation of power to the electrolyzer when the electrolyzer is drained	5.6.2.10
Material Handling Controls*	Ensure proper handling of primary confinement types outside of gloveboxes	5.6.2.3
	Ensure that design basis lift heights of primary confinement types (3013 canister, 3013 transport cask, MOX fuel transport cask, and transfer containers) are not exceeded	
	Prevent load handling activities that could potentially lead to a breach in the final C4 HEPA filters	

Table 5.6-1. MFFF Principal SSCs (continued)

Principal SSC	Safety Function	SA Design Basis Reference
Material Handling Controls*	Prevent impacts to the glovebox during normal operations from loads outside or inside the glovebox that could exceed the glovebox design basis	5.6.2.3
	Prevent potential overpressurization of the reusable plutonium oxide cans, due to radiolysis or oxidation of Pu (III) oxalate, and its subsequent impact to the glovebox	
	Prevent load handling events that could breach primary confinements	
Material Handling Equipment	Limit damage to fuel rods/assemblies during handling operations	11.7.7
	Prevent impacts to the glovebox through the use of engineered equipment	
Material Maintenance and Surveillance Programs*	Detect and limit the damage resulting from corrosion	5.6.2.4
MFFF Tornado Dampers	Protect MFFF ventilation systems from differential pressure effects of the tornado	11.4.11
Missile Barriers	Protect MOX Fuel Fabrication Building and Emergency Generator Building internal SSCs from damage caused by tornado- or wind-driven missiles	11.1.7
MOX Fuel Fabrication Building Structure (including vent stack)	Maintain structural integrity and prevent damage to internal SSCs from external fires, external explosions, earthquakes, extreme winds, tornadoes, missiles, rain, and snow and ice loadings	11.1.7
	Withstand the effects of load drops that could potentially impact radiological material	
MOX Fuel Transport Cask	Withstand the design basis fire without breaching	11.4.11
	Withstand the effects of design basis drops without release of radioactive material	
Offgas Treatment System	Provide an exhaust path for the removal of gases in process vessels	11.4.11

Table 5.6-1. MFFF Principal SSCs (continued)

Principal SSC	Safety Function	SA Design Basis Reference
Offgas Treatment System	Provide an exhaust path for aqueous phase evaporative cooling in process vessels, thereby providing a mechanism for heat removal	8.5 and 11.4.11
	Provide venting of vessels/equipment that potentially contain TBP and its associated byproducts to prevent over-pressurization in the case of excessive oxidation of TBP and/or its degradation products	8.5 and 11.4.11
PTFE Insulator	Provide insulation/separation between anode & cathode and anode and ground	5.5.2
Pressure Vessel Controls*	Ensure that primary confinements are protected from the impact of pressure vessel failures (bulk gas, breathing air, service air, and instrument air systems)	11.9.5
Process Cells	Contain fluid leaks within process cells	11.4.11
Process Cell Entry Controls*	Prevent the entry of personnel into process cells during normal operations	5.6.2.5
	Ensure that workers do not receive a radiological or chemical exposure in excess of limits while performing maintenance in the AP process cells	
Process Cell Fire Prevention Features	Ensure that fires in the process cells are highly unlikely	7.5.3
Process Cell Exhaust System	Effectively filter process cell exhaust	11.4.11
	Operate to ensure that a negative pressure exists between the process cell areas and the C2 areas	
Process Safety Control Subsystem		System design basis provided in 11.6.7. As necessary, basis for parameters provided as shown
	Prevent the formation of an explosive mixture of hydrogen within the MFFF facility associated with the use of the hydrogen-argon gas	8.5
	Ensure isolation of sintering furnace humidifier water flow on high water level	11.4.11 (See Sintering Furnace)
	Ensure the temperature of solutions containing HAN is limited to temperatures within the safety limits	8.5

Table 5.6-1. MFFF Principal SSCs (continued)

Principal SSC	Safety Function	SA Design Basis Reference
Process Safety Control Subsystem (continued)	Control the flowrate into the oxidation column	8.5
	Ensure the temperature of solutions containing organic is restricted to temperatures within safety limits in order to limit the rate of energy generation	8.5
	Limit the residence time of organics in process vessels containing oxidizing agents and potentially exposed to high temperatures and in radiation fields	8.5
	Ensure the temperature of solutions potentially containing hydrazoic acid is limited to prevent an explosive concentration of hydrazoic acid from developing	8.5
	Limit and control conditions under which dry-out can occur	8.5
	Ensure the temperature of solutions potentially containing metal azides is insufficient to overcome the activation energy needed to initiate the energetic decomposition of the azide	8.5
	Ensure the normality of the nitric acid is sufficiently high to ensure that the offgas is not flammable and to limit excessive hydrogen production	8.5
	Warn operators of glovebox pressure discrepancies prior to exceeding differential pressure limits	11.4.11
	Shut down process equipment prior to exceeding temperature safety limits	11.4.11
	Ensure the temperature of solutions containing solvents is limited to temperatures within safety limits	8.5
	Ensure the flow rate of nitrogen dioxide/ dinitrogen tetroxide is limited to the oxidation column of the purification cycle	8.5
	Ensure that the design basis heatup rate is not exceeded	8.5

Table 5.6-1. MFFF Principal SSCs (continued)

Principal SSC	Safety Function	SA Design Basis Reference
Process Safety Control Subsystem (Continued)	Monitor the electrolyzer for faults that could result in arcing or other imparting of electrical energy with the risk of initiation of titanium fire	11.6.7 System Description – 11.3.2.4
Seismic Monitoring System and Associated Seismic Isolation Valves	Prevent fire and criticality as a result of an uncontrolled release of hazardous material and water within the MFFF Building in the event of an earthquake	11.6.7 – for system 11.8.7 – for valves
Sintered silicon nitride barrier	Physically separate cathode from anode	5.5.2
Sintering Furnace	Provide a primary confinement boundary against leaks into C3 areas	11.4.11
Sintering Furnace Pressure Controls	Maintain sintering furnace pressure within design limits	11.4.11
Supply Air System	Provide unconditioned emergency cooling air to the storage vault and designated electrical rooms	11.4.11
Transfer Container	Withstand the effects of design basis drops without breaching	11.4.11
Waste Containers	Ensure that hydrogen buildup in excess of limits does not occur while providing appropriate confinement of radioactive materials	11.4.11
	[*Text removed under 10 CFR 2.390.]	10.5
	[*Text removed under 10 CFR 2.390.]	10.5

* Administrative control

Table 5A-7. Unmitigated Events, Assembly Workshop (continued)

Event Type/Workshop or Location/ Event Number	Unmitigated Event Description/Specific Location/Hazard Sources	Cause
Load Handling MFFF-Assembly Workshop AS-9 E-6	The drop of an assembly (or assemblies) onto the floor or onto another assembly while utilizing hoisting equipment results in breach of confinement, and dispersal of radiological materials. Specific Location: Assembly Packaging Assembly Mockup Loading Assembly Handling and Storage Assembly Mounting Unit Assembly Dry Cleaning Assembly Dimensional Inspection Assembly Final Inspection Mode: Normal Operation Hazard Sources: Radiological Material (maximum inventory of two fuel assemblies)	1. Human error or equipment failure
Load Handling MFFF-Assembly Workshop AS-12 E-6	A container of contaminated or radioactive material (i.e., a waste drum) fails or is damaged while being handled by miscellaneous handling devices and results in breach of the container and the dispersal of radiological materials. Specific Location: Assembly Packaging (Truck Bay) Mode: Normal Operation Hazard Sources: Radiological Material (maximum inventory in container)	1. Human error or equipment failure during waste drum handling operations

Table 5A-7. Unmitigated Events, Assembly Workshop (continued)

Event Type/Workshop or Location/ Event Number	Unmitigated Event Description/Specific Location/Hazard Sources	Cause
Load Handling MFFF-Assembly Workshop AS-14 E-6	The drop of an assembly transport package onto the floor while utilizing hoisting equipment results in breach of confinement, and dispersal of radiological materials. Specific Location: Assembly Packaging Assembly Packaging (Truck Bay) Mode: Normal Operation Hazard Sources: Radiological Material (maximum inventory of one fuel assembly transport package)	1. Human error or equipment failure

