11.10 HEAVY LIFT CRANES

Heavy lift cranes are defined as those overhead load handling systems in the MFFF that are designed to lift a load greater than the weight of a single fresh fuel assembly and associated lifting devices (i.e., greater than 1,800 lb [816 kg]), in accordance with NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants." The MFFF cranes that handle such loads are the bridge crane in the fresh fuel cask shipping truck bay (Room D-101), the bridge crane in the assembly loading area (Room B-185), the bridge crane in the fresh fuel cask handling area (Room B-185), the bridge crane stacker in Room B-254, the bridge crane in Room B-163, and the crane in the emergency diesel generator building. Other cranes may be identified as the design progresses. Heavy lift cranes will be evaluated in the ISA and will have appropriate design and controls (see Section 11.10.7) to ensure consequences to workers, the public, or the environment are below the 10 CFR §70.61 limits.

Operating experience (i.e., lessons learned) from MELOX and La Hague will be incorporated as appropriate into the design and operations of heavy lift cranes used at the MFFF.

11.10.1 Function

Heavy lift cranes in the MFFF are designed to safely and reliably hoist critical or noncritical loads that weigh in excess of 1,800 lb (816 kg). Critical loads are defined as those loads whose uncontrolled movement or release could result in unacceptable radiological dose consequences to workers, the public, or the environment. Other loads are considered noncritical.

Heavy lift cranes that handle critical loads must retain their load during normal operation, design basis accidents (including a loss of electrical power), and design basis natural phenomena events. Heavy lift cranes that do not handle critical loads, but do travel over areas where safety or confinement systems are located and could cause consequences greater than 10 CFR §70.61 limits if the crane were to fall, must remain structurally integral under normal, accident, and design basis natural phenomena conditions.

11.10.2 Description

The bridge crane in the fresh fuel cask shipping truck bay is designed to lift inbound or outbound material and equipment that is handled in the truck bay. Empty inbound fresh fuel shipping casks removed from shipping vehicles are stored in the truck bay until required for loading operations. Outbound casks loaded with fresh fuel may be staged in the truck bay awaiting shipment. Loaded fresh fuel shipping casks are normally handled in the truck bay on air pallets. However, in the event of a failure of the dock leveler height adjustment mechanism during the truck loading process, a cask could be lifted off of the dock leveler and moved to the loading dock by the truck bay bridge crane. The loaded cask would not be lifted over another loaded cask in this event. Any lift of a loaded fuel cask by the truck bay crane will be performed with appropriate impact limiters installed and with appropriate lift height limits (approximately 16 ft [4.9 m] above floor elevation) consistent with the qualification of the cask (30 ft [9.1 m] qualification height), which will mitigate the consequences of load drop accidents in the truck bay.

The bridge crane in the assembly loading area is designed to transfer an empty fresh fuel cask strongback from the strongback handling station to the assembly loading station, to remove the strongback top plate to provide access for loading fuel assemblies, to replace the strongback top plate after three fuel assemblies are loaded, and to transfer the loaded strongback from the assembly loading station to the strongback handling station. All loaded strongback transfers will be performed with appropriate lift height limits, which will mitigate the consequences of load drop accidents in the assembly loading area. Generally, there will be only one loaded strongback; therefore, they are not lifted over other loaded strongbacks.

The bridge crane in the fresh fuel cask handling area is designed to remove and replace the fresh fuel shipping cask impact limiters and cask lids. This crane is also designed to be used for other general maintenance purposes. Outbound casks loaded with fresh fuel may be staged in the cask handling area awaiting shipment. Loaded fresh fuel shipping casks are normally handled in the cask handling area on air pallets. However, in the event of a failure of an air pallet that required the cask to be lifted to withdraw the pallet, the cask could be lifted by the cask handling area crane. Any lift of a loaded fuel cask by the cask handling area crane will be performed with appropriate impact limiters installed and with appropriate lift height limits consistent with the qualification of the cask, which will mitigate the consequences of load drop accidents in the cask handling area.

The bridge crane stacker in Room B-254 is designed to transfer loaded pallets, each containing four waste drums, between the pallet conveyor and the pallet storage racks. With waste drums being lift in Room B-254, operators are aware of hazards of an event with the stacker allowing a drum to drop and would evacuate in the unlikely event of a waste drum being drop. Consequences from a drop of a waste drum are below the 10 CFR §70.61 performance requirements to the site workers, the public and the environment and require no principal SSCs.

The bridge crane in Room B-163 is designed to handle empty PuO_2 shipping package pallets. Because the empty PuO_2 shipping package pallets should be free of contamination (only minor amounts of contamination are permitted), dropping an empty pallet will not cause consequences that are in excess of 10 CFR §70.61 performance requirements to the worker, the public, or the environment

The crane in the emergency generator room is designed to be used for general maintenance purposes. Lifts over principal SSCs are only expected during maintenance on the principal SSCs.

11.10.3 Major Components

The crane in the fresh fuel cask shipping truck bay is a top-running, double-girder bridge crane, with electric bridge, trolley, and hoist drives. The rated capacity of the crane of 15 tons is specified to envelop the weight of all anticipated loads including a fully loaded fresh fuel cask and associated lifting devices, plus design margins specified in Crane Manufacturers' Association of America (CMAA)-70.

The crane in the assembly loading area is an under-running, double girder bridge crane, with under-running hoist and electric bridge, trolley, and hoist drives. The rated capacity of the

assembly loading area hoist of 5 tons is specified to envelop the weight of a fully loaded strongback and associated lifting devices, plus design margins specified in CMAA-74.

The crane in the fresh fuel cask handling area is a top-running, single girder bridge crane, with an under-running hoist and electric bridge, trolley, and hoist drives. The rated capacity of 10 tons is specified to envelop the weight of all anticipated loads including a fully loaded fresh fuel cask and associated lifting devices, plus the design margins specified in CMAA-74.

The stacker crane in Room B-254 is a top-running, single girder bridge crane, with an under-running trolley and load mast, and with electric bridge, trolley, and load mast drives. The rated capacity of 3 tons is specified to envelop the weight of a pallet with four fully loaded waste drums plus the design margins specified in CMAA-74.

The crane in the emergency generator room will be described later as the design progresses.

Lifting devices for fresh fuel shipping casks are designed in accordance with ANSI N14.6, "Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 lbs or More." Lifting devices for handling loads not covered by ANSI N14.6 comply with ANSI/ASME B30.9, "Slings," and ANSI/ASME B30.20, "Below-the-Hook Lifting Devices."

Other heavy lift cranes (if any) identified during detailed design will be described in the ISA.

11.10.4 Control Concepts

The stacker crane in Room B-254 is normally operated in automatic mode. The operator may also intercede via a local manual mode in which the interlocks are active in case of trouble in the automatic mode or for maintenance operations.

The crane in the assembly loading area is operated in the automatic mode for transfer of the strongback between the assembly loading station and the strongback handling station. All other operations are locally controlled by an operator using a radio control station.

All other heavy lift cranes in the MFFF are locally controlled by an operator using radio control stations. The physical configuration of the control stations is governed by ASME B30.2, "Overhead and Gantry Cranes."

11.10.5 System Interfaces

Interfaces between the heavy lift cranes and other facility systems include the basic structural connections between the crane runways and the supporting building walls and the ties to the normal electrical supply system, which provide power for the electric bridge, trolley, and hoist motors and brakes. If the control station is linked to the crane via radio communications instead of hard-wired electrical circuitry, the effects of interference between facility security, process monitoring, and control systems that operate using radio frequencies and crane controls are considered.

11.10.6 Design Basis for Non-Principal SSCs

The MFFF heavy lift cranes and their major components are designed, fabricated, and qualified to perform required functions in accordance with the following national codes and standards:

- Crane Design – CMAA-70, "Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes," 1994; and CMAA-74, "Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoists," 1994
- Under-Running Hoist Design – ASME B30.16, "Overhead Hoists (Underhung)," 1998
- Crane Operation – ASME B30.2, "Overhead and Gantry Cranes," 1996, and ASME B30.20, "Below-the-Hook Lifting Devices," 1993
- Special Lift Device Design – ANSI N14.6, "Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 lbs or More," 1993
- Normal Lift Device Design –ASME B30.9, "Slings," 1996 and ASME B30.20, "Below-the-Hook Lifting Devices," 1999.

Permanently installed heavy lift cranes at the MFFF are located within the protected structure of the buildings and are protected by the building from design basis natural phenomena events, except seismic. Where MFFF heavy lift cranes can move over principal SSCs, they are qualified to remain in place under all design loading conditions, including design basis earthquakes. Heavy lift cranes include design features to retain the load in the event of a loss of electrical power.

11.10.7 Design Basis for Principal SSCs

Heavy lift cranes at the MFFF have not been identified as principal SSCs. With the exception of the floor of the building (which is a principal SSC), and emergency generator SSCs during maintenance there are no cases where a heavy load will be lifted over a principal SSC. Building floors are evaluated for dynamic loads, including drop loads, as described in Section 11.1. A drop of any load handled by a heavy lift crane would not result in consequences in excess of 10 CFR §70.61 performance requirements to the worker, the public, or the environment; therefore, none of the lifts of these loads are critical lifts. Any non-heavy lift load lifted over a principal SSC will follow the Material Handling Controls described in Section 5.6.2.3. Any lift of a fresh fuel cask will be performed only when the qualified impact limiters are installed, and the maximum lift height of the cask will be less than the fresh fuel cask qualified drop height.

All heavy lift cranes will be operated in accordance with Material Handling Controls as described in Section 5.6.2.3.

Specific IROFS controls will be identified in the ISA.

11.11 LABORATORY

11.11.1 Function

The laboratory units listed in this section are based on the existing MELOX and La Hague designs. The particular functions of these units will likely evolve as the MFFF design progresses. Updates to the laboratory design functions will be provided in the license application for possession and use of SNM.

The main function of the laboratory is to perform chemical and physical analyses of samples coming from the AP and MP production areas. These analyses are required for manufacturing control, nuclear material management, and quality control. In addition, when processing AFS material, dedicated laboratory equipment will perform chemical analyses on the samples taken from the material entering the AP process that require chemical characterization. Any IROFS associated with laboratory operations will be identified in the ISA.

The following operations are also performed in the laboratory:

- Laboratory liquid and solid waste management
- Temporary storage of scrap materials from the laboratory
- Dissolution tests for AFS PuO_2 powders in a laboratory electrolyzer
- MP process adjustment in a test line
- Calibration
- Document storage.

11.11.2 Description

The MFFF laboratory includes multiple units. Operators receive samples from production units by pneumatic transfer and direct them to the different analytical stations. Most analyses are performed manually. A summary of the types of analyses performed on each type of sample with the number of samples is given in Table 11.11-1. The liquid samples characteristics and number are further detailed in Table 11.11-2.

The different units of the MFFF laboratory include the following:

- Receipt, weighing, fractionating, and dispatching of AFS PuO_2 powder
- PuO_2 dissolution and extraction of AFS PuO_2 powder
- Laboratory electrolyzer for AFS PuO_2 powder
- Impurity concentration determination by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES) and Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) of AFS PuO_2 powder
- Fluorine and chlorine determination of AFS PuO_2 powder
- Carbon, sulfur and nitrogen determination for AFS PuO_2 powder
- Receipt, weighing, and dispatching of MP pellets and powder, and AP PuO_2 powder

- Specific surface area analysis of MP powder and AP PuO_2 powder
- Grain size determination of AP PuO_2 powder
- Gas analysis of MP pellets and powder, and AP PuO_2 powder
- Gamma X-ray fluorescence of MP pellets
- Fluorine and chlorine determination of MP pellets and AP PuO_2 powder
- Oxygen-to-Metal ratio determination of MP pellets
- Solubility testing of MP pellets
- Dissolution of MP pellets and powder
- Impurity concentration determination by ICP-AES/ICP-MS of MP pellets and powder, AP PuO_2 powder, and AP liquid samples
- Uranium and plutonium content and isotopic composition determination by mass spectrometry of MP powder and pellets
- Alpha and gamma spectrometry for MP powder, AP PuO_2 powder and AP liquid samples
- Thermal stability testing of MP pellets
- Ceramographic tests of MP pellets
- Metallographic examination of rod specimens
- Weld corrosion testing of rod specimens
- High plutonium content solution analysis and preparation of AP liquid samples
- Low plutonium content solution analysis and preparation of AP liquid samples
- Alpha and gamma spectrometry preparation of AP liquid samples
- Mass spectrometry preparation of AP liquid samples with plutonium
- Mass spectrometry preparation of AP liquid samples with uranium
- H_2O and plutonium content gravimetric analyses for AP PuO_2 powder
- PuO_2 dissolution of AP PuO_2 powder
- Mass spectrometry preparation of AP PuO_2 powder
- AP sample storage (solid and liquid samples)
- Liquid waste processing
- Solid waste processing
- Calibration
- Preparation of reagents
- Test line

These units are discussed in the following sections.

11.11.2.1 Receipt, Weighing, Fractionating and Dispatching of AFS PuO_2 Powder

This unit receives AFS powder samples from the powder sampling glovebox of the milling unit (KDM) in the AP area by pneumatic transfer.

This unit manually receives scrap materials from nondestructive analyses and then repackages and pneumatically transfers the scrap materials to the production units for recycling. This unit is also used for transfer of AP PuO_2 recyclable powder from the receipt, weighing and dispatching of MP pellets and powder, and AP PuO_2 powder unit for recycling in the production units.

In this unit, AFS samples are weighed for material balance and dispatched after fractionation (i.e., division of powder into specimens) to the analytical units of the laboratory. Any excess powder is temporarily stored in this unit until the completion of the analyses; indeed, if there is a problem with the analyses, the additional powder can be used as a spare sample. After analyses, AFS PuO_2 powder from non-destructive analyses is brought to the receipt, weighing and dispatching of AFS PuO_2 powder unit where specimens are collected and repackaged into vials. These vials are periodically sent by pneumatic transfer to the AFS PuO_2 sampling glovebox of the milling unit in the AP area for recycling.

This unit is composed of two gloveboxes linked together by a tunnel:

- One glovebox is used for receipt of AFS samples from production units, weighing samples and performing sample fractionation, and sample repackaging of AFS and AP PuO_2 powder
- One glovebox is used for temporary sample storage and dispatching to the other analytical units.

11.11.2.2 PuO_2 Dissolution and Extraction of AFS PuO_2 Powder

Dissolution operations producing solutions with a high plutonium content are carried out in a shielded analytical line. There are two shielded lines for AFS PuO_2 powder dissolution and extraction in this unit which are similar; however, in one line, an additional glovebox contains a laboratory electrolyzer used for dissolution test of suspect AFS PuO_2 powder. The electrolyzer is described in Section 11.11.2.3.

Both PuO_2 dissolution lines receive PuO_2 powder samples by pneumatic transfer from the receipt, weighing, fractionating and dispatching unit for AFS PuO_2 powder. The samples are weighed and dissolved in a nitro-fluorhydric medium. The solutions are transferred either directly to the AFS powder ICP-MS analyzer for impurities determination or to one of the two ICP-AES units. For analysis by ICP-AES analyzer, plutonium extraction from liquid solutions is required. Plutonium is extracted from the aqueous solutions by an organic mixture of TBP and dodecane. After analysis, the excess aqueous dissolution solutions are transferred to the liquid waste processing unit before being transferred to the purification cycle in the AP area for recycling. Organic effluents from Pu extraction are transferred after decontamination (Pu re-extraction) to the liquid waste processing unit (LGF) where they are temporarily stored in a buffer tank.

This unit includes two PuO_2 dissolution and extraction lines. Except for the additional specific glovebox for the laboratory electrolyzer in one line, each line includes 5 gloveboxes connected by tunnels:

- One glovebox with a pneumatic transfer system inlet
- One glovebox with an analytical balance
- One glovebox with two remote-handling devices and dissolution equipment (heating plates, reflux cooled columns). In one line, this glovebox is connected to the electrolyzer glovebox
- One extraction glovebox with two remote-handling devices, an equipment airlock, a solid waste removal system, and a pneumatic sender for transfer to the ICP-MS or ICP-AES analyzers
- One glovebox for equipment introduction into the line.

11.11.2.3 Laboratory Electrolyzer for AFS PuO_2 Powder

AFS PuO_2 powders received during MFFF operations may contain many chemical impurities. Among these impurities, some oxides may be insoluble in the dissolution units (KDB and KDD) and may clog the transfer filter in the process units. The purpose of the small electrolyzer is to dissolve suspect powders electrolytically using a nitric solution with silver so that the powders can be tested for insoluble oxides. According to the dissolution test results, AFS PuO_2 tested can is either accepted in the AP process or rejected. For samples containing chloride ions, a dechlorination step is performed before dissolution and a bubbling system is implemented to strip chlorine gas. This unit is operated infrequently when AFS powders are suspected of being outside chemical specifications.

Waste liquid dissolution solutions are then sent to liquid waste processing unit LGF before transfer to the purification cycle in the AP area for recycling. Insoluble particles are filtered and then sent to waste storage unit.

The electrolyzer is installed in a glovebox connected to the dissolution glovebox of one of the lines of the dissolution and extraction unit. The electrolyzer glovebox is equipped with a catholyte cell, an anolyte cell for electrolytic dissolution, a remote-handling device, pumps and a bubbling system to trap desorbed chlorine when the powder contains chloride ions.

11.11.2.4 Impurity Concentration Determination by ICP-AES and ICP-MS of AFS PuO_2 Powder

The impurity concentration of AFS powder sample is determined by either Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES) or by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) analyzers. This unit receives acid solutions by pneumatic transfer from the dissolution and extraction unit for AFS PuO_2 powders.

The unit is divided in 3 lines: 2 identical lines with an ICP-AES analyzer and 1 line with an ICP-MS analyzer. The ICP-AES analytical lines receive acid solutions of dissolved AFS powder without Pu (which was extracted in the PuO_2 dissolution and extraction unit). The aqueous solutions are diluted with an internal standard (scandium) in nitric acid and then introduced into

the spray section of the plasma torch. The analyzer detects and determines the concentration of each element. The ICP-MS analytical line receives diluted acid solutions of dissolved AFS powder. The aqueous solutions are diluted with internal mass standards and then introduced into the spray section of the plasma torch. Mass spectrometry analysis provides the concentration of each element.

After analysis, the aqueous solutions are then transferred to the liquid waste processing unit before being transferred to the acid recovery unit of the AP area.

Each of the two identical ICP-AES lines is composed of two gloveboxes linked together by a tunnel. One glovebox is used for sample dilution, and the second glovebox is used for introducing samples into the ICP-AES analyzer. The ICP-AES analyzer is located outside the gloveboxes. Similarly, the single ICP-MS line is composed of two gloveboxes linked together by a tunnel. One glovebox is used for sample dilution, and the second glovebox is used for introducing samples into the ICP-MS analyzer. The ICP-MS analyzer is also located outside the gloveboxes.

11.11.2.5 Fluorine and Chlorine Determination for AFS PuO_2 Powder

This unit receives AFS PuO_2 powder samples by pneumatic transfer from the receipt, weighing, and dispatching unit dedicated to AFS PuO_2 powder. After weighing, the samples are heated in a furnace (1382°F [750°C]) under steam scavenging. The gaseous mixture formed is cooled to condense water and hydrochloric and hydrofluoric acids which are neutralized with NaOH (0.5N). The pyrohydrolysis product is then analyzed by ionometry with specific chloride and fluoride electrodes when the chloride content is likely to be high. This analysis prevents the ion chromatograph from being polluted by chlorides. The product is then analyzed by high-performance ion chromatography (HPIC) when the fluoride and chloride content is low. The iodide and bromide concentration can be also determined. After this non-destructive analysis, the analysis powders are returned to the sampling glovebox in the milling unit in the AP area to be either recycled in the dissolution units or rejected if they cannot be processed.

This unit is composed of 5 gloveboxes linked together by a tunnel:

- One glovebox for pneumatic transfer inlet and weighing, in the middle of the line
- Two identical gloveboxes, each containing a pyrohydrolysis furnace
- One glovebox with electrodes specific to chlorides and fluorides for ionometry
- One glovebox with an ion chromatograph for HPIC

11.11.2.6 Carbon, Sulfur and Nitrogen Determination for AFS PuO_2 Powder

This unit receives AFS PuO_2 powder samples by pneumatic transfer from the receipt, weighing, and dispatching unit. For carbon and sulfur analysis, the samples are weighed, and heated in a furnace (2732°F [1500°C]) under oxygen scavenging. The CO_2 and SO_2 formed as a result are then analyzed by infrared spectroscopy. For nitrogen analysis, the samples are weighed, heated in a furnace (3272°F [1800°C]) under helium scavenging: a Katharometer determines N_2 content by thermal conductivity measurement.

After analysis, the powder residue is recovered from the crucibles used for analyses. The powder is returned to the sampling glovebox in the milling unit in the AP area to be either recycled in the dissolution units or rejected if they cannot be processed. The non-recyclable crucibles are stored as waste in the waste storage unit.

This unit is composed of 3 gloveboxes linked together by a tunnel:

- One glovebox for pneumatic transfer inlet and weighing
- One glovebox with a furnace for carbon and sulfur analysis (same furnace and analyzer for both products)
- One glovebox with a furnace for nitrogen analysis

11.11.2.7 Receipt, Weighing, and Dispatching of MP Pellets and Powder, and AP PuO_2 Powder

This unit receives MP powder and pellet samples from the powder auxiliary unit and from the quality control gloveboxes of the MP Area by pneumatic transfer respectively. This unit also receives AP PuO_2 powder samples from the AP powder sampling glovebox of the AP area (KCB unit) by pneumatic transfer.

This unit receives scrap materials from nondestructive analyses, then repackages them and pneumatically transfers them to the production units for recycling. This unit also pneumatically receives ground and sintered pellets from the test line and transfers them to the analytical units.

In this unit, MP samples are weighed for material balance and dispatched after fractionation (i.e., division of pellets into smaller lots) to the analytical units of the laboratory. AP powder samples are received and directly dispatched in the analytical units of the laboratory with fractionation of AP powder samples being performed in the AP area (KCB unit) before sample transfer to the laboratory.

AP liquid samples are not received in this unit. The liquid samples are transferred directly from the AP liquid sampling gloveboxes to the analytical units by pneumatic transfer.

This unit is composed of three gloveboxes linked together by a tunnel:

- One glovebox is used for receipt of MP and AP samples from production units.
- One glovebox is used for weighing samples and performing MP sample fractionation.
- One glovebox is used for temporary sample storage and specimens dispatching to the analytical units.

11.11.2.8 Specific Surface Area Analysis of MP Powder and AP PuO_2 Powder

This unit checks the ability of powder to be sintered. The unit receives MP powder samples and AP PuO_2 powder samples by pneumatic transfer from the receipt, weighing, and dispatching unit.

Specific surface area determination uses the Bruanuer, Emmet, and Teller (BET) process, which includes the following steps:

- Powder sample weighing
- Gas desorbing by heating (356°F [180°C]) and scavenging with nitrogen gas
- Sample cooling with liquid nitrogen (nitrogen is adsorbed by the powder sample surface)
- Withdrawal of the sample from the liquid nitrogen
- Desorbed nitrogen measurement by thermal conductivity detection (under nitrogen and helium scavenging gases).

The volume of desorbed nitrogen is linked to the specific surface area of powder samples. Analysis products are returned to the production units as scrap materials.

This unit is composed of two gloveboxes linked together by a tunnel. One glovebox is used for weighing the samples, and the second glovebox is used to perform the BET process. This unit is linked with the grain size determination unit.

11.11.2.9 Grain Size Determination of AP PuO_2 Powder

This unit receives AP PuO_2 powder samples by pneumatic transfer from the receipt, weighing, and dispatching unit. The grain size of PuO_2 powder is determined by measuring the electrical resistance variation induced as particles suspended in an electrolyte pass through a calibrated orifice. Analysis products are filtered, dried and then recycled into the production units.

This unit is composed of one glovebox, including the grain size analyzer (i.e., Coulter counter with sample cell, measurement probe, electrolytic circuit, and electronic circuit). This unit is linked with the specific surface area analysis unit.

11.11.2.10 Gas Analysis of MP Pellets and Powder, and AP PuO_2 Powder

This unit receives MP powder and pellet samples and AP PuO_2 powder samples by pneumatic transfer from the receipt, weighing, and dispatching unit. The gas analyses performed in this unit include carbon, nitrogen, hydrogen, and sorbed gas analyses.

For MP powder samples, only the carbon analysis is performed. For AP PuO_2 powder samples, only carbon and nitrogen analyses are performed. For carbon analysis, the samples are weighed and heated in a furnace (2732°F [1500°C]) under oxygen scavenging. The CO_2 and SO_2 formed as a result are analyzed by infrared spectroscopy. For nitrogen analysis, the samples are weighed, heated in a furnace (3272°F [1800°C]) under helium scavenging and then a Katharometer determines N_2 content by thermal conductivity measurement. For hydrogen analysis, the samples are weighed, heated in a furnace (3092°F [1700°C]) under nitrogen scavenging and then H_2 thermal conductivity is determined by a Katharometer. For sorbed gases analysis, the samples are weighed, heated in a furnace (2732°F [1500°C]) under vacuum and then the volume of sorbed gases (after desorption) is measured by volumetry.

After analysis, the product residue is recovered from crucibles. Residues are returned to the production units as scrap materials, and non-recyclable crucibles are stored as wastes.

This unit could be used for AFS PuO_2 powders; however, this operation is avoided to prevent the risk of pollution by impurities contained in the AFS PuO_2 powders from reaching the MP and AP laboratory processes.

This unit is composed of four gloveboxes linked together by a tunnel:

- One glovebox is used for weighing.
- One glovebox is used for carbon analysis and includes one furnace.
- One glovebox is used for nitrogen and hydrogen analysis and includes two furnaces.
- One glovebox is used for sorbed gas analysis and includes one furnace.

11.11.2.11 Gamma X-Ray Fluorescence of MP Pellets

This unit receives MP pellet samples by pneumatic transfer from the receipt, weighing, and dispatching unit. The purpose of this analysis is (1) to determine the content of uranium, plutonium, and americium in MP pellets to determine the MP process dispersion, and (2) to carry out a representative subsampling of the batch for further analyses by ICP-AES/ICP-MS (impurities) and mass spectrometry (uranium and plutonium).

Samples are irradiated with gamma rays. The americium content of the samples is obtained from the gamma spectrum; whereas, the uranium and plutonium contents of the samples are obtained through exploitation of the X-ray fluorescence spectrum. After the testing is complete, the analysis products are divided and sent to the following locations:

- MOX dissolution unit
- Thermal stability testing unit
- MP Scrap Processing Unit as scrap.

This unit is composed of one glovebox. The introduction of samples to the analyzer is automated and the radiation cell of the analyzer is shielded.

11.11.2.12 Fluorine and Chlorine Determination of MP Pellets and AP PuO_2 Powder

This unit receives MP pellet samples and AP PuO_2 powder samples by pneumatic transfer from the receipt, weighing, and dispatching unit. After weighing, the samples are heated in a furnace (1382°F [750°C]) under steam scavenging. The gaseous vapor formed is cooled to condense water and hydrochloric and hydrofluoric acids and neutralized by NaOH (0.5N). The pyrohydrolysis product of MP pellets is then analyzed by ionometry using electrodes specific to chloride and fluoride ions to determine the fluorine and chlorine (F/Cl) contents. For AP PuO_2 powders samples, the condensed water is analyzed by ion chromatography to determine halides (Cl^-, F^-, and sometimes I^- and Br^-). After testing, the analysis products are returned to the production units as scrap materials.

This unit could be used for AFS PuO_2 powders; however, this operation is avoided to prevent the risk of pollution by impurities contained in the AFS PuO_2 powders from reaching the MP and AP processes.

This unit is composed of two gloveboxes linked together by a tunnel: one glovebox is used for weighing and heating, and the second glovebox is used for ionometry and ion chromatography analyses. The glovebox used for weighing and heating is also used for oxygen-to-metal (O/M) ratio determination and includes two different furnaces. One furnace is used for the determination of F/Cl content, and the second furnace is used for O/M ratio determination.

11.11.2.13 Oxygen-to-Metal Ratio Determination of MP Pellets

This unit receives MP pellet samples by pneumatic transfer from the receipt, weighing, and dispatching unit. After weighing, the samples are heated in a furnace (1,652°F [900°C]) under scavenging gases for oxidation-reduction treatment. Air is used for oxidation, and argon/hydrogen is used for reduction. The oxidation-reduction treatment ensures normal stoichiometry (O/M=2.00). The O/M stoichiometric ratio is then obtained by weighing after heating to determine the weight difference. After the determination is complete, the analysis products are returned to production units as scrap materials.

This unit is composed of one glovebox for weighing and heating. The glovebox is also used for pyrohydrolysis and contains two furnaces (the O/M furnace and F/Cl furnace).

11.11.2.14 Solubility Testing of MP Pellets

This unit receives MP pellet samples by pneumatic transfer from the receipt, weighing, and dispatching unit. After weighing, samples are dissolved in nitric acid (10N). Dissolution is performed under heating for 10 hours. Insoluble precipitate is then dissolved in nitric (14N) and hydrofluoric (0.05N) acids under heating. The acid solution is sent by pneumatic transfer to one of the ICP-AES/ICP-MS unit (LCP) for plutonium content determination. Generated liquid wastes are transferred to the liquid waste processing unit before being transferred to the purification cycle of the AP area for recycling.

This unit is composed of one glovebox, which is linked to the gloveboxes used for F/Cl and O/M ratio determination.

11.11.2.15 Dissolution of MP Pellets and Powder

Some MP sample analyses are performed in the liquid phase and require prior material dissolution:

- Determination of americium concentration by gamma spectrometry
- Determination of uranium and plutonium content and isotopic composition by mass spectrometry
- Determination of impurity concentration by ICP-AES/ICP-MS.

The MP dissolution unit receives MP pellet samples from the gamma X-ray fluorescence unit and MP powder samples from the receipt, weighing, and dispatching unit by pneumatic transfer. After weighing, the samples are dissolved in nitric (14N) and hydrofluoric (0.05N) acids under heating. Using pneumatic transfer, acid solutions are sent to the following units:

- The MOX mass spectrometry preparation unit for gamma and mass spectrometry analyses
- The ICP-MS analytical line for impurity-determination (LCP).

For analysis by ICP-AES analyzer, plutonium extraction from liquid solutions is required. Plutonium is extracted from the aqueous solutions by an organic mixture of TBP and dodecane. Organic effluents generated by plutonium extraction are transferred after decontamination to the liquid waste processing unit where they are temporarily stored in a buffer tank.