Table 5A-10. Unmitigated Events, Support Facilities Outside MFFF

Event Type/Workshop or Location/ Event Number	Unmitigated Event Description/Specific Location/Hazard Sources	Cause
Internal Fire Support Facilities Outside MFFF SF-1 E-1	A fire (involving diesel fuel storage, gas storage platform, the Reagents Processing Building, etc.) occurs and affects the MFFF Building resulting in structural damage. Specific Location: General Plant and Outside Areas Reagents Processing Building Gas Storage Facility Emergency Diesel Generator Building Standby Diesel Generator Building Secured Warehouse Building Access Control Building Administration Building Technical Support Building Mode: All Hazard Sources: Radiological Material (maximum inventory in MFFF susceptible to the consequences of external fires or explosions)	1. Combustibles and electrical short 2. Combustion of waste from exposure to chemicals 3. Maintenance activities 4. Combustibles and unknown ignition source
Internal Fire Support Facilities Outside MFFF SF-2 E-1	A fire (involving electrical equipment, transient combustibles, etc.) affects outside the AP/MP Building and results in a breach of confinement and the dispersal of hazardous materials potentially impacting the control room operator. Specific Location: General Plant and Outside Areas Mode: All Hazard Sources: Hazardous Material [*Text removed under 10 CFR 2.390.]	1. Combustibles and electrical short 2. Combustibles and unknown ignition source

Table 5A-10. Unmitigated Events, Support Facilities Outside MFFF (continued)

Event Type/Workshop or Location/ Event Number	Unmitigated Event Description/Specific Location/Hazard Sources	Cause
Explosion Support Facilities Outside MFFF SF-3 E-2	An explosion at a nearby support facility [*Text removed under 10 CFR 2.390.] outside the MFFF Building results in structural damage to the MFFF. Specific Location: General Plant and Outside Areas [*Text removed under 10 CFR 2.390.] Mode: All Hazard Sources: Radiological Material (maximum inventory in MFFF susceptible to disruption by structural damage)	combined with electrical short or Combustibles and unknown ignition source 2. Unintended interaction of chemicals which are explosively incompatible 3. Human error or equipment failure
Loss of Confinement / Dispersal of Nuclear Material Support Facilities Outside MFFF SF-14 E-3	A leak or break in an results in a breach of confinement, and the dispersal of radiological materials. Specific Location: [*Text removed under 10 CFR 2.390.] Mode: All Hazard Sources: Radiological Material (maximum inventory of waste tank)	

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As identified in Section 11.4.2.7.4, each emergency control room air intake is continuously monitored for hazardous chemicals. Monitoring will be performed for those chemicals whose unmitigated release could result in control room concentrations above the limits specified in Table 8-5a. The preferred limit is the IDLH value for a chemical as reported by the National Institute of Occupational Safety and Health. If a TEEL-3 value is less than an IDLH value for a given chemical, the TEEL-3 limit will be applied. For a chemical with no IDLH value, a TEEL-2 limit will be applied. Table 8-5a contains all the chemical limits used for the control room consequence assessment and provides the source for the specified limits.

Emergency actions will be initiated prior to reaching the chemical consequence concentration limits. Specific set-points will be determined during final design.

Chemical consequence categories for comparison to 10 CFR §70.61 are provided in Table 8-6.

8.4 CHEMICAL ACCIDENT CONSEQUENCES

8.4.1 Analysis

Consequence analysis follows the guidance found in NUREG/CR-6410. Conservatism is embedded in the source term and the ground-level release models.

The analysis to determine the effects to the IOC is based on the following assumptions:

- A ground level release (conservative);
- No mechanical or buoyancy plume rise (conservative);

- Neutrally buoyant gas model (conservative).

These bounding assumptions envelop uncertainties inherent in realistic analyses.

Data in Tables 8-2a through 8-2d were used to perform chemical consequence analyses associated with the largest credible unmitigated spill or loss of containment accident involving each of these chemicals. Airborne concentrations were calculated at distances correlating to the site worker (100 meters) and the IOC (160 meters). These concentrations were then compared to the TEELs presented in Table 8-5. From this comparison, a consequence category was established (low, intermediate, high) using the guidance outlined in Table 8-6. These consequence categories correspond to those identified in 10 CFR §70.61.

It should be noted that for the chemicals identified in Tables 8-2a through 8-2d whose onsite inventory is not yet established or is based on preliminary data, the analysis is based on a conservative projection for that chemical. Nonhazardous chemicals and gases identified in Table 8-2d were not evaluated. Except for oxygen, exposure to these gases poses an asphyxiant hazard only. Gas concentrations at asphyxiation levels are not credible at the distances corresponding to the CAB. Gas concentrations at asphyxiation levels may be credible for very large leaks at the distance corresponding to the site worker. Oxygen has no established toxicity limit.

Results of the chemical consequences calculation indicate that for all chemicals to which the requirements of 10 CFR §70.61 apply, unmitigated consequence categories fall within the acceptable range for site workers and the IOC, with the exception of those releases described in Section 5.5.2.10.6.3. Thus, no principal SSCs are required for the protection of site workers and the IOC, except as identified in Section 5.5.2.10.6.3.

Nitric acid leaks or spills in the Aqueous Polishing area of the MFFF were also modeled at temperatures up to the boiling point of nitric acid. The evaporation rate of the nitric acid was calculated using airspeeds determined from the air flow rate through the room and the minimal vertical cross-sectional area of the room. The consequences of these nitric acid leaks or spills over the full range of temperatures were calculated to be low for the site worker and the IOC.

Uranium dioxide powder [*Text removed under 10 CFR 2.390.] including evaluations of fire and seismic events, are calculated to be low consequence events for the IOC. Section 5.5 discusses the safety strategy to protect the facility worker and site worker for a fire

[*Text removed under 10 CFR 2.390.]

8.4.3 Uncertainty

Estimates of risks are often accompanied by uncertainty because of the complexity of the postulated scenarios and physical models used to describe them. At this stage of the design, conservative models were utilized for the chemical releases with the intent to bound any anticipated uncertainty. Uncertainties associated with more detailed consequence analyses performed for the ISA will be described in the license application for possession and use of SNM.

8.5 PROCESS SAFETY INFORMATION

8.5.1 Process Safety Controls

The MFFF includes three basic facilities:

- **Reagent Processing Building** – This building is the front end of the process, where reagents for the process are prepared and transported to the processing units.
- **AP Area** – This area is the location of the primary chemical processing (Aqueous Polishing).
- **MP Area** – This area contains the manufacturing unit for the production of fuel assemblies (MOX Process).

Each of these facilities has control requirements that are incorporated into the overall design of the control system for process safety control. The control system will be designed to be available and reliable.

Reagents are stored and chemical mixtures are prepared in the Reagent Processing Building and in the reagent storage area of the AP Area. The AP facility is broken down into process functional units, which are functionally made up of one or more subunits performing elementary unit operations. The breakdown into functional units allows each unit to be operated relatively independently of other functional units.

Process storage and operation conditions are controlled to prevent unintended exothermic and potential autocatalytic reactions in the Reagent Processing Building and AP Area. Autocatalytic and exothermic reactions of chemicals are prevented through control of the process parameters (e.g., reactant concentration, temperature, catalyst concentration in solution, and pressure) that affect the reactions.

Significant chemical-related risks and associated design bases information are discussed in the following sections.

8.5.1.1 Hazards Associated with Hydrogen Gas

This section discusses the hazards associated with hydrogen as used or produced in the various processes within the MFFF. The following text discusses the flammable and explosive nature of hydrogen and provides the basis for the limits to be applied in the design of the processes using or producing hydrogen to assure the risks associated with hydrogen hazards satisfy the performance requirements of 10 CFR §70.61. The subsections that follow this section discuss the specific hazards identified in Section 5.5 associated with hydrogen (i.e., hazards associated with hydrogen-argon mixture in sintering furnace, radiolysis, and electrolysis).

Flammability Phenomena

Hydrogen is flammable over a wide range of concentrations in air. The values typically quoted are for concentrations of hydrogen in air at standard atmospheric temperatures and pressures (i.e., 4% through 74% by volume of hydrogen). The leanest mixture that burns completely is 9%; however, hydrogen flames will propagate in the upward direction at concentrations as low as 4% because of the high diffusivity of hydrogen. The flammability limits of hydrogen have been found to be consistent for gas pressures below 1 atm up to 100 atm.