This unit is composed of three gloveboxes linked together by a tunnel. One glovebox is used for sample weighing. The second glovebox is used for material dissolution, which includes heating plates and total reflux condensers. The third glovebox is used for extraction.

11.11.2.16 Impurity Concentration Determination by ICP-AES/ICP-MS of MP Pellets and Powder, AP PuO_2 Powder, and AP Liquid Samples

The impurity concentration of MP pellet samples, MP powder samples, AP PuO_2 powder samples, and AP liquid samples are determined by either an ICP-AES analyzer or an ICP-MS analyzer. This unit receives acid solutions by pneumatic transfer from the following units:

- MOX dissolution unit (dissolved MP powder and pellet samples)
- PuO_2 dissolution unit (dissolved AP powder samples)
- High plutonium content solution analysis and preparation unit (AP liquid samples)
- Low plutonium content solution analysis and preparation unit (AP liquid samples).

For analyses by ICP-MS, aqueous solutions are diluted with international mass standards in nitric acid and then introduced into the spray section of the plasma torch. Mass spectrometry analysis provides the concentration of each element. Similarly, for analyses by ICP-AES, aqueous solutions (without Pu which was extracted in the dissolution unit) are diluted with a standard (scandium) in nitric acid and then introduced into the spray section of the plasma torch. Atomic emission spectroscopy analysis provides the concentration of each element. After analysis, aqueous solutions are then transferred to the liquid waste processing unit before being transferred to the acid recovery unit of the AP area for recycling. The ICP-AES and ICP-MS analyzers are also used for MP pellet solubility testing.

There is one ICP-MS line and one ICP-AES line. Each line is composed of two gloveboxes linked together by a tunnel. One glovebox is used for sample dilution, and the second glovebox is used for introducing samples into the analyzer. The ICP-MS and ICP-AES analyzers are outside the gloveboxes.

11.11.2.17 Uranium and Plutonium Content and Isotopic Composition Determination by Mass Spectrometry of MP Powder and Pellets

The mass spectrometry analysis units receive acid solutions from the MOX dissolution unit (i.e., dissolved MP powder and pellet samples) by pneumatic transfer via the MOX mass spectrometry preparation unit. In this unit, samples are prepared for mass spectrometry analyses. Solutions

are diluted with nitric acid. Uranium and plutonium are separated in ion exchange resin columns (liquid/solid separation). Recovered uranium or plutonium solutions are then dried and dissolved in nitric acid. Then the solutions are transferred by pneumatic transfer to one of the two mass spectrometers for analysis.

The MOX mass spectrometry preparation unit is composed of the following gloveboxes:

- Two identical mass spectrometry preparation lines. Each line includes four gloveboxes linked together by a tunnel:
  - Two gloveboxes for sample dilution
  - One glovebox for separation in ion exchange resin columns
  - One glovebox for drying and dissolving operations.
- Two tracer preparation lines. Each line includes two gloveboxes linked together by a tunnel.

The analysis unit receives by pneumatic transfer prepared solutions from the following units:

- MOX mass spectrometry preparation unit
- AP powder sample mass spectrometry preparation unit
- AP liquid sample (with Pu) mass spectrometry preparation unit
- AP liquid samples (with U) mass spectrometry preparation unit.

In the analysis unit, the solution is injected into a plasma of argon (ion source of the mass spectrometer). Aqueous solutions in excess are transferred to the liquid waste processing unit before being transferred to the acid recovery unit of the AP area for recycling.

The mass spectrometry analysis unit performs Pu, U content and Pu, U isotopic composition determination.

The mass spectrometry analysis unit is composed of the two identical lines:

- Each line includes:
  - One glovebox for solution reception
  - One glovebox for sample introduction into the ICP torch
  - One mass spectrometer outside gloveboxes.

This unit performs also dilution of MP powder dissolution solution before sample transfer to the gamma spectrometer for Americium-241 content determination.

11.11.2.18 Alpha and Gamma Spectrometry for MP Powder, AP PuO_2 Powder and AP Liquid Samples

This unit is composed of alpha and gamma spectrometers. The alpha spectrometer analyzer manually receives dried sources (deposits on glassware) from the AP samples alpha and gamma spectrometry preparation unit for determination of plutonium traces (AP liquid samples) and global alpha activity (AP liquid samples).

The gamma spectrometer analyzer manually receives:

- diluted solutions from the AP sample alpha and gamma spectrometry preparation unit for characterization of gamma emitters (or determination of fission products) (AP PuO_2 powder), determination of gamma activity (AP liquid samples), and determination of Americium-241 content (AP PuO_2 powder and liquid samples),
- diluted solutions from the MOX mass spectrometry preparation unit for determination of Americium-241 content in MOX powder.

The diluted solutions are transferred from their respective gloveboxes in specific bottles to the analyzer.

After analysis, the aqueous solutions are manually transferred to the liquid waste processing unit before being transferred to the purification cycle unit of the AP area for recycling.

Solid wastes (glassware or specific bottles) are drummed and stored in waste storage unit.

One alpha spectrometer and one gamma spectrometer are planned for the MFFF laboratory.

11.11.2.19 Thermal Stability Testing of MP Pellets

This unit receives MP pellet samples by pneumatic transfer from the gamma X-ray fluorescence unit. First the density is determined in both air and a specific reagent (i.e., the sample density is determined by weighing a sample before and after plunging the sample into a liquid reagent). The sample is then heated (3,092°F [1,700°C]) under an argon atmosphere for 24 hours. After heating, the density is determined again in both air and in a specific reagent. The densities are compared with the theoretical density. The analysis products are returned to production units as scrap materials after analysis.

This unit is composed of three gloveboxes linked together by a tunnel: one glovebox for weighing, the second glovebox for heating, and the third glovebox for pellet density measurement. The three gloveboxes are located in the test line area.

11.11.2.20 Ceramographic Tests of MP Pellets

This unit receives MP pellet samples by pneumatic transfer from the receipt, weighing, and dispatching unit. The ceramographic tests include:

- Macroscopic examination
- Porosity spectrum determination
- Grain size analysis
- Plutonium homogenization analysis.

Analyses require sample preparation, which consists of pellet longitudinal cutting, coating in a resin, and polishing. After analysis, the analysis products are uncoated for pellet recovery with liquid nitrogen in the specific surface area unit. Recovered pellets are returned to the production units as scrap materials. Aqueous solutions from the polishing operation (that contain diamond

waste) and from chemical treatment (with high chromium and fluoride content) are manually transferred to the liquid waste processing unit before being transferred to the waste storage unit.

This unit is composed of five gloveboxes linked together by a tunnel:

- One glovebox for pellet cutting and coating
- Two gloveboxes for pellet polishing with polishing machines
- One glovebox for chemical treatment
- One glovebox for microscopic examination.

11.11.2.21 Metallographic Examination of Rod Specimens

This unit receives rod specimens by manual transfer from the rod cladding and decontamination units (welding stations) in the MP area. Metallographic examination consists of fuel rod "upper end plug" weld inspection (i.e., verification of circumferential weld and seal weld quality). The analysis requires sample preparation in a glovebox, which consists of:

- Crosswise rod cutting
- Polishing
- Decontamination
- Contamination checks before removing rod specimens from the glovebox.

Cut and decontaminated rod samples are directed to the metallographic examination unit or to the weld corrosion testing line. At the metallographic examination unit, cut and decontaminated samples are submitted to additional preparatory operations (i.e., coating in resin, polishing, chemical treatment, and ultrasonic cleaning) before being transferred to microscopic examination of welds. A clad stratigraphy analysis is performed on cut and decontaminated rod samples to examine weld longitudinal sections. This analysis requires the same preparatory operations.

After analysis, all analysis products are drummed and directed to the waste storage unit.

This unit is composed of four gloveboxes linked together by a tunnel:

- One glovebox for rod cutting
- One glovebox for decontamination and contamination checks
- One glovebox for polishing and chemical treatment
- One glovebox for examination.

Fume hoods are used for polishing and microscopic examination.

11.11.2.22 Weld Corrosion Testing of Rod Specimens

This unit receives rod specimens by manual transfer from the metallographic examination unit. The purpose of corrosion testing in an autoclave is to check circumferential welds and seal welds for possible corrosion, by scavenging the rod specimen with steam at high temperature and high pressure. Weld corrosion tests are performed on cut and decontaminated samples.

Two kinds of tests are performed. The first test is performed in an autoclave (in accordance with ASTM G2-88 international standard). In this test, rod specimens are placed in an autoclave (187 bars, 680°F(360°C), with water) for 72 hours. The weld is then examined visually. The second test is an accelerated corrosion test. In this test, rod specimens are submitted to a reagent (bath of molten salts) and then placed in a furnace (860°F, 460°C) for a few minutes before visual inspection.

This station is composed of two autoclaves and a fume hood, which includes a furnace for the accelerated test.

11.11.2.23 High Plutonium Content Solution Analysis and Preparation of AP Liquid Samples

Since the radiochemical composition of the samples is not homogeneous throughout the AP process, samples with the same radiochemical composition are grouped together in analysis channels, which provide appropriate radiation shielding. The laboratory therefore houses one analytical line with radiation protection for receiving and analyzing samples with high plutonium content.

This unit receives AP liquid samples directly from the liquid sampling gloveboxes (KPG) of the AP area by pneumatic transfer and from the pneumatic departure station dedicated to ALS (Active Local Sampling) samples. This unit covers samples with a plutonium content in excess of 1 g/L. Additional, this unit receives samples with a high level of americium. The unit performs the following operations:

- Dilution of samples before pneumatically transferring the samples to other analytical units for further analyses:
  - to the AP liquid sample (with Pu) mass spectrometry preparation unit for plutonium, uranium content and isotopic composition determination
  - to the low plutonium content solution analysis and preparation unit for oxalate ions, uranium, and tributyl phosphate (TBP) determination
  - to the alpha and gamma spectrometry preparation unit for determination of Americium-241, alpha and gamma activity, and plutonium traces
  - to the impurity concentration determination unit
- Analysis of total plutonium concentration by X-ray fluorescence
- Determination of Pu and Pu (VI) concentration by spectrophotometry
- Determination of solution density
- Determination of acidity
- Pu extraction prior to impurity determination by ICP-AES.

After analysis, aqueous solutions are transferred to the liquid waste processing unit before being transferred to the purification cycle of the AP area for recycling. Organic effluents from Pu

extraction are transferred after decontamination to liquid waste processing unit where they are temporarily stored in a buffer tank.

The unit is composed of four gloveboxes, which are linked by tunnels. Three of the gloveboxes contain remote-handling devices. The first glovebox is fitted with a fiber optic spectrophotometer, a conductivity meter and a titration device, a Pu extraction device, a pneumatic transfer system inlet (from analytical lines), a pneumatic transfer system outlet, and a material feed system (airlock). A small glovebox is connected to the first glovebox and is used for introduction of equipment. The second glovebox is fitted with a solid waste removal system and an analytical balance. The third glovebox is fitted with an X-ray fluorescence device and a diapason densimeter as well as a pneumatic transfer system inlet (from AP sampling benches).

11.11.2.24 Low Plutonium Content Solution Analysis and Preparation of AP liquid Samples

This unit receives AP liquid samples directly from the liquid sampling gloveboxes (KPG) and from the pneumatic departure station dedicated to ILS (Inactive Local Sampling) samples, located in the AP area, by pneumatic transfer, including samples with a plutonium content of less than 1 g/L. This unit also receives AP liquid samples that have been diluted and pre-treated in the unit discussed above.

The following analyses are carried out at this station:

- Plutonium concentration by Pu(IV) spectrophotometry after oxidation of plutonium to Pu(IV)
- Uranium concentration by high-performance liquid chromatography (HPLC)
- TBP concentration by HPLC
- Oxalate concentration by High-Performance Ion Chromatography (HPIC)
- Hydrazine concentration by HPIC
- Chloride ions concentration by ionometry
- pH, acidity and solution conductivity determination
- Transfer of the solutions to other analytical unit for further analyses:
  - to the alpha and gamma spectrometry preparation unit for determination of Americium-241, alpha and gamma activity, and plutonium traces.
  - to the AP liquid samples with U mass spectrometry preparation unit for uranium isotopic composition determination
  - to the impurity concentration determination unit.

Aqueous effluents are transferred to the liquid waste processing unit before being transferred to the acid recovery unit of the AP area for recycling.

The unit is composed of three gloveboxes linked by tunnels:

- One glovebox is fitted with:
  - An optical fiber spectrophotometer
  - A special HPLC device for measuring uranium
  - A special HPLC device for measuring TBP
  - A pneumatic transfer system inlet (from lines)
  - A material feed airlock.
- One glovebox is fitted with a pneumatic transfer system inlet/outlet, a solid waste removal system, a conductimeter, and a pH meter.
- One glovebox contains a HPIC device for measuring oxalate ions, a HPIC device for measuring hydrazine, and electrodes specific to chloride for measuring chloride ions.

11.11.2.25 Alpha and Gamma Spectrometry Preparation of AP Liquid Samples

This unit receives AP liquid samples directly from the high and low plutonium content solution analysis and preparation units by pneumatic transfer. This unit also receives dissolved PuO_2 powder samples from the PuO_2 dissolution unit.

This unit is used to prepare sources for alpha and gamma spectrometry. The following analyses are performed for AP liquid samples:

- Determination of Americium-241 content by gamma spectrometry
- Determination of amount of plutonium traces by alpha spectrometry
- Determination of gamma activity
- Determination of alpha activity.

For AP dissolved PuO_2 powder samples, the Americium-241 content is determined and the gamma emitters are characterized by gamma spectrometry.

The following operations are performed during sample preparation. For alpha spectrometry, sources are deposited on cupels and dried. For gamma spectrometry, solutions are diluted and bottled.

The sources are transferred from the glovebox to the fume hood via an airlock. In the fume hood, the activity level of the sources is monitored and the packaging is verified in order to check that it is free from contamination. The sources are then transferred manually to the detectors (alpha or gamma spectrometer). Aqueous effluents generated by preparation are transferred to the liquid waste processing unit before being transferred to the acid recovery unit. Organic effluents are transferred to the liquid waste processing unit where they are temporarily stored.

The unit has a glovebox connected to a fume hood by an airlock. The glovebox is fitted with a pneumatic transfer system receiver, a drying device for alpha spectrometry preparation, and a solid waste removal system. One alpha spectrometer and one gamma spectrometer are planned for the MFFF laboratory.

11.11.2.26 Mass Spectrometry Preparation of AP Liquid Samples with Plutonium

This unit receives AP liquid samples directly from the high plutonium content solution analysis and preparation unit by pneumatic transfer. The unit also receives tracers from the MOX mass spectrometry preparation unit for uranium and plutonium content analyses. The samples are purified (separation of plutonium and uranium), put into another medium, and sent by the pneumatic transfer system to one of the two mass spectrometers for analysis.

Aqueous solutions generated by preparation are transferred to the liquid waste processing unit before being transferred to the acid recovery unit of the AP area for recycling. Solid wastes are directed to the waste storage unit.

The unit is composed of three gloveboxes connected by a tunnel. One glovebox is fitted with a pneumatic transfer system outlet to send samples to the mass spectrometers. One purification glovebox is fitted with a material feed airlock, a plutonium and uranium separation device and an analytical scale. The other purification glovebox is fitted with a solid waste removal system and a pneumatic transfer system inlet.