The flammability limits are affected by temperature and by various concentrations of inert diluents, see Figure 8.5.1.1-1 for gas mixtures containing argon. Increasing the temperature tends to lower the lower flammability limit (LFL) and raise the upper flammability limit (UFL) for hydrogen in air, until the spontaneous ignition temperature is reached. At that point any amount of hydrogen coming into contact with oxygen burns with a slow flame (less than 1 m/s at less than 8% H_2 in air). Increasing the temperature of a mixture of pure hydrogen in air will cause the LFL to decrease from 9 to 5.4%, and the UFL to increase from 74 to 88%. This effect is different when hydrogen is diluted with an inert gas such as argon.

As shown in Figure 8.5.1.1-1, flammable mixtures of hydrogen in air can be made nonflammable by the addition of enough inert gas, such as argon, provided sufficient controls are placed on the environment in which the mixed gas is used. Different diluents have different levels of inerting efficiency which must be accounted for in evaluating the potential risks for creating explosive mixtures.

DCS uses the guidance of NFPA 69-1997 as the design basis for control of flammable mixture concentrations within the AP process vessels. NFPA 69 provides various options to accomplish this, including the following:

- The combustible concentration shall be maintained at or below 60% of the LFL when automatic instrumentation with safety interlocks is provided, or
- The combustible concentration shall be maintained at or below 25% of the LFL.

Explosion Phenomena

Hydrogen gas mixtures can become explosive if a sufficient amount of fuel and oxidant is distributed throughout the mixture while the mixture is not exposed to an ignition source or it is below the spontaneous ignition temperature. Even if the mixture is exposed to an ignition source or raised to high enough temperature, the mixture will only ignite and explode under certain conditions. The explosiveness of the mixture depends on the gas concentration, temperature, pressure (i.e., the flammability limits), the container surface conditions and the container size. Gas concentrations below or above the LFL and UFL are nonexplosive. Because the flammability limits vary with temperature and gas composition, these variables are considered when choosing the applicable lower and upper explosive limits (the LEL and UEL).

Outside of the sintering furnace in the BMP and BAP, the MFFF intends to control combustible gas concentrations to levels below 60% of the LFL to ensure that the LEL is not exceeded and to

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prevent explosions in the BMP and BAP. Inside of the sintering furnace, the MFFF intends to control the combustible gas concentrations to levels above the UFL at high temperatures, prevent or limit the introduction of air or other oxygen sources into the furnace, and to provide enhanced administrative controls during startup and shutdown of the furnace to ensure that the supply of combustible gas is stopped or the furnace is purged of combustible gases whenever the furnace is offline and prior to energizing the resistor heaters.

Explosions due to lean hydrogen concentrations below 8% in air will result in a peak pressure rise slightly above 1 bar (14.5 psi) because the low H_2 concentration does not allow downward propagation of the flame. At slightly higher concentrations of 9 to 10% H_2 (i.e., above the downward lower flammability limit) the peak pressures may be close to 3 to 4 bar (44 to 58 psi). The hydrogen concentration and temperature also play strong roles in determining whether the mixtures burn or explode. Thus, physical structures that mitigate or contain potential explosions are designed with these limits in mind.

Besides increasing the temperature of a combustible hydrogen mixture to above its spontaneous ignition temperature, the mixture can be ignited by a weak spark, such as one caused by the discharge of static electricity from a human body; open flames; hot surfaces or matches. Ignition of a gas mixture can result in the generation of a variety of different combustion regimes ranging from slow flames to detonations. Under certain conditions after ignition, slow flame fronts may be accelerated and transformed into detonations by the phenomenon of flame acceleration (FA) and deflagration to detonation transition (DDT). The conditions necessary to accelerate a flame to detonation are specific to the properties of the burned and unburned gas mixture and the physical layout and dimensions of the containment structure. Explosions may be prevented by controlling critical dimensions in the containment structure or by preventing the conditions necessary to sustain combustion or initiate ignition. Because of the complexity of the internal structures of the sintering furnace, the MFFF intends to prevent these types of explosions by controlling the conditions necessary to support combustion or initiate ignition.

<u>Hydrogen Formation by High Temperature Reactions</u>

Hydrogen can be formed at high temperatures by reactions with burning metals in which the oxygen atoms in the water are stripped off by unoxidized metal, thus releasing free hydrogen atoms. Hydrogen explosions in furnaces processing certain reactive metals (especially titanium) have been reported as a result of this reaction. The sintering furnace only processes a mixture of oxidized forms of uranium and plutonium. Therefore, any water that could come into contact with these oxides from excessive humidity in the process gas will only form steam and is not expected to become dissociated into free hydrogen. Explosions caused by increasing the hydrogen content of the process gas by this mechanism are thus precluded. Chapter 5.5.2.4.6.2 discusses the hazards involved with steam overpressure events.

8.5.1.1.1 Argon-Hydrogen Mixture in Sintering Furnace and Hydrogen Storage

A mixture of argon and hydrogen gas is used in the sintering furnace to provide the required atmosphere for pellet sintering. The gases are mixed outside of the MFFF building in the proper proportion and transferred to the pellet sintering areas via facility piping. Inherent with the use of hydrogen are the associated hazards of fire and explosion. These hazards are present at the gas storage/mixing area, sintering furnace area, furnace gloveboxes and airlocks, sintering furnace exhaust and associated HVAC system, and the sintering furnace itself. Control of the hazards associated with hydrogen in these areas is discussed in the following paragraphs.

Fire and explosion events are prevented in the sintering furnace area, furnace gloveboxes and airlocks, sintering furnace exhaust, and associated HVAC system by the process safety control subsystem. The process safety control subsystem prevents the formation of flammable mixtures of hydrogen. The design basis for this control is 50% of the lower flammability limit (LFL) of hydrogen in air. 50% of the LFL will not be exceeded during normal or off-normal conditions. The LFL is considered the safety limit, while 25% of the LFL is the expected setpoint at which necessary control actions are initiated during normal operations. Actual setpoints will be determined as part of final design.

Fire and explosion events are prevented in the sintering furnace by the use of design features and procedures (administrative controls) that prevent the formation of flammable mixture of hydrogen in air. The basis for these engineered and administrative controls is NFPA 86C, *Industrial Furnaces Using a Special Processing Atmosphere*. As stated in Chapter 7.0, Fire Protection, fire safety for the sintering furnace is in accordance with the applicable requirements of NFPA 86C-1995.

The design bases of PSSCs associated with fire and explosion at the facility gas storage area (external events) are discussed in Section 11.1.7.

8.5.1.1.2 Hydrogen Production due to Radiolysis

Radiolysis is the process of hydrogen gas production by radiolytic dissociation of hydrogenous materials. Within the MFFF process, the hazards associated with radiolysis are present in some AP processes and in some waste drums. The potential for hydrogen production in the MOX process is low due to the negligible quantity of hydrogenous materials.

The design bases associated with the control of the hazards associated with hydrogen gas is in accordance with standard NFPA practices. The lower flammable limit (LFL) is considered the safety limit. This is the value at which an event may occur because the hydrogen concentration may be flammable. 25% of the LFL is the design basis value. This is the value used to design the process and as necessary, is used to initiate control actions during normal operations.

In the AP processes, the risk associated with radiolysis is mitigated by maintaining adequate dilution airflow and ensuring an exhaust path exists. Calculations will be performed as part of detailed design to determine appropriate air flow rates and summarized in the ISA. Should normal airflow be lost to an AP process vessel, emergency scavenging air will be provided as described in Section 11.9. These airflow rates will ensure that 25% of the LFL is not exceeded during normal or off-normal conditions.

Hydrogen production and accumulation may occur in the waste and byproducts, such as contaminated organic waste or organic-additive-bearing waste containing significant amounts of plutonium, scraps in transuranic (TRU) waste containers, and other liquid waste. Where this may become a hazard, the containers are equipped with a filtered vent system that limits hydrogen accumulation by providing an exhaust flow path while maintaining confinement of radioactive materials.

8.5.1.1.3 Hydrogen Production by Electrolysis

The dissolution unit and the dechlorination and dissolution unit utilize a catholyte loop in which nitric acid is used to dissolve plutonium oxide. This electrolytic dissolution process introduces the risk of generating hydrogen gas.