11.11.2.27 Mass Spectrometry Preparation of AP Liquid Samples with Uranium

This unit receives AP liquid samples directly from the low plutonium content solution analysis and preparation unit by pneumatic transfer. The samples that this station prepares have high uranium content and a low plutonium level. The samples are purified by elimination of Pu traces in ion exchange resins, placed into another medium, and sent by the pneumatic transfer system to one of the two mass spectrometers for uranium isotopic composition determination.

Aqueous solutions generated by preparation are transferred to the liquid waste processing station before being transferred to the acid recovery unit of the AP area. Solid wastes are directed to the waste storage unit.

The unit is composed of two gloveboxes connected by a tunnel. One glovebox is fitted with a pneumatic transfer system inlet, a material feed airlock, a plutonium and uranium separation device and an analytical scale. The other glovebox is fitted with a solid waste removal system and a pneumatic transfer system outlet to send samples to the mass spectrometers.

11.11.2.28 H_2O and Plutonium Content Gravimetric Analyses for AP PuO_2 Powder

This unit performs the H_2O and plutonium content determination of samples by gravimetry. The sample is divided. For H_2O content, 1g is weighed and heated at 1652°F (900°C) and the weight difference is measured to determine the H_2O content. For plutonium content, 3g are weighed and heated at 2192°F (1200°C) and the weight difference is measured to determine the plutonium content. After analysis, the powder is recovered and sent to the production units via the laboratory for recycling.

Three gloveboxes, installed in the AP area (KCB unit), are used for this operation:

- One glovebox is fitted with a scale and a link to the sampling glovebox in this unit.
- One glovebox is fitted with a fractionation device.

- One glovebox is fitted with a drying oven and a gravimetry analysis device.

11.11.2.29 PuO_2 Dissolution of AP PuO_2 Powder

Dissolution operations producing solutions with a high plutonium content are carried out in a shielded analytical unit. Extensive shielding of gloveboxes is not required for AP PuO_2 Powder samples.

The PuO_2 dissolution unit receives AP PuO_2 powder samples by pneumatic transfer from the receipt, weighing, and dispatching unit. The samples are weighed, and dissolved in nitric (14N) and hydrofluoric (0.05) acids.

This unit performs some analyses on raw dissolution products - plutonium content by X-ray fluorescence and density measurements, and plutonium extraction for analyses by ICP-AES. Samples are also transferred to one of the ICP-AES/ICP-MS stations for a determination of impurities. Dissolution solutions are transferred to the alpha and gamma spectrometry preparation (for Americium-241 content and characterization of gamma emitters), to the AP powder mass spectrometry unit (for Pu content and isotopic composition) and to the ICP-AES/ICP-MS analyzers (for impurity content determination). Aqueous solutions generated in this unit are transferred to the liquid waste processing unit before being sent to the purification cycle in the AP area. Organic effluents generated by plutonium extraction are transferred after decontamination to liquid waste processing unit where they are temporarily stored in a buffer tank.

This unit consists of four gloveboxes:

- One glovebox with a remote-handling master slave and a pneumatic transfer system inlet
- One glovebox with two remote-handling devices fitted with an analytical balance
- One glovebox with two remote-handling devices, a solid waste removal system, and a dissolution device (heating plates, reflux cooled condensers)
- One glovebox with two remote-handling devices fitted with:
  - One equipment airlock
  - One pneumatic transfer system outlet
  - One pneumatic transfer system inlet
  - One densimeter
  - One X-ray fluorescence spectrometer
  - One plutonium extraction device.

11.11.2.30 Mass Spectrometry Preparation of AP PuO_2 Powder Samples

A specific unit is reserved for the preparation of plutonium oxide samples to prevent contamination by uranium. The purpose of this line is to prepare samples in order to determine the plutonium content and the isotopic composition of plutonium by mass spectrometry. This unit receives AP dissolved PuO_2 powder samples from the AP PuO_2 dissolution unit by pneumatic transfer. This unit carries out dilution, purification, and change of medium before

transferring the solutions to be analyzed to one of the two mass spectrometers for analysis. The aqueous effluents generated in the unit are then transferred to the liquid waste processing unit before being transferred to the purification cycle in the AP area. Solid waste is drummed and sent to the waste storage unit.

This unit is composed of three gloveboxes:

- One glovebox is fitted with a material feed airlock and analytical scales.
- One glovebox (separation chemistry) is fitted with a solid waste removal system, a separation device (ion exchange resin) and a pneumatic transfer system inlet.
- One glovebox is fitted with a pneumatic transfer system outlet.

11.11.2.31 AP Sample Storage

Two gloveboxes are reserved for AP liquid and powder sample storage. The AP powder storage glovebox is located in the AP area (KCB unit). This glovebox is linked by pneumatic transfer to the AP powder sampling glovebox for reception and removal of samples. Stored samples are mainly used as spare samples.

The AP liquid storage glovebox is located in the laboratory. This glovebox is mainly used for possible client checks and for new analyses (spare samples). This glovebox is linked by pneumatic transfer to:

- AP liquid sampling gloveboxes (KPG) in the AP area for the reception of samples
- High and low plutonium content solution analysis and preparation lines to perform new analyses
- Liquid waste processing unit of the laboratory for sample removal.

11.11.2.32 Liquid Waste Processing

The liquid waste processing unit is composed of four 15.8-gal (60-L) buffer tanks, which collect the laboratory effluents generated by analyses:

- Two tanks to collect and transfer solutions to the purification cycle in the AP area after fluoride ions complexation and analysis
- One tank to collect solutions that are transferred to the acid recovery unit after analysis
- One tank to collect solutions that are non-recyclable in the AP process and temporarily store the solutions.

Two gloveboxes are located atop these tanks for manual introduction of wastes, sampling, etc.

Each tank is equipped with:

- A pump to transfer or homogenize the solutions
- A sampling point for solution characteristics analysis before transfer

- Level sensors.

11.11.2.33 Solid Waste Processing

The laboratory solid waste processing operation consists of:

- Recovering scrap material from coated pellets and crucibles in order to recycle it into the production units.
- Effluent treatment to obtain a solid matrix that can be stored as waste. This operation is only performed on very low plutonium content solutions whose characteristics are not in compliance with production criteria.

[ ]

Wastes are treated at each unit that generates nonrecyclable effluents or residues.

11.11.2.34 Calibration

This unit manages and periodically checks working standards and MP process measuring instruments involved in product quality. This unit stores reference standards and transfer standards. A checklist accompanies each working standard and measuring instruments.

This unit is composed of one glovebox for contaminated equipment calibration and several measuring instruments outside the glovebox.

11.11.2.35 Preparation of Reagents

This unit includes several laboratory benches and fume hoods for preparing, checking, and distributing chemical reagents for the different analytical processes. Additionally, the multi-elementary solutions used for the calibration of ICP-AES/ICP-MS analyzers are prepared at this unit. The reagent preparation room is equipped with items such as: scales, heating plates, a conductimeter, a pH-meter, and a drying oven.

11.11.2.36 Test Line

The MP test line is located in the laboratory. The main steps of the pellet fabrication process are reproduced at the test line to adjust process parameters and characterize MP blends. This unit receives MP primary blend and final blend powder samples and MP sintered pellet samples.

The following operations are performed using primary blend:

- Primary blend tap and bulk density measurement and flowability test.
- Primary blend milling.
- Sieving.
- Final blend preparation by mixing the primary blend with UO_2 powder.
- Final blend tap and bulk density measurement and flowability test.
- Lubricant addition and homogenization.
- Pelletizing (at different pressures).
- Green density measurement.
- Sintering. The test line is not equipped with a sintering furnace. Thus, the green pellets are transferred to the MP Sintering Units.
- Grinding.
- Visual inspection and laboratory analyses. Ground pellets are pneumatically transferred to the receipt, weighing, and dispatching unit of the laboratory.

After processing in the test line, products return to production units as scrap materials.

This unit is composed of four gloveboxes linked together by a tunnel and fitted with a ball mill, a sieve, a mixer, and a press.

Two other gloveboxes are linked together by a tunnel and are fitted with a grinder and a dust removal system.

11.11.3 Major Components

The major components of the laboratory are described in Section 11.11.2.

11.11.4 Control Concepts

The Manufacturing Management Information System (MMIS) manages overall production data that permit production control, nuclear material management, and product quality control within the MFFF. The MMIS provides authorization for material flow to, from, and within the laboratory. Analytical results are stored in a local subsystem of the MMIS, called the LMIS (Laboratory Management Information System). The laboratory is equipped with independent systems (e.g., PCs, PLCs, computers). Figure 11.11-1 shows the laboratory system environment.

11.11.5 System Interfaces

The system interfaces of unit are described in Section 11.11.2. Links between the laboratory and the other units of the MFFF are shown in Figure 11.11-2.

11.11.6 Design Basis for Non-Principal SSCs

The laboratory is designed to perform chemical and physical analyses of samples coming from the MP and AP production units. In addition, when processing AFS material, the AFS portion of the Laboratory will perform chemical analyses on the samples taken from the cans entering the AP process. The MFFF is designed for receiving samples sent by pneumatic transfer from the production units to the laboratory. The analyses are performed manually in the laboratory. The laboratory is designed to support the MFFF capacity of 70 metric tons of heavy metal per year.

11.11.7 Design Basis for Principal SSCs

The following principal SSCs associated with the laboratory are:

- C4 confinement system
- Chemical safety controls
- Laboratory material controls
- Combustible loading controls
- Criticality controls
- Fire barriers
- Fire detection and suppression
- Fluid transfer systems
- Glovebox
- Glovebox pressure controls
- Material handling controls
- Material handling equipment
- Material maintenance and surveillance programs
- Process control safety subsystem
- Facility worker action

The design bases for principal SSCs associated with the laboratory units (e.g., HVAC, confinement) is included and discussed with other systems. Criticality safety is discussed in Chapter 6. The detailed MOX process hazard evaluations performed in support of the Integrated Safety Assessment will identify specific IROFS associated with the MFFF Laboratory.

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Tables

Table 11.11-1. MFFF Laboratory Sample Analysis Description

Product Type	Analyses Required	Analytical Principle	Anticipated Average Sampling Frequency

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Product Type	Analyses Required	Analytical Principle	Anticipated Average Sampling Frequency

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Table 11.11-1. MFFF Laboratory Sample Analysis Description

Product Type	Analyses Required	Analytical Principle	Anticipated Average Sampling Frequency

Table 11.11-2. MFFF Laboratory AFS/AP Sample Analysis Description

Unit	Equipment		Sampling number	Sampling type	Solution nature	Activity mCi/l	Composition	Determinations	Anticipated Frequency		Observations
	No.	Function							Periodicity	Exceptional	

Table 11.11-2. MFFF Laboratory AFS/AP Sample Analysis Description

Unit	Equipment		Sampling number	Sampling type	Solution nature	Activity mCi/l	Composition	Determinations	Anticipated Frequency		Observations
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Figures

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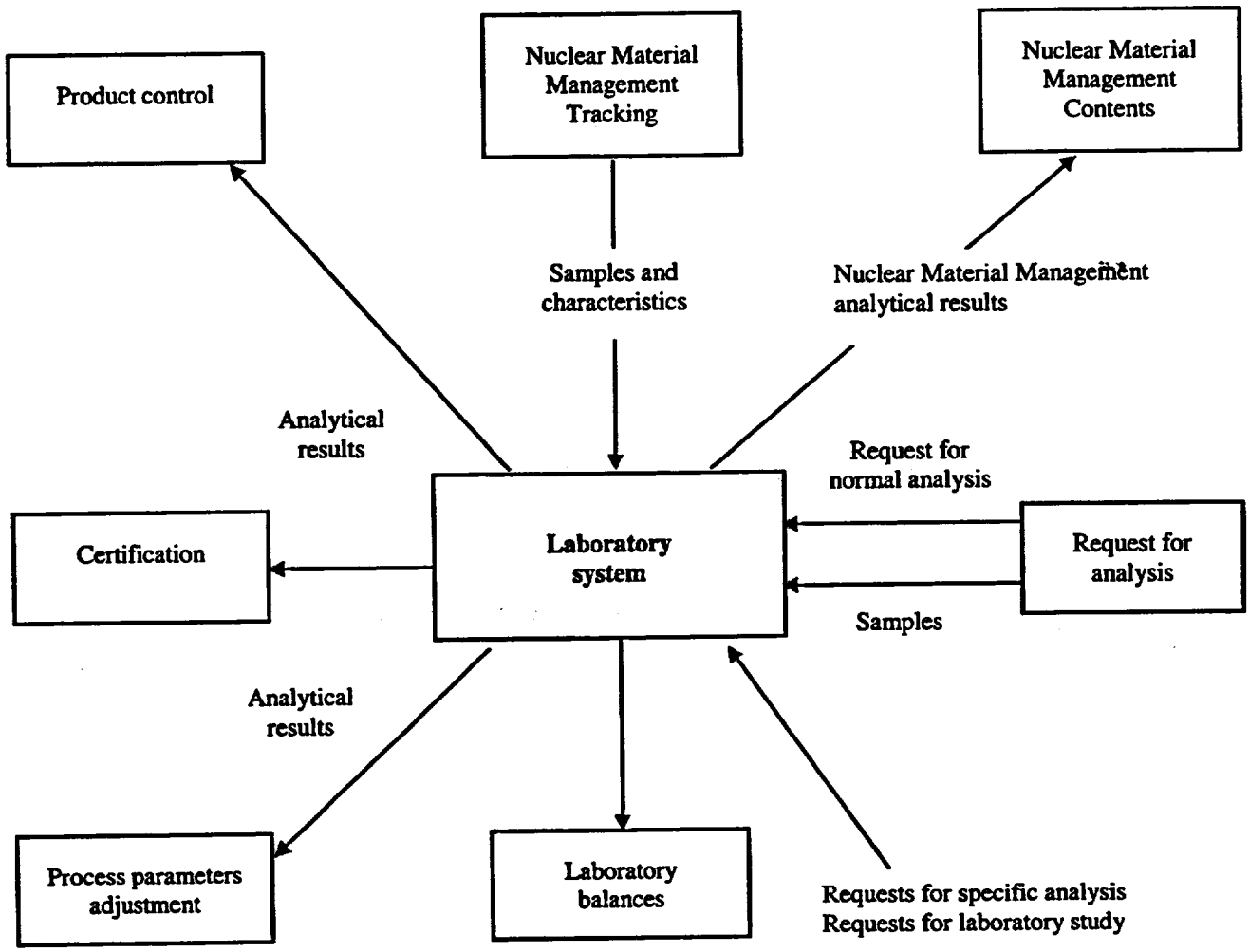