The design bases associated with the control of the hazards associated with hydrogen gas is in accordance with standard NFPA practices. The LFL is considered the safety limit, the value at which an event may occur because the hydrogen concentration may be flammable. 25% of the LFL is the design basis value. This is the value used to design the process and as necessary is used to initiate control actions during normal or off normal operations.

The production of hydrogen during electrolysis is a function of the nitric acid normality. As described in Section 5.5.2.4, the normality of the nitric acid will be maintained sufficiently high to ensure that the off-gas is not flammable. Calculations will be performed as part of detailed design and summarized in the ISA to determine the appropriate nitric acid limits. These limits will ensure that 25% of the LFL is not exceeded during normal or off-normal conditions.

8.5.1.2 Solvent Related Hazards

Some units within the AP process are fed with solvent. The potential for solvent related fires and explosions exists due the possible attainment of a flammable/explosive mixture in the gaseous phase due to excessive heating.

As described in section 5.5.2, a combination of IROFS will be in place to ensure that explosive conditions associated with solvent vapors are prevented from occurring. These IROFS will include controlling the temperature of solutions containing solvents, minimizing the potential ignition sources, and providing an exhaust path for dilution of vapors.

8.5.1.3 Hydroxylamine Nitrate (HAN) and Hydrazine (N_2H_4) in Nitric Media

The Aqueous Polishing (AP) process uses a mixture of hydroxylamine nitrate (HAN) and nitric acid (HNO_3) during the extraction step of the plutonium purification unit (KPA) to strip plutonium from the solvent after removal of americium and gallium. HAN has a number of advantages as a plutonium reductant. It is nonmetallic, it is readily decomposed to innocuous products by heating, the gaseous reaction products – nitrogen (N_2), nitrous oxide (N_2O), and water (H_2O) – contribute to minimization of the volume of solid wastes produced, and it possesses the proper Pu (IV) to Pu (III) reduction attributes. However, due to the potential for HAN to undergo an autocatalytic reaction with nitrous acid under certain conditions, the use of HAN in the AP Process introduces an explosion/overpressure hazard.

Experience and insights gained from previous accidents involving HAN and experimental data from the Hanford and Savannah River sites are utilized in conjunction with La Hague Plant experience to assist in the determination of safe operating conditions for the storage and the handling of HAN, hydrazine and nitric acid.

The HAN-nitric acid system is a complex multi-parametric system involving the interdependence of the following four parameters:

- Chemical concentration of each reactant
- Molar ratio of nitric acid to HAN
- Temperature of the mixture
- Concentration of metal ion catalysts.

A general feature that has characterized many of the previous accidents with HAN mixtures without hydrazine is the inadvertent increase of solution temperature and/or concentration of or an inadvertent acid addition to these solutions. Experimental results indicate that high nitric acid concentrations or the presence of impurities (such as metal ions) increase the likelihood of the initiation of an autocatalytic reaction. Furthermore, for systems without metal catalyst, a trend of decreasing the autocatalytic reaction temperature threshold when increasing the nitric acid to HAN ratio has been found. Maintaining low nitrous acid concentrations has been indicated as important to storage and use of HAN, with respect to autocatalytic reactions. Previous attempts to characterize the stability of a system have examined both experimental and accident conditions in which the concentrations of nitric acid and HAN have increased. In these systems the energy liberated as a result of an autocatalytic reaction also increases as a function of the original energy content of the solution and the initial concentrations of HAN.

To understand the behavior of systems comprised of HAN, hydrazine, plutonium and metal ions with nitric acid, the various associated reactions are modeled. In this manner the kinetic rates for reactions governing production and consumption of nitrous acid are used to describe the stability of the system under normal, abnormal, and accident conditions. The chemical reactions that govern the solutions that may contain HAN include:

- Plutonium (IV) reduction by HAN
- Plutonium (IV) reduction by Hydrazine
- Plutonium (III) Re-oxidation
- HAN reaction with nitrous acid
- Hydrazine reaction with nitrous acid
- Catalyzed Nitrous Reactions with Metal Ions

Additional discussion of the safety strategies and specific controls associated with control of these reactions is found in Section 5.5.

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11.3.2.3.6 Chemical Process Ranges

This section is not applicable to this unit.

11.3.2.3.7 Chemical Process Limits

This section is not applicable to this unit.

11.3.2.4 Dissolution Unit (KDB)

11.3.2.4.1 Function

The primary function of the Dissolution Unit is to dissolve the PuO_2 powder.

11.3.2.4.2 Description

The PuO_2 powder compatible with the dissolution process (i.e., with a chloride concentration of less than 500 µg/g) and compatible with the AP process (i.e., without unacceptable quantities of impurities) is electrolytically dissolved in the Dissolution Unit in preparation for separation of impurities (specifically americium, gallium, and uranium) in the Purification Cycle. The powder from the Decanning Unit dosing hopper is gradually fed into the electrolyzer by the screw conveyor. Samples from the dilution and sampling tank are analyzed to determine the fissile material content and the required degree of dilution before being sent to the Purification Cycle feed tank via the buffer tank TK7000.

The Dissolution Unit consists of a single processing line. Two tanks are also connected to this line to allow for greater process flexibility: one tank (TK4000) is used to collect any overflows from the processing tanks of this dissolution unit and the Dechlorination and Dissolution Unit and the other tank (TK6000) can be used to receive a batch that may not be compatible, unless diluted, with the purification process (i.e., with unacceptable quantities of impurities). The contents of tank TK6000 can be distributed in small fractions (diluted by the main process stream) into the process. The cadmium-lined hopper and the screw conveyor are installed on scales in a glovebox located in the Decanning Unit. The PuO_2 powder is fed into the hopper. The total and the differential weights per unit of time are continuously recorded. The instantaneous flow is computed and compared with the setpoint, and the flow rate is adjusted by varying the speed of the screw.

Ag^{2+} ions are electrolytically produced in the cylindrical electrolysis compartment. The cathode well is fed from a nitric acid slab tank by an airlift via a drip pot. The cathode well overflows into the slab tank via another drip pot. The electrolysis cell solution flows into a complementary pot and the flat powder-receiving compartment. The powder-receiving compartment is connected to the powder feed screw conveyor by a chute, which is provided with a branch for unblocking it, a valve to prevent moisture from rising and powder from falling in after completion of electrolysis, and impacters to facilitate powder transfer to the electrolyzer.

A stirrer is used to continuously circulate the dissolution solution.

- Draining of the anolyte circuit containing the dissolution solutions by pump, through a bag pre-filter and a Poral® filter and to receiving tank TK3000.
- Draining of the cathode well by siphon to receiving tank TK3000.
- Draining of the nitric acid storage tank TK1500 by airlift into tank TK3000.

Receiving tank TK3000

In normal operation, draining solutions received in receiving tank TK3000 are transferred to dilution and sampling tank TK5000 via a pump and filter. Dilution and sampling tank TK5000 is made of 316L stainless steel and has a useful volume of 106 gal (400 L). This tank is used for diluting the dissolution solution to reduce the plutonium and ^{235}U concentrations before feeding the Purification Cycle. Dilution and sampling tank TK5000 is equipped with a depleted uranyl nitrate inlet from the Uranyl Nitrate Reagent System, a nitric acid inlet, an emergency scavenging air inlet, sparging pipes to homogenize the solution, and a sampling line.

possible for batches with low uranium content. The stripped plutonium is diluent washed in pulsed column PULS3100 prior to the final valence adjustment. Remaining traces of unstripped plutonium are extracted in five-stage plutonium barrier mixer-settler MIXS4000. Hydroxylamine nitrate (0.15N HAN) and hydrazine nitrate (0.14N N_2H_4) are introduced via a slightly acidic solution (0.2N HNO_3) in the last stage of the plutonium barrier. Hydrazine nitrate is added to act as an anti-nitrous agent and also to prevent parasitic oxidation of Pu (III) to Pu (IV) in pulsed column PULS3000. The solvent from the plutonium barrier flows to uranium-stripping mixer-settler MIXS5000.