Figure 11.11-1. Laboratory System Environment

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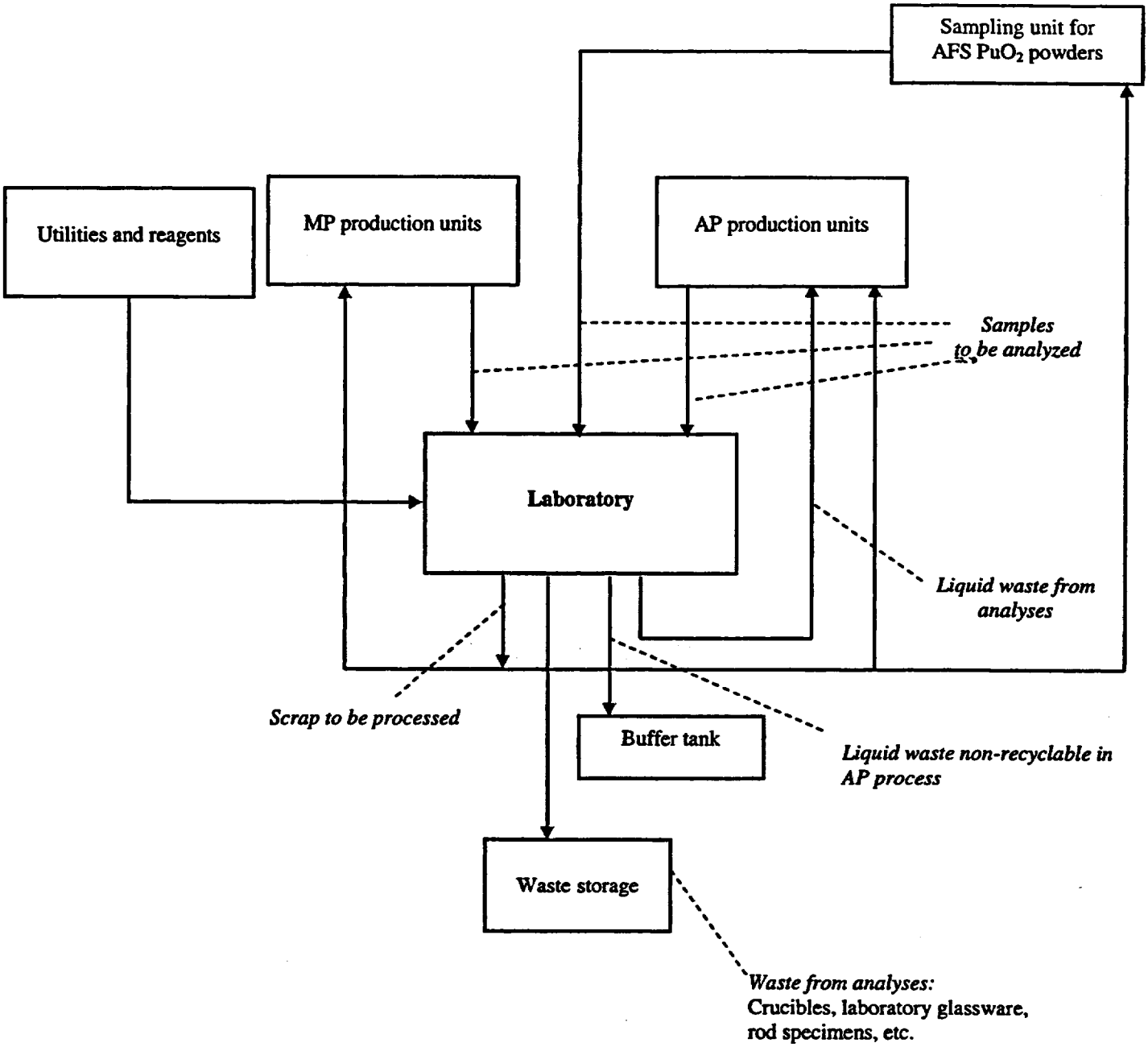

Figure 11.11-2. Links Between the Laboratory and the Other Units of the MFFF

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11.12 SEISMIC QUALIFICATION OF EQUIPMENT, SYSTEMS, AND COMPONENTS

This section identifies seismic classification and analysis requirements that apply to structures, systems, and components (SSCs) associated with the MOX Fuel Fabrication Facility (MFFF), including process equipment, gloveboxes, ducts, piping, and piping and duct supports. SSCs are seismically qualified to ensure that in the event of a design basis earthquake, safety functions are performed and/or maintained as appropriate. Seismic qualification requirements are applied using a graded classification program that considers the relative importance of the safety function and the structural behavior of the SSC. Seismic qualification requirements, including seismic loading, analytical approach, and acceptance criteria, are specified based on the seismic classification assigned to each SSC. Seismic qualification of structures is discussed in Section 11.1. Principal SSCs are identified in Chapter 5.

11.12.1 Seismic Classification of Structures, Systems, and Components

SSCs at the MFFF are seismically classified both by seismic category and by a more specific functional classification called seismic performance requirement. Application of these classifications to MFFF SSCs is discussed in the following sections.

11.12.1.1 Seismic Category

The Seismic Category I (SC-I) classification is applicable to MFFF SSCs and the supporting SSCs that are required to withstand the effects of the design basis earthquake in order to prevent or mitigate design basis accidents. The SC-I classification applies to all principal SSCs that must perform safety functions during and/or after the design basis earthquake to comply with the MFFF safety assessment as described in Chapter 5.

Those portions of systems whose function is not required after a design basis earthquake but whose failure could adversely impact the ability of an SC-I system to perform its safety function are designed so that the design basis earthquake will not cause such failure. Any such portion of a system is designated as Seismic Category II (SC-II). Items that are neither SC-I nor SC-II are not classified with respect to seismic category. However, components that form boundaries between SC-I and SC-II portions of systems are designed to SC-I requirements.

11.12.1.2 Seismic Performance Requirement

The seismic performance requirement classification segregates SC-I and SC-II SSCs by the safety functions they must perform during or after a seismic event. Definitions for each classification are provided below. Classifications C and B apply to SC-I SSCs. Classification A is synonymous with SC-II. Unless noted otherwise, the safety functions must be performed both during and after design basis earthquakes.

- C2: Item must remain active during and after design basis earthquakes
- C1: Item must remain active after design basis earthquakes
- B3: Item must maintain pressure boundary integrity

- B2: Item must maintain structural integrity in the elastic stress range
- B1: Item must maintain structural integrity, with limited plastic deformation
- A: Item must not fail in a way that compromises a principal SSC by interaction (SC-II).

The seismic performance of SSCs in each classification is ensured by establishing analysis or test procedures and acceptance criteria specific to the function being performed.

11.12.2 Analysis Requirements for SC-I and SC-II Elements

This section presents general requirements for the seismic analysis of SSCs classified as SC-I and SC-II.

11.12.2.1 Seismic Design Parameters

SC-I and SC-II SSCs are qualified for seismic loading based upon ground motion that meets or exceeds the design basis earthquake for the facility. SSCs are analyzed using in-structure response spectra corresponding to the point of structural attachment. In-structure response spectra are generated in accordance with one of the methods cited in the American Society of Civil Engineers' "Standard Seismic Analysis of Safety-Related Nuclear Structures" (ASCE 4-98), Section 3.4. The in-structure response spectra are peak-broadened to account for uncertainties in the specification of analysis input parameters.

11.12.2.2 Seismic Inertia Analysis Procedures

The inertial response of SC-I and SC-II SSCs to seismic loading is generally determined using either dynamic or static analyses where justified. General requirements for these procedures are described below.

11.12.2.2.1 Response Spectrum Dynamic Analysis Method

Response spectrum dynamic analyses used to qualify SC-I and SC-II elements for seismic loading are performed in accordance with ASCE 4, Section 3.2.3. Elements of this method are as follows:

- **Mass/stiffness representation** – Analytical models of SSCs are developed based on decoupling criteria. The models incorporate all mass and stiffness characteristics that significantly affect dynamic response. The effects of support stiffness, in particular, are considered. A change in calculated response of 10% or more is considered significant. Masses are lumped or distributed as appropriate. Modeling considerations given in ASCE 4 apply.
- **Dynamic loading** – Loading in the form of acceleration response spectra corresponding to the equipment support points is used to determine the equipment seismic inertial response. For equipment supported at multiple points, the envelope of the acceleration response spectra corresponding to each support point is used to determine the inertial response.

- **Damping** – The effects of structural damping are incorporated in the analysis by selecting acceleration response spectrum curves that reflect an appropriate level of damping for the equipment response. Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," October 1973 is used for guidance in determining the proper damping.
- **Modal participation** – All vibratory modes below a rigid cutoff frequency of 33 Hz are included in calculating the system dynamic response. In the event that the mass participating in the response in any of the three global directions is less than 90% of the total system mass, corrections are made to account for the response of the non-participating mass.
- **Modal combinations** – Individual modal responses obtained for a model due to loading in a given direction are combined using the "square root of the sum of the squares" (SRSS) method and 10% closely spaced mode criteria. Modal combinations are performed before spatial combinations.
- **Spatial combinations** – The seismic analysis considers the combined effects of seismic loading in both principal horizontal directions acting concurrently with loading in the vertical direction. The responses in the horizontal and vertical directions are calculated independently and then combined. SRSS is the preferred method of combining spatial responses.

11.12.2.2.2 Equivalent Static Seismic Inertia Analysis

SC-I and SC-II elements that are adequately represented by a single-degree-of-freedom or simple multiple-degree-of-freedom model may be analyzed using the equivalent static analysis procedure. Elements of this procedure are as follows:

- **Design load** – The seismic design load applied to an element in a given direction is determined by multiplying the mass of the element by the peak acceleration from the applicable floor or ground motion response spectrum, amplified by a factor taken from ASCE 4, Section 3.2.5. The factor accounts for the number of degrees of freedom in the element. The seismic response of the element is calculated considering the design load to act at the element center of mass.
- **Spatial combinations** – The seismic analysis considers the combined effects of seismic loading in both principal horizontal directions acting concurrently with loading in the vertical direction. The responses in the horizontal and vertical directions are calculated independently and then combined in accordance with ASCE 4, Section 3.2.7.1.2. SRSS is the preferred method of combining spatial responses.

11.12.2.3 Seismic Anchor Movement Analysis

Where SSCs are supported at multiple points, the effects of the relative displacements of these support points under seismic conditions are incorporated in the overall seismic response calculation. The effect of seismic anchor movements is calculated by applying the worst-case combination of peak support point displacements. The results of the seismic anchor movement

analysis are combined by SRSS with the results of the seismic inertia analysis to determine the overall seismic response.

11.12.3 Seismic Qualification Requirements

Requirements for the qualification of SC-I or SC-II SSCs, as well as components not classified with respect to seismic category, are presented below. Acceptance criteria for SC-I and SC-II items are specified based on seismic performance requirement.

11.12.3.1 Qualification of C2 and C1 Elements for Operability

Qualification of active SC-I components to perform required functions during and after (i.e., C2 classification) or after only (i.e., C1 classification) the design basis earthquake is typically demonstrated by analysis or by "shake table testing" as necessary. Shake table testing is required for cases where analysis alone is insufficient to ensure operability after a seismic event (e.g., electrical components). Qualification by analysis, in general, uses design code allowable stress acceptance criteria based on elastic deformation.

11.12.3.2 Qualification of B3 Elements for Pressure Boundary Integrity

Qualification of SC-I/B3 SSCs to maintain pressure boundary integrity during and after the design basis earthquake is typically demonstrated by analysis or by "shake table testing" as necessary. Qualification by analysis ensures that stresses in system pressure boundary elements and their supports meet allowable stresses based on elastic limits specified in the applicable design codes for the stipulated seismic loading combinations.

11.12.3.3 Qualification of B2 Elements for Structural Integrity

Qualification of SC-I/B2 SSCs to maintain structural integrity during and after a design basis earthquake is typically demonstrated by analysis or by "shake table testing" as necessary. Qualification by analysis ensures that stresses in all structural elements in the load path calculated under design basis earthquake loading conditions meet ANSI/AISC N690-1994, "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities (SC-I)," code allowable stresses for the "extreme" seismic loading combination.

11.12.3.4 Qualification of A and B1 Elements to Maintain Configuration

Qualification of SC-I/B1 and SC-II/A SSCs to maintain basic configuration during and after the design basis earthquake is typically demonstrated by analysis or by "shake table testing" as necessary. Qualification by analysis ensures that stresses in all structural elements in the load path calculated under seismic loading conditions meet ANSI/AISC N690-1994 code allowable stresses for the "abnormal extreme" seismic loading combination.

11.12.3.5 Qualification of Non-Seismic Category Elements

The seismic analysis of non-seismic category elements is based on occupational safety concerns, good engineering practice, and protection of the capital investment in the plant. The primary source of information regarding system qualification and seismic loading is the Uniform Building Code.

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12. HUMAN FACTORS ENGINEERING FOR PERSONNEL ACTIVITIES

Human factors engineering (HFE) is conducted as part of design development to provide reasonable assurance that the potential for human error is considered and minimized to the extent practical by facilitating appropriate personnel actions and inhibiting operator errors.

12.1 IDENTIFICATION OF PERSONNEL ACTIONS

Control of the operations of the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) relies to a great extent on automated systems to ensure consistent production quality and facility safety. In general, the operations staff is expected to perform the following types of tasks:

- Initiate batch or continuous operations
- Monitor the progress of the operations
- Perform or initiate performance of quality control checks at preprogrammed hold points in the process
- Monitor and confirm the status of confinement systems, fluid systems, and other facility systems
- Respond to or recover from off-normal conditions.

Personnel actions are facilitated by the automated control systems that are provided. Automated controls are provided by normal, protective, and safety control subsystems of the AP and MP Systems, the Utility Control System, and the Emergency Control System. These systems are designed with a tiered backup-type architecture. The MFFF control systems are described in Section 11.6.

The normal control subsystems constitute the operators' primary system interface and controls plant systems within normal parameters. The normal control subsystems do not have a safety function and are not considered principal structures, systems, and components PSSCs).

The safety control subsystems perform monitoring and control functions necessary to meet various 10 CFR 70.61 performance requirements, and are identified as PSSCs. The safety control subsystem operates independently of the normal control subsystems. Actions associated with safety control functions have precedence over and override normal and protective control actions. A description of the normal controllers and safety controllers is in Sections 11.6.3.3.1 and 11.6.3.3.3.

The emergency control system provides two redundant, independent, and hardwired control divisions, which automatically intervene and take control of the operation of principal structures, systems, and components "PSSCs" in the event of certain accident conditions. A description of the emergency controllers is found in Section 11.6.3.3.4.

The personnel and equipment protective (PEP) control subsystem is not a PSSC. It is designed to satisfy the industrial safety requirements of 29 CFR 1910 and to protect the equipment. The PEP control subsystem has no human-system interface (HSI) that allows an operator to bypass its

functionality. The operators are not required to interface with nor be cognizant of the protective control system except to perform maintenance or to monitor its sensors or resultant actions. The operators have no direct access to the controllers and cannot routinely intervene in their operation. Monitoring of the PEP control system's sensors and actions is performed through the normal control system HSI. A description of the personnel and equipment protective controllers is found in section 11.6.3.3.2.

With respect to the operation of principal SSCs involved with confinement, the operator selects operational configurations and adjusts control settings as dictated by ambient conditions. Major components are started or taken out of service manually by operators as necessary to balance equipment run time or to perform maintenance.

There are no design basis events that require immediate operator action to mitigate the consequences to below the performance criteria of 10 CFR 70.61. Errors in operator actions have been anticipated in the system design while considering other deterministic design basis accident assumptions and scenarios.

Operators primarily perform monitoring activities in response to emergency conditions. The AP and MP processes are designed to shut down during upset conditions.

An Integrated Safety Analysis (ISA) will include evaluation of internal, man-made-external, and natural phenomena hazards. A subset of the events analyzed within the ISA involves personnel actions that have the potential to result in adverse consequences. The ISA will include evaluation of operator actions and in-actions as well as errors of omission and commission.

If an operational upset occurs during normal operations, the operations staff first confirms that the operation of SSCs is within the safety limits and ensures that the control system has initiated appropriate action (e.g., start redundant fan, initiate process shutdown). If events lead to intervention of the safety control system, restoration of control to the normal control system is a manual action.