Uranium is stripped in a slightly acidic (0.02N HNO_3) solution in an eight stage uranium-stripping mixer-settler MIXS5000. The unloaded solvent from uranium-stripping mixer-settler MIXS5000 is directed to the Solvent Recovery Cycle. The stripped uranium stream is then diluent washed in the three stage mixer-settler MIXS5100. If an isotopic dilution of the uranium stream is required, the ^{235}U concentration can be decreased by the addition of depleted uranyl nitrate from the Uranyl Nitrate Reagent System in the first stage of uranium-stripping mixer-settler MIXS5000. The aqueous phase from uranium diluent washing is sent to uranium buffer tank TK5200 then stored in tank TK5300 before being sent to the Liquid Waste Reception Unit. Depleted uranyl nitrate can also be added in TK5300 prior to this transfer.

The final valence adjustment of Pu (III) to Pu (IV) is achieved by oxidizing the Pu (III) solution with nitrous fumes in oxidation column CLMN6000. The stripped plutonium is first sent to slab settler SLAB3300 before going to oxidation column CLMN6000 to remove any residual organic materials (e.g., TBP). The settled organic phase is sent to plutonium rework tank TK8500. In the oxidizing step, aqueous plutonium solution is contacted in packed column CLMN6000 with nitrous fumes to oxidize Pu (III) to Pu (IV) and to eliminate excess HAN, hydrazine and hydrazoic acid. Then, air stripping of the plutonium solution in air-stripping column CLMN6500 destroys the remaining nitrous acid. The plutonium nitrate solution is received in plutonium reception tank TK7000 from where it is transferred to the batch constitution tanks of the Oxalic Precipitation and Oxidation Unit. In case of a process deviation, the aqueous phase from tank TK7000 is recycled through tank TK9500 after verification of hydrazine and HAN decomposition.

Tanks TK8000 and TK8500 are installed in the Purification Cycle to permit plutonium rework. These tanks also receive drain solutions from the pulsed columns and mixer settler banks. Tank TK8000 collects solutions that may contain non-extracted metal (e.g., silver) ion species from pulsed columns PULS2000, PULS2100 and PULS2200. Received solutions are then recycled into pulsed column PULS2000. Tank TK8500 collects solutions that may contain HAN, hydrazine, and hydrazoic acid from pulsed columns PULS3000, PULS3100 and PULS3200 and from mixer settlers MIXS4000, MIXS5000 and MIXS5100. The organic phase in tank TK8500 is sent to pulsed column PULS3000 for recycling while the aqueous phase is directed to tank TK9500 to be treated by oxidizing Pu (III) to Pu (IV) by bubbling NO_x through the solution.

The selected aqueous-to-organic ratios in the plutonium extraction and plutonium stripping operations enable the process to obtain a plutonium concentration close to 40 g/L at the outlet of the Purification Cycle.

11.3.2.6.3 Process Chemistry

The following chemical equations describe the primary reactions involved in the Purification Cycle.

The extraction of plutonium from the aqueous phase to the organic phase is based on the formation of a plutonium (IV) nitrate/TBP complex and its very low solubility in aqueous solutions containing moderately strong nitric acid:

$$Pu(NO_3)_4 + 2\,(C_4H_9)_3PO_4 \Rightarrow Pu(NO_3)_4 \bullet 2(C_4H_9)_3PO_4 \qquad (11.3\text{-}11)$$

The extraction coefficient for Pu (IV) in TBP is dependent upon aqueous nitric acid concentration and temperature. The operating conditions for the feed are 4.5N nitric acid concentration and 30°C, which ensure high extraction efficiency. The diluent acts as a low density solvent for the TBP to promote good separation between the aqueous and organic streams. Most impurities remain in the aqueous phase and continue processing in the raffinate stream. Further refinement to improve the quality of plutonium is accomplished by scrubbing the loaded organic with an aqueous solution of 1.5N nitric acid and aluminum nitrate in the scrubbing column.

The relative extraction coefficients for the various valence states of plutonium are as follows: Pu(IV) > Pu(VI) >> Pu(III). Based on the very low extraction coefficient of Pu(III), the reduction of Pu(IV) to Pu(III) will cause a transfer of plutonium back into the aqueous phase in the plutonium stripping column. The plutonium reduction from valence IV to III by HAN proceeds as follows:

$$2NH_3OH^+ + 4\,Pu^{+4} \Rightarrow 4\,Pu^{+3} + N_2O(g) + H_2O + 6\,H^+ \qquad (11.3\text{-}12)$$

$$2NH_3OH^+ + 2\,Pu^{+4} \Rightarrow 2\,Pu^{+3} + N_2(g) + 2\,H_2O + 4\,H^+ \qquad (11.3\text{-}13)$$

These reactions are exothermic, and proceed rapidly. Increases in temperature and concentration increase the reaction rates.

Plutonium reduction by the hydrazine in the stripping solution is also possible by the following reaction; however, this reaction is much slower than those with HAN described above:

$$6\,Pu^{4+} + N_2H_4 + H_2O \Rightarrow 6\,Pu^{3+} + N_2O(g) + 6\,H^+ \qquad (11.3\text{-}14)$$

The parasitic re-oxidation of Pu(III) to Pu(IV) can occur with nitrous acid, which is always present to some extent in nitric acid, as follows:

$$2Pu^{3+} + 2HNO_2 + HNO_3 + 2\,H^+ \Rightarrow 2Pu^{4+} + 3HNO_2 + H_2O \qquad (11.3\text{-}15)$$

Under certain conditions, HAN can be autocatalytically oxidized by nitric acid to produce nitrous acid. This proceeds according to the following reaction:

$$2\,HNO_3 + NH_2OH \Rightarrow 3\,HNO_2 + H_2O \qquad (11.3\text{-}16)$$

containing two stages of HEPA filters), and an exhauster before being released through the stack. Details of the final filtration units are found in Section 11.4.9.

11.3.2.13.3 Process Chemistry

This section is not applicable to this unit.

11.3.2.13.4 Process Equipment

Figure 11.3-23 provides a simplified drawing of the Offgas Treatment Unit.

11.3.2.13.5 Chemical Process Inventories

The normal inventories of radionuclides and chemicals involved in this unit are provided in Tables 11.3-25 and 11.3-26, respectively.

11.3.2.13.6 Chemical Process Ranges

The Offgas Treatment Unit operates continuously. The NO_x scrubbing column is designed to treat approximately 62N m^3/h, including additional air. The designed capacity of the column pulsation air extraction is 150N m^3/h. The main ventilation line (offgas scrubbing and filters) is designed to process approximately 600N m^3/h, including additional air. The main flows of this unit are provided in Table 11.3-27.

11.3.2.13.7 Chemical Process Limits

Normal operating parameters are described in Section 11.3.2.13.6. Principal SSCs are described in Chapter 5. Specific operating limits and the associated IROFS will be provided in the ISA.

11.3.2.14 Liquid Waste Reception Unit (KWD)

The Liquid Waste Reception Unit receives liquid waste from the AP process for temporary storage and pre-treatment before sending it for final treatment and disposal. [*Text removed under 10 CFR 2.390.]

11.3.2.14.1 Function

The Liquid Waste Reception unit is dedicated to the reception, storage, and pre-treatment of the low level, high alpha, stripped uranium and organic waste streams.

- The low level liquid waste stream is comprised of the following: (1) room HVAC condensate, rinsing water from laboratories, and washing water from sanitaries which are potentially non-contaminated and are collected as low –low level liquid waste; (2) the distillate stream from the acid recovery unit which is contaminated and slightly acidic; and (3) miscellaneous floor washes from C2/C3 rooms and overflows or drip tray material from some of the reagent tanks in the AP building.

- The high alpha waste is a combination of three waste streams: americium, alkaline waste and excess acid. The americium stream collects americium and gallium nitrates and all of the silver used in the dissolution unit, along with traces of plutonium. The alkaline waste stream from the solvent recovery unit contains dilute caustic soda, sodium carbonate, sodium azide, and traces of plutonium and uranium. The excess acid stream from the acid recovery unit contains high alpha activity excess acid.

- The stripped uranium (< 1% U-235) waste stream receives the contents of the uranium dilution tanks in the purification cycle.