At this stage of design, very few if any personnel actions are expected to be relied on for safety. Specific actions required to prevent or mitigate design basis events will be identified during final design and included in the appropriate procedures.

12.2 HFE DESIGN PLANNING

HFE design includes the identification of HFE programmatic goals and scope and a description of the plans for HFE review, including HFE team makeup and the processes for conducting HFE reviews. The ISA process will identify the sensors, instruments, and actuators that are relied on for safety. The appropriate HSI requirements will be identified, and the human performance requirements will be established during the detailed design process. Activities associated with the maintenance or operation of the instruments, sensors and actuators relied on for safety will be evaluated for Human Factors attributes.

12.2.1 Goals and Scope of Human Factors Engineering Program

HFE principles are applied to the MFFF design based on the guidelines of IEEE 1023 (1988), *IEEE Guidelines for the Application of Human Factors Engineering to Systems and Equipment, and Facilities of Nuclear Power Generating Facilities.* The goals of the HFE program are as follows:

- Include HFE principles in the design of the MFFF such that personnel activities that are relied on for safety do not challenge the performance capabilities of the operators
- Verify that the design is appropriate with respect to HFE principles prior to construction of the MFFF
- Demonstrate the adequacy of the human factors design by integrated system validation and, if necessary, final HFE/human-system interface (HSI) verification of personnel activities during construction and startup of the MFFF
- Document the HFE process including analysis, findings, and deviations
- Institute procedures that ensure the HFE principles are appropriately applied to changes to the baseline design as described in section 15.2.1 of the CAR.

The scope of HFE during the design phase of the MFFF is to apply HFE criteria to the design of principal SSCs that have associated personnel activities for operation, testing, or maintenance. HFE is also applied to system interfaces and the supporting equipment and systems that control the environment in which the personnel activities will be performed. Aspects of the design that reduce the risk of errors or challenges to principal SSCs are evaluated.

During the construction and startup of the MFFF, a formal review will be conducted to verify and validate the personnel activities and to ensure that the HFE design was appropriately applied to the facility and that procedures and training in support of facility operations are appropriate. The personnel responsible for conducting HFE design reviews are discussed later in this chapter.

12.2.2 Organizational Responsibilities

The MFFF Engineering Manager is responsible for the implementation of the HFE program, and authorizes the HFE team to recommend and coordinate actions to ensure HFE principles are adequately reflected in the design. The HFE team, represented by appropriate controls engineering and operations experience, verifies the implementation of HFE design criteria as part of the review of the final design. The team is supplemented as appropriate during construction and startup by additional operations and maintenance personnel.

12.2.3 HFE Process

HFE is applied to the MFFF in a multiple-phase approach. Three distinct phases, corresponding to preliminary design, final design, and construction and startup, are used for HFE. The phased approach is used to provide efficiencies during the design process and to incorporate the considerable operating experience of the La Hague and MELOX facilities. HFE is risk-informed, and is conducted commensurate with the safety significance, complexity, and degree

of human-system interaction. The HFE approach provides for the appropriate review of operating experience and ongoing participation in design reviews by operations personnel. During detailed design, detailed task analysis is completed, along with HSI design, inventory, and characterization, and HFE verification and validation in support of construction and startup.

12.2.3.1 Preliminary Design

The MFFF is based on the proven design of COGEMA's MELOX and La Hague facilities. During the preliminary design of the MFFF, the control system architecture, control philosophies, and HSIs were developed with emphasis on the proven control methods from MELOX and La Hague. The original design and ongoing evolution of these facilities incorporated various degrees of human factors methods and reflect several years of safe operation. To supplement their use as a "reference design," operational experience is incorporated into the design through a combination of lessons-learned evaluations (focusing on operability and maintainability issues, and involving current operations and maintenance personnel) and review of the design on an ongoing basis by experienced operations staff.

Functional allocation of tasks is based on the design and operation of the two reference facilities, as reflected by the establishment of the design based on the existing designs and the continued involvement of operations staff in reviews of the design as it evolves. As stated in Section 12.1, the MFFF is an automated facility and the tasks assigned to humans involve primarily initiating, verifying, and monitoring system status.

12.2.3.2 Final Design

Criteria for HFE are identified in MFFF design basis documents and will be applied throughout the final design for aspects of operation and maintenance of the MFFF. The task analysis will be completed during final design, and will reflect the personnel activities relied on for safety identified as part of the development of the ISA. During the detailed design of the human-system interface, inventory and characterization of the interfaces will be performed. Evaluation of the characteristics of the human-system interfaces will use the review criteria of NUREG-0700, Rev. 2, as the basis, as applicable for a fuel fabrication facility.

The design will be verified in accordance with the configuration management and design control processes discussed in Chapter 15, through review of design documents including task analyses, HSI design, inventory, and characterization, and other elements of the design involving personnel action. Elements of the HSI subject to HFE review include the overall work environment, work space layout, control panel and console design, control and display device layout, and information and control interface design details, as applicable. HFE review also applies to the development of operating, maintenance, and test procedures, as well as the development and/or consideration of training to those procedures, as appropriate.

HFE results will be factored into the Integrated Safety Analysis (ISA) appropriately. HFE results include:

- The MFFF HFE design review plan describing the methodology used to implement HFE activities during final design

- Summary of the system functions, analysis of personnel activities, and human-system interface inventory and characterization
- Information regarding exceptions taken to HFE criteria and the justification for those exceptions as appropriate.

HFE results will be reflected in the ISA Summary accompanying the license application for the possession and use of SNM.

12.2.3.3 Construction

The final personnel activities review will be performed during startup testing. The HFE review team will be supplemented by additional operations, maintenance, and engineering personnel as appropriate. The procedures for the final personnel activities review will be developed during the construction phase. NUREG-0700, Rev. 2, will be used as the guideline for the review, as applicable to a fuel fabrication facility. Procedures developed during the construction phase will be integrated into the configuration management program such that changes to principal SSCs during construction will be evaluated for aspects of personnel activities.

The final review will be an integrated system validation of personnel activities relied on for safety including, but not limited to, human-system interfaces, procedure development, training development, staffing, and maintenance tasks. The human performance activities identified in the functional allocations and task analysis will be updated to reflect the final results of the ISA.

HFE information will be maintained as part of ISA documentation, and will include a summary description of the methodologies and findings of the human-system interface verification and validation, including task verification, design verification, and integrated system validation. Additionally, the configuration management system will capture summary resolution of significant HFE issue resolution occurring as a result of design reviews or audits, assessments, or incident investigations (see Chapter 15). HFE discrepancies and accepted design solutions or corrective actions, along with schedule for implementation of the solutions, as appropriate, are documented in accordance with QA procedures.

As part of ISA documentation associated with personnel activities relied on for safety, this information is also subject to configuration management controls as discussed in Section 15.2. Changes to the facility design or operating procedures (i.e., as a result of design changes or conclusions of incident investigations or deficiencies identified during audits or assessments) are reviewed in accordance with the appropriate configuration management procedures, which will include review against HFE criteria. This ongoing maintenance of the HFE design basis ensures the appropriate human factors considerations continue to be reflected in the design and operation of the facility.

12.2.4 Issue Tracking

As indicated above, HFE issues identified as a result of this verification are processed as design review comments and tracked to resolution in accordance with configuration management and design control procedures. Deviations from the HFE design criteria are documented, justified, and approved.

12.3 OPERATING EXPERIENCE

As a result of the selection of existing facilities with successful operating histories as a reference design for the MFFF, and the ongoing involvement of operations and engineering personnel from these facilities in the development of design, no additional formal operating experience review is anticipated. During the design phase, the relevant operational experiences of similar facilities is incorporated into the MFFF design. During the operational phase of the MFFF, the operational experiences of the MFFF will become part of the continuing review of the facility as specified in Section 6.3 of IEEE Std 1023.

12.4 FUNCTION AND TASK ANALYSIS

Operational tasks are well established for the existing facilities for the purposes of preliminary design. Additional task analysis will be conducted during detailed design as discussed in Section 12.2.3.

12.5 HSI DESIGN, INVENTORY, AND CHARACTERIZATION

HSI design, inventory, and characterization are initially based on the MELOX and La Hague designs. Additional detail will be developed during detailed design, as discussed in Section 12.2.3.

12.6 OTHER CONSIDERATIONS

Staffing, procedure development, and training will be addressed in the HFE plan developed as part of detailed design. HFE verification and validation is discussed in Section 12.2.3. Final HFE/HSI design verification, if necessary, will be conducted during startup. Additional details will be discussed in the license application for possession and use of SNM.

13. SAFEGUARDS

13.1 PHYSICAL PROTECTION PLAN

Design bases for physical protection are provided under separate cover, and are withheld from public disclosure pursuant to 10 CFR 2.790(d).

13.2 MATERIAL CONTROL AND ACCOUNTING

Design bases for material control and accounting are provided under separate cover, and are withheld from public disclosure pursuant to 10 CFR 2.790(d).

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14. EMERGENCY MANAGEMENT

This chapter addresses the need for an emergency plan for the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF). In accordance with 10 CFR §70.22(i), each applicant to possess in excess of 2 curies of plutonium in unsealed form, or for which a criticality accident alarm system is required, must provide either:

- An evaluation showing that the maximum dose to a member of the public offsite due to a release of radioactive materials would not exceed 1 rem effective dose equivalent or an intake of 2 milligrams of soluble uranium, or
- An emergency plan for responding to the radiological hazards of an accidental release of special nuclear material and to any associated chemical hazards directly incident thereto.

DCS expects to be able to demonstrate that the maximum dose to a member of the public offsite due to a release of radioactive materials would not exceed 1 rem effective dose equivalent or an intake of 2 milligrams of soluble uranium. Therefore, an emergency plan for responding to the radiological hazards of an accidental release of special nuclear material and to any associated chemical hazards directly incident thereto is not required.

DCS commits to providing with the license application for possession and use of special nuclear material, an evaluation that demonstrates that the maximum dose to a member of the public would not exceed 0.01 Sv (1 rem) effective dose equivalent or an intake of 2 milligrams of soluble uranium in accordance with 10 CFR §70.22(i)(1)(i).

DCS will establish a protocol with the U.S. Department of Energy Savannah River Operations Office (DOE-SR) that will provide for integration with the existing Savannah River Site emergency preparedness program, including limitation of site access in the event of an emergency at the MFFF (see Section 1.1.2.1).

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15. MANAGEMENT MEASURES

Management measures supplement principal structures, systems, and components (SSCs) (and later, items relied on for safety [IROFS]) by providing the administrative and programmatic framework for configuration management, maintenance, training and qualifications, procedures, audits and assessments, incident investigation, and records management associated with principal SSCs and personnel activities relied on for safety. Management measures are implemented through a quality assurance (QA) program in accordance with 10 CFR Part 50 Appendix B. The QA program also provides additional measures for ensuring that the design, construction, and operation of principal SSCs are controlled commensurate with their importance to safety.

15.1 QUALITY ASSURANCE

Duke Cogema Stone & Webster (DCS) submitted its MOX Project Quality Assurance Plan (MPQAP) (Rev. 2) prior to the Construction Authorization Request utilizing Option A of Section 15.1 of NUREG 1718. MPQAP Revision 3, incorporating the clarifications and commitments identified in the Safety Evaluation Report issued by the NRC on October 1, 2001, was transmitted to the U.S. Nuclear Regulatory Commission (NRC) on March 26, 2002. DCS has implemented and commits to maintaining its QA Program, which is based on the applicable requirements of Parts I and II of American Society of Mechanical Engineers (ASME) NQA-1-1994, as revised by the ASME NQA-1a-1995 Addenda and NRC Regulatory Guide 1.28 (Rev. 3).

The DCS QA Program is composed of the Quality Assurance Program Policy Statement, the MPQAP, and implementing QA project procedures. The DCS QA Program is a living program that is kept current to continuously provide the QA management measures needed for the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF). The revision of the MPQAP issued for the Construction Authorization Request provides the QA management measures for quality-affecting activities for both the Base Contract (design) and Option 1 (construction). Quality-affecting activities are defined in MPQAP Section 2.1.1, "Program Basis," as "deeds, actions, processes, tasks or work which influence the achievement or verification of quality requirements and objectives for Quality Level 1 and 2 structures, systems and components (SSCs) and their associated activities." MPQAP Section 2.2, "Graded Quality Assurance," defines the DCS quality levels for the MOX Fuel Project.

The DCS MPQAP was developed to incorporate the QA requirements from the following nuclear quality standards into the implementing QA project procedures:

- 10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants*
- Parts I and II of ASME NQA-1-1994, *Quality Assurance Requirements for Nuclear Facility Applications*, as revised by the ASME NQA-1a-1995 Addenda
- NRC Regulatory Guide 1.28 (Rev. 3), *Quality Assurance Program Requirements (Design and Construction).*

These nuclear quality standards form the basis for the MPQAP implementing QA requirements for the design and construction of the MFFF. Sections 1 through 18 of the MPQAP describe the QA requirements for quality-affecting activities and coincide with the 18 criteria of 10 CFR Part 50, Appendix B. Each MPQAP section lists the NQA-1-1994 Basic Requirement, NQA-1a-1995 Addenda and Regulatory Guide 1.28 (Rev. 3) applicability, and the applicable supplements and appendices that DCS commits to implementing for each of the 10 CFR Part 50, Appendix B criteria. Detailed QA requirements for each criterion are then presented in their respective sections.

The requirements of the MPQAP are applied to DCS and subcontractor MFFF design and construction activities that affect principal SSCs. Principal SSCs are defined as those SSCs determined initially to be needed to protect the public, the worker, and the environment against the radiological consequences of accidents and natural phenomena. Principal SSCs are those SSCs (and human actions) that are or are expected to be IROFS during the conduct of the Integrated Safety Analysis (ISA).

Principal SSCs were determined based on a review of the applicable regulations and MELOX and La Hague experience. Classification of principal SSCs was then confirmed or changed, as necessary, by the safety assessment of the design basis. Final classification will be based on the ISA. QA requirements are applied to principal SSCs (and their associated activities) in a graded fashion based on the SSC's safety significance.

Definitions of quality levels and the methodology used for applying a graded QA approach to principal SSCs and to IROFS after completion of the ISA are provided in MPQAP Section 2.2 and are further discussed in the following (Section 15.1.6).

15.1.1 DCS Organization

The DCS organization for the Base Contract and Option 1, as related to QA, is fully described in MPQAP Section 1.0, "Organization." This section of the MPQAP summarizes the organizational structure and Base Contract and Option 1 responsibilities of the DCS management team.

15.1.2 DCS Quality Assurance Function

The MPQAP Introduction details how the DCS QA Program is implemented and maintained during the design and construction phases of the MFFF. QA planning, implementation, and documentation of proper implementation are also described in MPQAP Section 2.0, "Quality Assurance Program." QA implementing procedures are established to ensure the availability and reliability of IROFS.

The DCS QA Program is a living program that changes with each phase of the project. QA controls are established and personnel are trained prior to controls being implemented. The DCS QA Program is based on the line organization being responsible and accountable for the quality of the assigned work. The QA organization is responsible for developing, maintaining, and implementing the DCS QA Program and verifying the achievement of quality in implementing the program through audits, surveillances, assessments, and quality engineering reviews.

The QA organization reports to the Project Manager, is independent of the line organization, and meets the independence requirements of NQA-1-1994 Basic Requirement 1, "Organization." The QA organizational structure is shown in Figure 1.0-3 in MPQAP Section 1.0 for the Base Contract and Figure 1.0-4 for Option 1. QA responsibilities are further discussed in MPQAP Section 1.2.4.2, "QA Manager."