11.3.2.14.2 Description

Low Level Liquid Waste

Chemical waste tank #1, TK2050, collects overflows/drip tray contents from the de-mineralized water, nitric acid, manganese nitrate, and decontamination solution systems in a common header. It also collects overflows/drip tray contents from the sodium hydroxide and sodium carbonate systems in a separate common header. The tank is equipped with 1.5 N nitric acid and 0.1N sodium hydroxide addition systems for pH adjustment, a cooling loop to provide a means to remove the heat of reaction from acid/alkali reaction, a mixer, MIX2050, to provide agitation to aid mixing in the tank, and a manual sampling point. After pH adjustment, the low level waste is pumped to tank TK1000/TK2000.

Floor wash waste tank TK2060 collects the floor washes from all the uncontaminated C2 and C3 rooms in the AP area. These streams are generated in the course of routine housekeeping activities in these rooms and are separate from the overflows/drip tray streams that are collected in tank TK2050. The tank is equipped with a manual sampling point. The low level waste is periodically pumped to tank TK1000/TK2000.

Chemical waste tank #2, TK2070, is dedicated to oxalic acid service. It collects oxalic acid overflows/drip tray contents. The tank is equipped with a manual sampling point. The low level waste is pumped to portable drums for off-site disposal. The vents from these three tanks are collected in a vent header and routed to a nitric acid system scrubbing column.

Low level waste buffer tanks TK1000 and TK2000 collect the low, low level waste from room HVAC condensate, rinsing water from laboratories, washing water from sanitaries, and the contents of tank TK2060. These tanks also collect the distillate from the acid recovery unit, seal water from the vacuum radiation monitoring system, and the chemical wastes from tank TK2050. Tanks TK1000 and TK2000 operate in parallel. Three way valves are used to direct the flow to one of the two tanks. These tanks serve as buffer tanks and transfer the material to reception tank TK3000 for pH adjustment and sampling. A set of redundant pumps are used for the transfer. Piping and valves around the tanks and pumps allow the tank contents to be re-circulated to the tanks for mixing or to spray nozzles to wash down the tanks from the inside. Mixing is provided using the recirculation stream with an eductor.

In the unlikely event of a release of firewater in the corridors, the firewater drains into a sump. A pump transfers the firewater to tank TK3000 via a seal pot. Tank TK3000 is used to adjust the pH of the material using 1.5N nitric acid and 0.1N sodium hydroxide. A cooling loop provides means to remove the heat of acid/alkali reaction. In-tank mixing is provided using a re-circulation loop with an eductor. After sampling, a pump transfers the tank contents to tank TK4000 which is the final holding point before materials are pumped off-site to Savannah River Site (SRS). If the sampled material in tank TK4000 does not meet the SRS waste acceptance criteria (WAC), the stream may be recycled to acid recovery unit tank TK1500 for further processing.

High Alpha Liquid Waste

Alkaline waste tank TK4010 receives via a steam jet alkaline waste from the solvent recovery unit. Sodium nitrite is then added to TK4010 prior to acidification in TK4015 to destroy the sodium azide. A sampling measurement is then performed to ensure that the azide has been destroyed prior to combining the alkaline waste with other waste streams in TK4030.Americium reception tank TK4020 receives via a steam jet the high americium stream from the acid recovery unit. The excess acid stream from the acid recovery unit is transferred directly to tank TK4030.

The alkaline waste, americium and excess acid streams, are mixed in the batch constitution tank TK4030. Bubbling air is provided to this tank to aid in mixing its contents. The composite stream is referred to as "high alpha liquid waste." The tank is equipped with automatic sampling capabilities and a means to add 1.5N nitric acid for pH adjustment. This stream is transferred via a steam jet to tank TK4040.

The high alpha storage tank TK4040 serves as a holding point and along with TK4050, provides ninety day storage for the high alpha waste. The tank is equipped with automatic sampling capabilities and can transfer its contents via a steam jet to TK4050.

High alpha buffer tank TK4050 is the final holding point before for treatment. A [*Text removed under 10 CFR 2.390.] The tank is provided with a line for low level distillate from the acid recovery unit to rinse

[*Text removed under 10 CFR 2.390.]

All tanks in the high alpha system are vented to the offgas treatment unit's scrubbing column.

Stripped Uranium Liquid Waste

Stripped uranium reception tank TK3010 operates in parallel with tank TK3020 and receives material from the purification unit's isotopic dilution tank. The contents of tanks TK3010 and TK3020 are transferred via steam jet to tank TK3030. Stripped uranium buffer tank TK3030 is equipped automatic sampling capabilities, a means to add 1.5N nitric acid, and bubbling air to aid in mixing the tanks contents. The contents of TK3030 are transferred via steam jet to tank TK3040.

Stripped uranium transfer tank TK3040 is the final holding point before

[*Text removed under 10 CFR 2.390.] The tank is provided with an input line for addition of low level distillate from the acid recovery unit. The distillate is used to

[*Text removed under 10 CFR 2.390.]

11.3.2.14.3 Process Chemistry

This section is not applicable to this unit.

11.3.2.14.4 Process Equipment

Figures 11.3-23 through 11.3-26 provide simplified drawings of the Liquid Waste Reception Unit.

11.3.2.14.5 Chemical Process Inventories

The normal inventories of radionuclides and chemicals involved in this unit are provided in Tables 11.3-28 and 11.3-29, respectively.

11.3.2.14.6 Chemical Process Ranges

The Liquid Waste Reception unit operates continuously. The main flows for this unit are provided in Table 11.3-30.

11.3.2.14.7 Chemical Process Limits

Normal process parameters are described in 11.3.2.14.6. Principal SSCs are described in Chapter 5. Specific operating limits and associated IROFs will be provided in the ISA.

11.4.1.5 System Interfaces

In general, MFFF confinement systems and components (indicated above) interface with each other, with instrumentation and controls, and with normal, standby, and emergency power.

11.4.2 MOX Fuel Fabrication Building HVAC Systems

The MOX Fuel Fabrication Building HVAC systems are shown in Figures 11.4-11 and 11.4-12. The MOX Fuel Fabrication Building HVAC systems maintain differential pressures between confinement zones and maintain an environment suitable for personnel and process operations.

The MOX Fuel Fabrication Building HVAC systems discussed in this section are as follows:

- Offgas Treatment Unit
- Very High Depressurization Exhaust System
- High Depressurization Exhaust System
- Process Cell Exhaust System
- Medium Depressurization Exhaust System
- Supply Air System
- Emergency Control Room Air-Conditioning System
- Truck Bay Ventilation System
- Shipping and Receiving Area Air-Conditioning System.

11.4.2.1 Offgas Treatment Unit

The functions, description, major components, control concepts, and interfaces of the Offgas Treatment Unit are described in Section 11.3.2.13.

11.4.2.2 Very High Depressurization Exhaust System

11.4.2.2.1 Function

The functions of the Very High Depressurization (VHD) Exhaust System are as follows:

- Maintain a negative pressure differential between the C4 (glovebox) and C3 (process room) confinement zones
- Filter contaminants from glovebox exhaust gases/air prior to discharge through the exhaust stack
- Maintain an environment suitable for the manufacturing process.

See Chapter 5 for a list of safety functions.

11.4.2.2.2 Description

The VHD Exhaust System is depicted schematically on Figure 11.4-11. The VHD Exhaust System provides confinement of radioactive materials within the glovebox by maintaining a continuous negative differential pressure between the C4 and C3 confinement zones under normal operating conditions.

During a tornado, the HDE, MDE, POE and HSA systems are shut down during the period when the tornado dampers are closed. The VHD system continues to run against the closed tornado dampers. The HDE, MDE, POE and HSA systems are re-started after the tornado passes.

The glove box atmosphere is exhausted through two stages of HEPA filters at the glovebox boundary, one stage of HEPA filters at the C3 boundary, and two stages of final HEPA filters prior to being discharged to the atmosphere through the MFFF stack, which is continuously monitored. Air or gases supplied to the gloveboxes are supplied through two stages of HEPA filters. The filters on the supply and exhaust of each glovebox are provided to confine radioactive materials within the glovebox as close to the point of origin as practical..

At least one stage of the glove box inlet or exhaust HEPA filtration is testable. The filter design for the glove boxes includes one bag-out type filter housing on the inlet and exhaust with in place testing ports, on the filter housing, to check for proper seating of the filter. This filter housing is on the external stages only. The HEPA filter stage on the inside of the glove box are not tested. All intermediate HEPA filters at the C3 boundaries have the same provisions, as above, for testing. Exhaust flow is maintained by one of four 100%-capacity exhaust fans located downstream of two 100%-capacity final filtration units. The exhaust fans discharge to the MOX Fuel Fabrication Building stack.

The ductwork incorporates manual and automatic dampers and controls to distribute and regulate the movement of air (and gas as applicable) through each glovebox. Fire-rated protective features are provided when ductwork passes through a fire barrier into another fire area.

Components of the Very High Depressurization Exhaust System can be tested periodically for operability and required functional performance. Airflow can periodically be measured in the exhaust ducts and at gloveboxes. The operating sequence that would bring the spare components into service and transfer to alternate power sources can be tested periodically.

The glovebox exhaust is conveyed through a common exhaust duct to the fans and final filters of the VHD Exhaust System. This exhaust path is used to maintain the environmental requirements of the equipment contained within the glovebox, remove heat, maintain the operating differential pressure, and provide the much higher exhaust flows from a glovebox, if a maximum postulated breach of confinement were to occur. The higher flow required by a breach of confinement is initiated by the opening of automatic dump valves that allow sufficient flow to assure that a minimum velocity of 125 ft/min (38.1 m/min) is achieved through the maximum postulated breach.

The VHD Exhaust System also exhausts the intermittent flows from the discharge of the pneumatic transfer fans in the NTP, LTP, and LLP systems.

After power to the furnace is tripped, no safety systems are required to maintain primary confinement.

11.4.7.8 Vessels

Vessels provided in the AP systems that provide a primary confinement function are welded construction and are vented by the Offgas Treatment System. Vessels that may require access are located in gloveboxes, which provide primary confinement.

11.4.8 Fire Protection and Confinement

In the event of a fire, nuclear materials must be confined.. Fire and nuclear material confinement barriers generally include a group of rooms, constituting a volume capable of containing the radioactive products that may be released by a fire within the area. Figure 11.4-14 provides an overview of the fire and nuclear material confinement barriers for process rooms.

The fire areas are surrounded by fire-rated barriers. Access to rooms is via a confinement airlock with a separate HVAC exhaust duct. Fire dampers capable of operating at high temperatures are placed on the room HVAC inlet and exhaust. Exhaust system components are designed with the proper temperature rating so that they can perform their required function under the conditions that may exist in the event of a fire. Air stream dilution is used to protect the final filter stage before the stack. The dilution factor depends on the temperature of the fire, the flow rate, and the flow of dilution air. Fire detection and suppression are described in Chapter 7.

For areas with no dispersible nuclear material, fire dampers are provided on the inlet and exhaust that are closed automatically upon sensing high temperature or upon activation of the gas suppression system.

For areas with dispersible nuclear material and without gloveboxes (e.g., waste storage and polishing cells), the main objective is to maintain differential pressure between the room and the surrounding areas. In case of fire, the fire damper on the HVAC inlet is automatically closed in order to limit air supply to the fire. The exhaust fire isolation damper is manually closed if set thresholds (e.g., temperature of exhaust, temperature at the last filtration level before the stack, pressure drop at the last filtration level and low flow rate at the stack) are exceeded.

For areas with gloveboxes, a change in the HVAC configuration could impair the pressure gradient between gloveboxes and the room. No modification in the HVAC configuration is expected in the case of an incipient fire that can be suppressed immediately. For the case of a larger fire, the main confinement principle is to maintain differential pressure between the room and the surrounding areas. The fire damper on the room HVAC inlet is automatically closed. The fire isolation valve on the glovebox HVAC inlet and exhaust are manually closed. The exhaust fire isolation damper (room) and/or fire isolation valve (glovebox) is manually closed if set thresholds (e.g., temperature on exhaust, temperature at the last filtration level before the stack, pressure drop at the last filtration level, low flow rate at the stack) are exceeded.

11.4.9 Final Filtration Units

The final filtration units provide the last stages of HEPA filtration prior to the air being discharged to the stack. These units are installed in the VHD Exhaust System, HD Exhaust System, Process Cell Exhaust System, MD Exhaust System, and Offgas Treatment System. The final filters are capable of operating during a fire in rooms that are exhausted through the filters and to safely handle products of combustion.

Each of the final filtration units for the VHD Exhaust System, HD Exhaust System, Process Cell Exhaust System, and MD Exhaust System consists of a filter assembly housing, a two stage spark arrester, and two stages of HEPA filters. The Off Gas Treatment System consists of two stages of HEPA filters. The final filter housings are stainless steel, bag-in/bag-out type and are equipped with necessary test ports to permit in-place testing of HEPA filter stages with dioctyl phthalate (DOP) to monitor system efficiency. Dampers are provided so that filter housings can be completely isolated from the HVAC system during filter replacement.

The first stage spark arrester (referred to as a roughing filter) is made of a stainless steel wire mesh. The second stage spark arrester (referred to as a steel/glass fiter) is made of a stainless steel mesh with interwoven fiberglass designed to remove particles greater than 1 micron. The complete spark arrester assemblies are designed and fabricated to the same temperature ratings as the exhaust pipe/duct in which they are installed. Frames are metallic construction. The spark arresters are fabricated of noncombustible materials and are designed to pass design flow rates under fully loaded conditions without structural failure.

HEPA filters are fabricated of glass media with metallic frames and silicone gaskets. The filters are at least 99.97% efficient and can operate in continuous service at 450°F (232°C). The filters can withstand a differential pressure of 10 in WG (2488 Pa) without failure.

The final filtration units, exhaust plenums, exhaust fans, and associated control devices are located as far as practicable from a postulated fire, where they are not exposed to the fire's direct effects. Redundant trains are located in separate fire areas. The integrity of the final filtration units is not degraded by fire and smoke.

Analyses based on final design are in progress to demonstrate that the HEPA filters are protected from fire and other operating conditions and to demonstrate that the ventilation systems LPF is 10^{-4} or better. See Section 5.4.4.4 for information on operating conditions that will damage HEPA filters.

11.4.10 Design Basis for Non-Principal SSCs

The design of the ventilation and air-conditioning systems is in accordance with the applicable standards and guidelines published by the following organizations:

- Air Moving and Conditioning Association
  - AMCA-99-1986, *Standards Handbook*
- American Conference of Governmental Industrial Hygienists

- Supply Air System components:
  - Emergency air duct
  - Inlet filters
  - Pressure boundary upstream of the inlet filters
  - Tornado dampers
- Offgas Treatment Unit (Scrubbing function is not credited in the accident analysis)
  - Pressure boundary
  - Final filters
  - Exhaust Fans

11.4.11.1.1 Design Basis Standards

The design of the HVAC systems and confinement for the MFFF is consistent with the criteria and design guidance provided in Regulatory Guide 3.12, *General Design Guide for the Ventilation System of Plutonium Processing and Fuel Preparation Plants*. One noted exception to this Regulatory Guide is that there are no adsorbers in the filter lines, therefore the heaters and water mist spray for fire protection of final HEPA filters are not required.

The design of the principal ventilation SSCs is developed in accordance with the following codes and standards (as applicable to each SSC):

- Energy Research and Development Administration
  - ERDA 76-21 *Nuclear Air Cleaning Handbook*, 2nd edition
- American Society of Mechanical Engineers
  - AG-1-1997, *Code on Nuclear Air and Gas Treatment*
  - B31.3- 1996, *Process Piping, including 1998 Addenda*
  - N509-1989 (R1996), *Nuclear Power Plant Air-Cleaning Units and Components*
  - N510-1989 (R1995), *Testing of Nuclear Air-Treatment Systems*
- National Fire Protection Association
  - NFPA 801-1998, *Fire Protection for Facilities Handling Radioactive Materials.*

11.4.11.1.2 C2 Confinement System Passive Barrier

Additional design basis associated with this PSSC is as follows:

- Two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors in each final filtration assembly;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);
- Automatic fire-rated dampers between designated fire areas;
- In-place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;

- Final filters and downstream ductwork remain structurally intact during and after design basis earthquakes and withstand the effects of tornadoes.