15.1.3 Provisions for Continuing Quality Assurance

The MPQAP was implemented during the early design phase of the project and will be maintained as a living document through deactivation of the MFFF. The MPQAP and applicable implementing QA project procedures are reviewed and revised as necessary to reflect any changes that occur during the design, construction, operation, and deactivation phases of the project. In addition, the MPQAP and implementing procedures are revised when corrective actions and regulatory, organizational, or work scope changes warrant changes to the DCS QA Program. The section titled "Provisions for Continuing QA" in the Introduction of the MPQAP addresses when the MPQAP will be revised and how revisions will be submitted to the NRC.

15.1.4 Management Measures

Management measures are addressed in the MPQAP Introduction. This section of the MPQAP summarizes the applicable MPQAP sections and QA requirements for each of the following management measures:

- Quality Assurance
- Configuration Management
- Maintenance
- Training and Qualification of Plant Personnel
- Procedures
- Audits and Assessments
- Incident Investigations
- Records Management.

The application of these management measures ensures that principal SSCs (before completion of the ISA) and particularly IROFS (after completion of the ISA) are available and reliable to perform their design function.

15.1.5 Regulatory Guide 1.28

DCS commits to meeting the requirements of ANSI/ASME NQA-1-1994 and ASME NQA-1a-1995 Addenda for design and construction, as well as the specific qualification criteria for inspection and test personnel, QA records, and internal and external audit requirements as mandated by Regulatory Guide 1.28 (Rev. 3). DCS's commitment to these requirements is addressed in MPQAP Section 2.0.

15.1.6 Graded Quality Assurance Process

15.1.6.1 Categorization of SSCs

MPQAP Section 2.2 discusses the process by which principal SSCs are assigned a quality level classification commensurate with the SSCs' safety significance. Initially, the safety significance of principal SSCs was established using a deterministic method based on an evaluation of applicable regulations and the MELOX and La Hague experience. Assignment of SSCs into QA classifications (i.e., quality levels) is based on the definitions found in MPQAP Section 2.2. Classification will be confirmed or revised by the ISA.

15.1.6.2 Identification of Quality Assurance Controls

MPQAP Section 2.2 addresses the application of graded controls on principal SSCs according to their safety function and significance. These controls are determined to provide a safety benefit by allowing preferential allocation of resources to more significant principal SSCs and by reducing the resources allocated to SSCs of lesser or no safety significance while maintaining reasonable confidence in SSC performance.

SSCs that are relied on for preventing or mitigating design basis events and ensuring compliance with the performance requirements of 10 CFR §70.61 are IROFS and designated QL-1. QL-1 SSCs are further categorized during detailed design commensurate with their safety significance.

SSCs whose single failure can directly result either in a criticality accident or in exceeding 10 CFR §70.61 public (i.e., offsite) radiological performance requirements are designated QL-1a. These SSCs are normally subject to all of the applicable controls of the MPQAP. No grading of QA controls applies to these SSCs unless justified on a case-by-case basis.

SSCs whose failure, in conjunction with the independent unlikely failure of an additional SSC, can result in a criticality accident or a release in excess of 10 CFR 70.61 public or worker radiological, chemical, or environmental performance requirements are designated QL-1b. These SSCs may have reduced QA controls. Justification for such grading is documented in accordance with the applicable QA procedure.

SSCs that are not IROFS and are not required to meet 10 CFR §70.61 performance requirements but that support normal operations of the facility (e.g., occupational exposure, radioactive waste management) and also function to further reduce public, worker, and environmental risks (e.g., physical interaction protection, radiological and criticality alarms) are designated Quality Level 2 (QL-2). These SSCs have selected (graded) QA controls applied to the extent they are needed consistent with their intended function. Selection and documentation of these controls is in accordance with the applicable QA project implementing procedure.

15.1.6.3 Feedback Mechanisms

MPQAP Section 2.2 addresses control of feedback mechanisms needed to ensure that changes to design; lessons learned from adverse trends; corrective actions due to nonconformances and deficiencies from audits, surveillances, and assessments; and construction activities result in

changes to graded QA controls to maintain reasonable confidence in SSC performance. Changes in QA controls are reviewed and documented in accordance with applicable QA project procedures.

15.1.6.4 Reassessing Safety Significance

MPQAP Section 2.2 addresses the reassessment of SSC safety significance and potential reclassification resulting from changes in construction activities or changes in facility design. The impact of such changes is evaluated and documented in the applicable project documents. The applicable procedures for the DCS design control process and configuration management process ensure that the impact of changes is reviewed and evaluated before implementation. Reclassification and subsequent changes in the application of QA controls are also controlled by the applicable QA procedures.

15.1.7 Quality Assurance Program Updates

DCS commits that the MPQAP and applicable implementing procedures will be revised to reflect any necessary changes that occur between the construction approval and the license application to possess and use special nuclear material (SNM). This commitment is documented in the section titled "Provisions for Continuing QA" in the MPQAP Introduction.

15.1.8 10 CFR Part 21

DCS is subject to the requirements of 10 CFR Part 21, "Reporting of Defects and Nonconformances" for design, construction , procurement, testing, and operations of all Quality Level 1 SSCs. Appropriate procedures for implementing these requirements will be described in the license application for possession and use of SNM.

MPQAP Section 4.0, "Procurement Document Control," commits to invoking the requirements of 10 CFR Part 21 on suppliers of materials, parts, components, and services that affect IROFS SSCs.

15.2 CONFIGURATION MANAGEMENT

This section describes the configuration management program for SSCs, throughout the design, construction, testing, operation, and deactivation of the MFFF. This section will be updated to include additional details of the operational configuration management program in the license application for possession and use of SNM. Configuration management of SSCs is implemented through requirements of the MPQAP and associated QA procedures.

15.2.1 Configuration Management Policy

Configuration management for SSCs is provided throughout MFFF design, construction, testing, operation, and deactivation. Configuration management provides the means to establish and maintain consistency among design requirements, the physical configuration, and facility documentation. During design and construction, the Engineering Manager has responsibility for configuration through the design control process. Design documentation is controlled under the configuration management requirements in accordance with the DCS MPQAP and appropriate

QA procedures associated with configuration management, design control, document control, records management, and other interfacing processes. Design changes to SSCs undergo a formal change and review process, including interdisciplinary reviews as appropriate, in accordance with these procedures.

Configuration management provides the means to establish and maintain the essential features of the design basis of SSCs. Elements of the configuration management program ensure that changes to the facility's design and design bases are appropriately connected to physical implementation of those changes within the facility, and in turn provide for continued safe operation of the facility. As the MFFF project progresses from design and construction to operation, configuration management is maintained by the engineering organization as the overall focus of activities changes.

During the design phase of the project, configuration management is based on the design control provisions of Section 3 of the MPQAP and associated procedural controls over design documents to establish and maintain the technical baseline. Design documents that provide design input, design analysis, or design results are identified with the appropriate quality level (i.e., commensurate with that of the associated SSCs). During the construction phase of the project, changes to design documentation issued for construction, procurement, or fabrication are systematically reviewed and verified, evaluated for impact, and approved prior to implementation (also in accordance with MPQAP and procedural requirements). Proper implementation is verified and reflected in the design basis documentation.

During licensed operation, changes to the MFFF will be reviewed and processed in accordance with the requirements of 10 CFR §70.72, reflected in QA and operating procedures, prior to implementation as described in Section 5.7.3.

15.2.1.1 Scope of Structures, Systems, and Components

The scope of SSCs under configuration management includes all SSCs and provides reasonable assurance that the safety functions of principal SSCs (and IROFS, following confirmation through the Integrated Safety Analysis) are properly controlled, and that changes to principal or non-principal SSCs do not inadvertently create an unanalyzed condition. Design documents subject to configuration management include calculations, safety analyses, design criteria, engineering drawings, system descriptions, technical documents, and specifications that establish design requirements. During the design phase, these design documents and considered under configuration management when approved.

The scope of documents included in the configuration management program expand throughout the design process as the project transitions to construction and operation.

During construction, start-up, and operation, the scope of documents under configuration management expands to include, as appropriate: vendor data; test data; inspection data; startup, test, operating and administrative procedures, and nonconformance reports. These documents include supporting documentation and are generated through functional interfaces with QA, maintenance, and training and qualifications of personnel. The configuration management

program provides for evaluation, implementation, and tracking of changes to SSCs, processes, equipment, computer programs and activities of personnel.

15.2.1.2 Interfaces with Other Management Measures

The configuration management program is implemented through or otherwise related to other management measures. Key interfaces and relationships to other management measures are described below:

- **Quality Assurance** – The MPQAP is described in Section 15.1. The QA program established the framework for configuration management and other management measures.

- **Records** – Records are generated and processed in accordance with applicable requirements of the MPQAP and provide evidence of the conduct of activities associated with configuration management.

- **Maintenance** – Maintenance is described in Section 15.3. Maintenance requirements are established as part of the design basis which is controlled under configuration management. Maintenance records provide evidence of compliance with preventative and corrective maintenance schedules.

- **Training and Qualifications** – Training and qualification is controlled in accordance with the applicable provisions of the MPQAP as described in Section 15.4. Personnel qualifications and/or training to specific processes and procedures are management measures that support the safe operation, maintenance, or testing of principal SSCs. Training and qualification requirements and documentation of training may be considered part of the design basis controlled under configuration management.

- **Corrective Action** – Audits, assessments, and incident investigations are described in Sections 15.6 and 15.7. Corrective actions identified as a result of these management measures may result in changes to design features, administrative controls, or other provisions of the configuration management program through the MPQAP and QA procedures. Periodic assessments of the configuration management program, described in Section 15.2.5, are also conducted in accordance with the audit and assessment program described in Section 15.6.

- **Plant Procedures** – Operating, administrative, maintenance, and emergency procedures are discussed in Section 15.5. These procedures are used to conduct various operations associated with principal SSCs and will be reviewed for potential impacts to the design basis.

15.2.1.3 Objectives of Configuration Management

The objective of configuration management is to ensure design and operation within the design basis of Principal SSCs by: identifying and controlling preparation and review of documentation associated; controlling changes; and maintaining the physical configuration of the facility consistent with the approved design.

Configuration control is accomplished during design through the use of procedures for controlling design, including preparation, review (including interdisciplinary review), and design verification where appropriate, approval, and release and distribution for use. Engineering documents are marked with a quality level classification (e.g., documents associated with IROFS are QL-1) and receive reviews and verifications, consistent with their safety significance, prior to being issued. Changes to the approved design also are subject to a change and review process to ensure consistency with the design bases of principal SSCs.

Configuration verification is also accomplished through design verification, which ensure that design documents are consistent and that design requirements for principal SSCs are met. During construction and testing, this verification also extends to verification that as-built configurations are consistent with the design, and that testing that is specified to demonstrate performance of principal SSCs is accomplished successfully. Periodic audits and assessments of the configuration management program and other design reviews confirm that the program meets its goals and that the design is consistent with the design bases. Incident investigations are conducted in accordance with the MPQAP and associated procedures in the event problems are encountered. Prompt corrective actions are developed as a result of incident investigations or in response to adverse audit/assessment results, in accordance with QA procedures.

These goals are accomplished during operation with similar activities associated with changes to the facility in accordance with 10 CFR § 70.72 and with periodic audits and assessments of the configuration management program and the physical facility, including walkdowns as appropriate.

15.2.1.4 Description of Configuration Management Activities

Configuration management includes those activities conducted under the design control provisions of MPQAP Section 3 for ensuring that design and construction documentation is prepared, reviewed, and approved in accordance with a systematic process. This process includes interdisciplinary reviews appropriate to ensure consistency between the design and the design bases of principal SSCs. During construction, it also includes those activities that ensure that construction is consistent with those design documents. Finally, it includes activities that provide for operation in accordance with the limits and constraints established in the ISA, and that provide for control of changes to the facility in accordance with 10 CFR §70.72. These activities are discussed in the section above and in the MPQAP.

Configuration management includes designation of principal SSCs under the QA classification and grading provisions of Section 2 of the MPQAP. The graded approach to controlling SSCs includes applying the most stringent QA controls to SSCs with the highest safety significance. The less stringent controls applied to principal SSCs with less safety significance as nonetheless controlled under configuration management and the applicable controls are documents in the same way as other principal SSCs. QA classification (i.e., quality levels) and grading are accomplished in accordance with QA procedures.

Configuration management also includes records to demonstrate that personnel conducting activities that are relied on for safety or that are associated with principal SSCs are appropriately qualified and trained to conduct that work.

Implementing documents are controlled within the document control system discussed in Section 6 of the MPQAP. These documents support configuration management by ensuring that only reviewed and approved operating, test, calibration, surveillance, and maintenance procedures and specifications and drawings are used for procurement, construction, installation, testing, operation, and maintenance of SSCs, as appropriate. Maintenance, including post-maintenance testing, and plant procedures for the operating facility are discussed in Sections 15.3 and 15.5, respectively.

Configuration management is supported by document control and records management in accordance with Sections 6 and 17, respectively, of the MPQAP, which are implemented in part through an electronic data management system (EDMS). Additional databases may include trending of deficiencies and corrective actions, which are controlled in accordance with the appropriate audit, assessment, and incident investigation procedures. Additional databases may be used as part of the operating facility and will be controlled in accordance with appropriate software control procedures, including verification and validation as applicable.

Startup testing is also subject to configuration management. Additional details of MFFF startup testing and any operational readiness reviews conducted as a result of the conclusions of the ISA will be discussed in the license application for possession and use of SNM.

15.2.1.5 Organization Structure and Staffing Interfaces

During design and construction, the configuration management program is administered by the MFFF Engineering organization. MFFF Engineering (described in Chapter 4) includes engineering disciplines with responsible lead engineers in charge of each discipline, under the direction of design managers who report to the Engineering Manager. The lead discipline engineers have primary technical responsibility for the work performed by their disciplines, and are responsible for the conduct of interdisciplinary reviews as discussed previously in this section. Reviews are also conducted, as appropriate, by construction management, operations, QA, regulatory/ISA, and procurement personnel. The design control process also interfaces with the document control and records management process via QA procedures.

During licensed operation, the configuration management program is expected to be administered by the operations organization, with the regulatory management organization providing review and assessment functions consistent with radiological and criticality safety functions and audit/assessment functions. The QA organization will continue to maintain QA program audit and assessment responsibilities. Additional information regarding the operations-phase configuration management program will be provided in the license application for possession and use of SNM.

15.2.2 Design Requirements

Design requirements and associated design bases are established and maintained by the MFFF Engineering organization. The configuration management controls on design requirements and the safety assessment of the design bases are described previously in this section. Design requirements are documented in a design requirements document which provides for a hierarchical distribution of these requirements through basis of design documents. The design requirements document and basis of design documents are controlled under the design control provisions of the configuration management system as described above, and are subject to the same change control as analyses, specifications, and drawings. Computer codes used in the design of principal SSCs are also subject to design control measures, with additional requirements as appropriate for software control, verification, and validation.

Principal SSCs are designated as QL-1 (IROFS) and associated design documents are subject to interdisciplinary reviews and design verification as appropriate. Analyses constituting the safety assessment of the design bases, and later the ISA, are subject to the same requirements. Changes to the design are evaluated to ensure consistency with the design bases. Methods for conducting the safety assessment of the design bases of principal SSCs are described in Chapter 5.