11.4.11.1.3 C3 Confinement System

Additional design basis associated with this PSSC is as follows:

- C3 zone pressure is maintained at a negative pressure relative to atmosphere during normal and transient operation;
- Designed to maintain system exhaust safety function assuming single active component failure;
- Redundant 100 percent capacity final filter assemblies with two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors in each final filter assembly upstream of the HEPA filters;
- Two 100 percent capacity fans in C3 exhaust system;
- Manual or automatic fire-rated dampers between designated fire areas;
- In-place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);
- Provide emergency cooling capability for selected areas;
- Fans are powered from normal (non-PSSC), standby (non-PSSC), and emergency power supplies (PSSC);
- Remains operational after facility fires and design basis earthquakes and withstand the effects of tornadoes

11.4.11.1.4 C4 Confinement System

Additional design basis associated with this PSSC is as follows:

- C4 zone pressure maintained at negative pressure with respect to C3 process room during normal operation and transients;
- Designed to maintain system exhaust safety function assuming single active component failure;
- Redundant 100 percent capacity final filter assemblies with two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors in each final filter assembly upstream of the HEPA filters;
- Four 100 percent capacity fans in C4 exhaust system;
- Manual actuated fire isolation valves between designated fire areas;
- VHD Exhaust system is designed to maintain a 125-ft/min (38.1-m/min) face velocity across a design basis glovebox breach. The design basis breach is equal to the maximum credible glovebox breach;
- In –place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);

- Fans can be powered from the normal (non-PSSC), standby (non-PSSC), emergency (PSSC) or uninterurruptible power supplies (PSSC).

11.4.11.1.5 Emergency Generator Ventilation System

Additional design basis associated with this PSSC is as follows:

- One 100 percent capacity air conditioning unit for each switchgear room;
- One 100 percent capacity roof ventilator for engine room cooling during standby (engine fan cools room during operation);
- Fans are powered from normal (non-PSSC), standby (non-PSSC), and emergency (PSSC) supplies;
- Remains operational after facility fires and design basis earthquakes and withstand the effects of tornadoes

11.4.11.1.6 Emergency Control Room Air Conditioning System

- Maintain habitable environment in emergency control room
- Dual emergency control room air intakes with continuous monitoring for hazardous chemicals
- Maintain a positive pressure with respect to surrounding areas
- One 100 percent capacity (per control room) filtration assembly (using pre-filter, two HEPA filter stages, and chemical filters) for control room air supply
- In-place HEPA filter testing capability for HEPA filter assemblies in accordance with ANSI-N510;
- One 100 percent capacity (per control room) air handling unit;
- One 100 percent capacity exhaust fan and one 100 percent capacity booster fan;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent
- Fans are powered from normal (non-PSSC), standby (non-PSSC), and emergency (PSSC) supplies;
- Remains operational during and after facility fires and after design basis earthquakes and withstand the effects of tornadoes

11.4.11.1.7 High Depressurization Exhaust System

See C3 Confinement System above for additional design basis associated with this PSSC.

11.4.11.1.8 Process Cell Exhaust System

Additional design basis associated with this PSSC is as follows:

- Redundant 100 percent capacity final filter assemblies with two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors in each final filter assembly upstream of the HEPA filters;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);
- Manual fire-rated dampers between designated fire areas;

- In-place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;
- Fans are powered from normal (non-PSSC), standby (non-PSSC), and emergency power supplies (PSSC);
- Remains operational after facility fires and design basis earthquakes and withstands the effects of tornadoes
- Two 100 percent capacity fans;
- Process Cell pressure is maintained at a negative pressure relative to atmosphere during normal and transient operation;
- Designed to maintain system exhaust safety function assuming single active component failure.

11.4.11.1.9 Supply Air System

Additional design basis associated with this PSSC is as follows:

- Provide supply air for emergency cooling;
- HEPA filter stages for building air supply for static confinement;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);

11.4.11.1.10 MFFF Tornado Dampers

Additional design basis associated with this PSSC is as follows:

- Withstand the effects of design basis tornadoes;
- Remains operational after facility fires and design basis earthquakes

11.4.11.1.11 Offgas Treatment System

Additional design basis associated with this PSSC is as follows:

- Two stages of HEPA filters prior to discharge to the atmosphere;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);
- In-place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;
- Final filters and ductwork remain structurally intact during and after design basis earthquakes and withstand the effects of tornadoes.

11.4.11.2 Gloveboxes and Glovebox Pressure Controls

Gloveboxes are designed to provide a confinement barrier for hazardous material. They are designed to remain functional during and after a design basis earthquake.

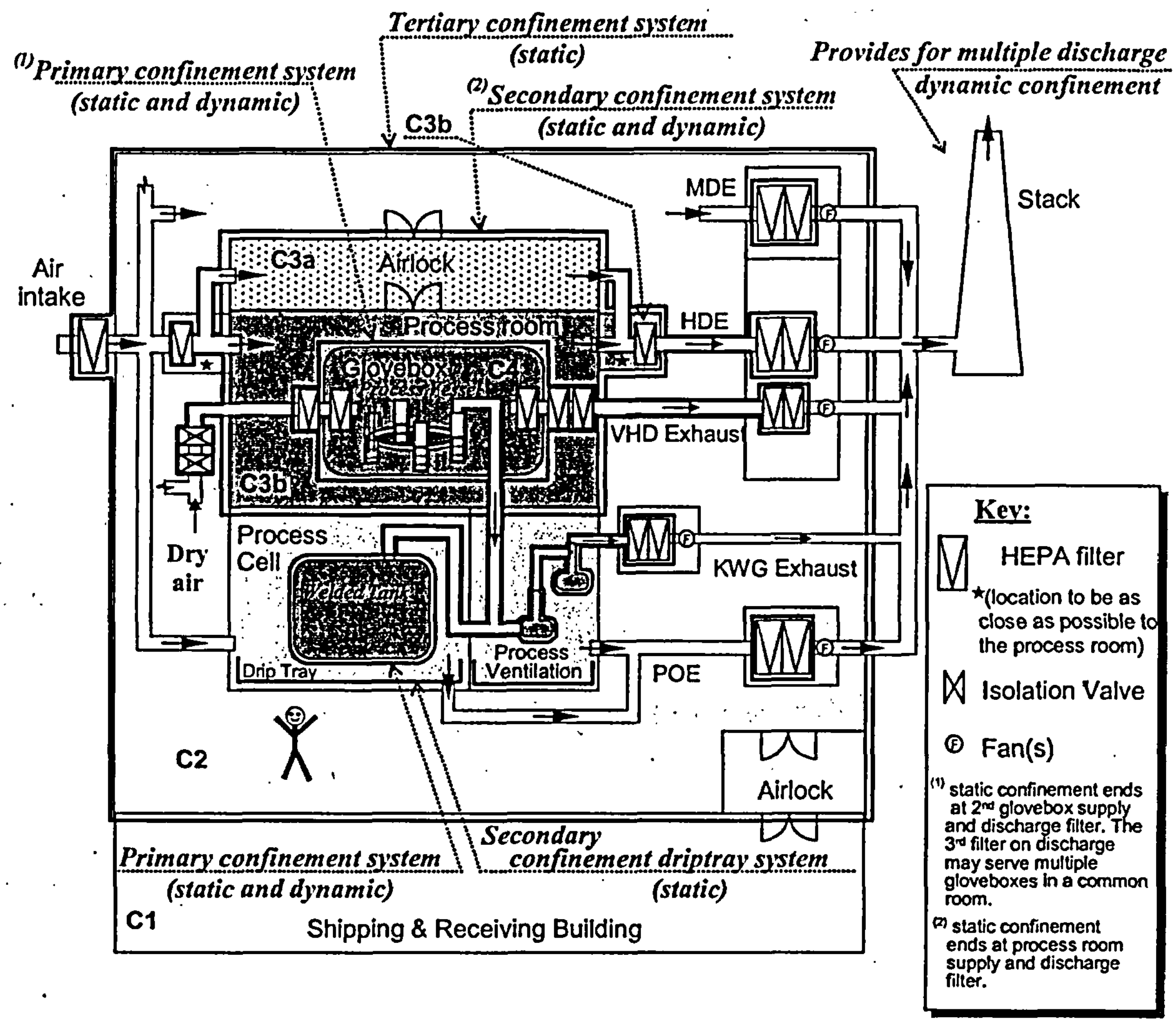

Figure 11.4-2. Example of AP Confinement

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