The design bases documented in Chapters 5 through 11 are consistent with those flowed down from and/or described in the design requirements document, basis of design documents, and the analyses, specifications, and drawings constituting the preliminary design, including the analyses supporting the safety assessment. The configuration management system captures these requirements and resulting design bases in accordance with design control, document control, and records management procedures. The MFFF Engineering organization maintains the configuration management program using QA procedures and document control and records management processes and procedures.

15.2.3 Document Control

Document control is implemented for the MFFF in accordance with Section 6 of the MPQAP and associated QA procedures. The EDMS is used both to file project records and to make available the latest revision (i.e., the controlled copy) of design documents. The EDMS provides an "official" copy of current analysis, specification, technical report, drawing, or procedure, and DCS personnel are trained to use this system to retrieve controlled documents. The system is capable of generating indices of controlled documents, which are uniquely numbered (including revision number). Controlled documents are maintained until cancelled or superseded, and cancelled or superseded documents are maintained as a record, currently for the life of the project or termination of the license, whichever occurs later. Section 15.8 discusses records management. Hard-copy distribution of controlled documents is provided when needed in accordance with applicable QA procedures (e.g., when EDMS access is not accessible).

As part of the configuration management system, the document control system captures the following documents, either through controlled documents (as appropriate) or records generated by the associated QA procedures:

- Design requirements, through the controlled copy of the design requirements document

- The design bases, through the controlled copy of the basis of design documents
- The safety assessment of the design bases of principal SSCs, through the controlled copies of supporting analyses
- QA procedures
- Training records
- Engineering documents including analyses, specifications, technical reports, and drawings; and documentation generated by management measures such as audits and assessments.

15.2.4 Change Control

QA procedures control changes to the technical baseline. The process includes an appropriate level of technical, management, and safety review and approval prior to implementation. During the design phase of the project, the primary method of controlling changes is the design control process described in Section 3 of the MPQAP and associated QA procedures. This process includes the conduct of interdisciplinary reviews which constitute a primary mechanism for ensuring consistency of the design with the design bases. During both construction and operation, appropriate reviews to ensure consistency with the approved safety assessment of the design bases of principal SSCs and the ISA, respectively, will similarly ensure that the design is constructed and operated/modified within the limits of the design basis. Additional details are provided below.

15.2.4.1 Design Phase

Changes to the design include a systematic review of the design bases for consistency. In the event of changes to reflect design or operational changes from the established design bases, both the safety assessment and other documents affected by design bases of SSCs – including the design requirements document and basis of design documents, as applicable – are properly modified, reviewed, and approved prior to implementation. Approved changes are made available to personnel through the document control function discussed previously in this section.

During design, the primary method of ensuring consistency between documents, including consistency between design changes and the safety assessment, is the interdisciplinary review process. The Licensing and Safety Analysis Manager leads the safety assessment function, and performs interdisciplinary reviews as appropriate to ensure design changes either (1) do not impact the safety assessment, (2) are accounted for in subsequent changes to the safety assessment or ISA, or (3) are not approved or implemented.

15.2.4.2 Construction Phase

When the project enters the construction phase, changes to documents issued for construction, fabrication, and procurement will be documented, reviewed (including interdisciplinary reviews as appropriate), approved, and posted against each affected design document. Vendor drawings and data also undergo an interdisciplinary review, as appropriate, to ensure compliance with

procurement specifications and drawings, and to incorporate interface requirements into DCS documents as appropriate.

Upon NRC authorization of construction, design changes will be evaluated against the approved design bases of principal SSCs. Numerous changes are expected to the design as detailed design progresses and construction begins. A systematic process consistent with the process described above will be employed to evaluate changes in the design against the design bases of principal SSCs and/or the ISA (as a function of the state of development of the ISA). DCS will notify the NRC of potential changes that reduce the level of commitments or margin of safety in the design bases of principal SSCs, and will not implement such changes without prior NRC approval.

15.2.4.3 Operations Phase

During licensed operation, changes to design will also be documented, reviewed (including interdisciplinary reviews as appropriate), and approved prior to implementation.

Upon receipt of the license to possess and use SNM, DCS will implement a change process that fully implements the provisions of 10 CFR §70.72. This process will be described in more detail in the license application for possession and use of SNM.

15.2.5 Assessments

Periodic assessments of the configuration management program are conducted to determine the program's effectiveness and to correct deficiencies. These assessments will include review of the adequacy of documentation and the as-built facility (as appropriate during construction and operation). Such audits and assessments will be conducted and documented in accordance with QA procedures and the overall facility audit and assessment program described in Section 15.6.

15.3 MAINTENANCE

This section outlines the maintenance program to be implemented for the operations phase of the MFFF. The maintenance program will be described in more detail in the license application for possession and use of SNM. Preventive maintenance activities, surveillance, and performance trending provide reasonable and continuing assurance that IROFS will be available and reliable to perform their safety functions.

The purpose of planned and scheduled maintenance for IROFS is to ensure that the equipment and controls are kept in a condition of readiness to perform the planned and designed functions when required. Appropriate plant management is responsible for ensuring the operational readiness of IROFS under this control. For this reason, the maintenance function is administratively closely coupled to operations. The maintenance function plans, schedules, tracks, and maintains records for maintenance activities.

DCS commits to implementation of a maintenance program as described below for the MFFF.

15.3.1 Safety Controls

Maintenance requirements for IROFS (e.g., calibration frequency, functional testing requirements, and replacement of specified components) will be specified to ensure the reliability/availability of IROFS commensurate with the risks identified in the ISA.

15.3.2 Maintenance Elements

Maintenance activities generally fall into the following categories:

- Surveillance/monitoring
- Preventive maintenance
- Corrective maintenance
- Functional testing.

These maintenance categories are discussed in the following sections.

15.3.2.1 Surveillance/Monitoring

Surveillance of IROFS, including instrument calibration and testing, is performed at specified intervals. The purpose of the surveillance program is to measure the degree to which IROFS meet performance specifications. The results of surveillances are trended, and when the trend indicates potential IROFS performance degradation, preventive maintenance frequencies are adjusted or other appropriate corrective action is taken.

Incident investigations may uncover root causes of failures that are related to the type or frequency of maintenance. The lessons learned from such investigations are factored into the surveillance and preventive maintenance programs as appropriate.

Maintenance procedures prescribe compensatory measures, if appropriate, for surveillance tests of IROFS that can be performed only while equipment is out of service.

15.3.2.2 Preventive Maintenance

Preventive maintenance includes preplanned and scheduled periodic refurbishment, partial or complete overhaul, or replacement of IROFS, if necessary, to ensure their continued safety function. Planning for preventive maintenance includes consideration of results of surveillance and monitoring, and includes instrument calibration and testing.

15.3.2.3 Corrective Maintenance

Corrective maintenance involves repair or replacement of equipment that has unexpectedly degraded or failed. Corrective maintenance of IROFS restores the equipment to acceptable performance through a planned, systematic, controlled, and documented approach for the repair and replacement activities.

15.3.2.4 Functional Testing

Functional testing of IROFS is performed as appropriate following initial installation, as part of periodic surveillance testing, and after corrective or preventive maintenance or calibration to ensure that the item is capable of performing its safety function when required. Functional testing is conducted using approved procedures that include compensatory measures, if appropriate, while the test is being conducted.

15.3.3 Work Control Methods

Maintenance-related work control methods include maintenance management and tracking (i.e., integration of maintenance activities with ongoing operations activities), interfaces with radiation protection and associated work permits, implementation of lockout/tagout requirements, and maintenance procedures for IROFS.

15.3.4 Relationship of Maintenance Elements to Other Management Measures

The maintenance function interfaces with the configuration management system by obtaining the approved and controlled drawings, specifications, and procedures for the item to be maintained. Through the training program, personnel are trained in the maintenance of IROFS. Procedures are used for maintenance of IROFS. Records of performance trends and maintenance history for IROFS are maintained in the maintenance management system.

15.4 TRAINING AND QUALIFICATIONS OF PLANT PERSONNEL

This section describes the training program for the operations phase of the MFFF. The training program requirements apply to those plant personnel who perform activities relied on for safety. The MPQAP provides training and qualification requirements, during the design and construction phases, for QA training of personnel performing quality-affecting activities; for nondestructive examination, inspection, and test personnel; and for auditors.

DCS commits to the establishment of an operational training program in accordance with the description below. This information will be updated as appropriate with the license application for possession and use of SNM.

15.4.1 Organization and Management of Training

Line managers are responsible for the content and effective conduct of training for their personnel. Training responsibilities for line managers are included in position descriptions, and line managers are given the authority to implement training for their personnel. The training organization provides support to line managers by facilitating the planning, directing, analyzing, developing, conducting, evaluating, and controlling of a systematic performance-based training process, which may include a graded approach, that fulfills job-related training needs.

Plant procedures establish the requirements for indoctrination and training of personnel performing activities relied on for safety. Exceptions from training requirements may be granted when justified and documented in accordance with procedures and approved by appropriate management.

Lesson plans are used for classroom and on-the-job training to provide consistent subject matter. When design changes or plant modifications are implemented, updates of applicable lesson plans are included in the change control process of the configuration management system.

Auditable training records are maintained to support management information needs associated with personnel training, job performance, and qualifications.

15.4.2 Analysis and Identification of Functional Areas Requiring Training

A needs/job analysis is performed and tasks are identified to ensure that appropriate training is provided to personnel.

The training organization consults with relevant technical experts as necessary to develop a list of tasks for which personnel training for specific jobs is appropriate. The list of tasks selected for training is reviewed and compared to the training materials as part of the systematic evaluation of training effectiveness. The task list is also updated as necessitated by changes in procedures, processes, plant systems, equipment, or job scope.

15.4.3 Position Training Requirements

Minimum training requirements are developed for those positions whose activities are relied on for safety. Initial identification of job-specific training requirements is based on experience from MELOX and La Hague and United States facility experience. Entry-level criteria (e.g., education, technical background, and/or experience) for these positions are contained in position descriptions.

15.4.4 Basis for and Objectives of Training

Learning objectives identify the training content, as established by needs/job analyses and position-specific requirements. The task list from the needs/job analysis is used to develop action statements that describe the desired post-training performance. Objectives include the knowledge, skills, and abilities the trainee should demonstrate; the conditions under which required actions will take place; and the standards of performance the trainee should achieve upon completion of the training activity.

15.4.5 Organization of Instruction

Lesson plans are developed from the learning objectives which are based on job performance requirements. Lesson plans and other training guides are developed under the guidance of the training function. Lesson plans are reviewed by the training function and, generally, by the organization cognizant of the subject matter. Lesson plans are approved prior to issue or use. Lesson plans are used for classroom training and on-the-job training as required.

15.4.6 Evaluation of Trainee Learning

Trainee mastery of learning objectives is evaluated through observation/demonstration or oral or written tests as appropriate. Such evaluations measure the trainee's skills and knowledge of job performance requirements.

15.4.7 Conduct of On-the-Job Training

In addition to appropriate classroom training, on-the-job training is used for IROFS activities when appropriate. On-the-job training is conducted using current performance-based training materials by designated personnel who are competent in the program standards and methods of conducting the training. Completion of on-the-job training is demonstrated by actual task performance where feasible and appropriate. When the trainee cannot perform the actual task, a simulation of the task is performed with the trainee explaining task actions using the conditions encountered during the performance of the task, including references, tools, and equipment reflecting the actual task to the extent practical.

15.4.8 Systematic Evaluation of Training Effectiveness

Under the direction of the training function, the training program is systematically evaluated periodically to measure the program's effectiveness in producing competent employees. Feedback is provided by the trainees after completion of classroom training sessions to provide data for this evaluation for program improvements. These evaluations identify program strengths and weaknesses, determine whether the program content matches current job needs, and determine if corrective actions are needed to improve the program's effectiveness. The training function is responsible for leading the training program evaluations and for implementing any corrective actions. Program evaluations may consist of an overall periodic evaluation or a series of topical evaluations over a given period.

Evaluation objectives that are applicable to the training program or topical area being reviewed are developed and may address the following elements of training:

- Management and administration of training and qualification programs
- Development and qualification of the training staff
- Position training requirements
- Determination of training program content, including its facility change control interface with the configuration management system
- Design and development of training programs, including lesson plans
- Conduct of training
- Trainee examinations and evaluations
- Training program assessments and evaluations.

Evaluation results are documented, and noteworthy practices and weaknesses are highlighted in the training program. Identified deficiencies are reviewed, improvements are recommended, and changes are made to procedures, practices, or training materials as necessary.

15.4.9 Personnel Qualification

The qualification requirements for key management positions are given in Chapter 4. While Chapter 4 currently stresses the organization for the design and construction of the MFFF, it will

be revised with the license application for possession and use of SNM to address operations and the qualifications of key plant management positions.

The qualification requirements for technical personnel are determined as discussed in Section 15.4.2. Training and qualification requirements associated with quality-affecting activities are given in the MPQAP. Such requirements include QA training for project personnel and qualification of nondestructive examination personnel, inspection and test personnel, personnel performing special processes, and auditors.

15.4.10 Provisions for Continuing Assurance

Personnel performing activities relied on for safety are evaluated at least biennially to determine whether they continue to understand, recognize the importance of, and have the qualifications to perform their activities that are relied on for safety. The evaluation may be by written test, oral test, or on-the-job performance evaluation. The results of the evaluation are documented. When the results of the evaluation dictate, retraining or other appropriate action is provided. Retraining is also required due to plant modifications, procedure changes, and QA program changes that result in new or changed information that needs to be disseminated.

15.5 PLANT PROCEDURES

This section outlines the provisions for plant procedures to be implemented for the startup, testing, and operations phases of the MFFF. The MPQAP provides requirements during the design and construction phases for QA procedures, which detail the controls for design input, processes, verification, changes, and approval. Plant procedures will be described in more detail in the license application for possession and use of SNM.

15.5.1 Types of Procedures

Generally, four types of plant procedures are used to control activities: operating procedures, administrative procedures, maintenance procedures, and emergency procedures.

Operating procedures are used to directly control process operations. These are procedures for workstation and control room operators. Operating procedures include directions for normal operations, including startup and some testing, operation, and shutdown, as well as off-normal conditions of operation, including alarm response. Operating procedures include required actions to ensure radiological and nuclear criticality safety, chemical safety, fire protection, emergency planning, and environmental protection. They include operating limits and controls and specific direction regarding administrative controls to ensure operational safety. If needed, safety checkpoints (e.g., hold points for radiological or criticality safety checks, QA verifications, or operator independent verification) are identified at appropriate steps in the procedure.

Administrative procedures are used to perform activities that support the process operations, including management control activities such as the following:

- Configuration management
- Nuclear criticality, radiation, chemical, and fire safety

- Human-system interface
- Quality assurance
- Design control
- Plant personnel training and qualification
- Audits and assessments
- Incident investigations
- Record keeping and document control
- Reporting.

Maintenance procedures address preventive and corrective maintenance, surveillance (i.e., calibration, inspection, and other surveillance testing), and functional testing following maintenance. Where appropriate, maintenance procedures include requirements for pre-maintenance activity involving reviews of the work to be performed and reviews of procedures.

Emergency procedures address the preplanned actions of operators and other plant personnel in the event of an emergency.

15.5.2 Preparation of Procedures

DCS will identify necessary plant procedures on the basis of past operating experience and review of the design including the ISA. Plant procedures are prepared by individuals assigned by management. Procedures are approved by cognizant management. The MPQAP contains requirements for design control of IROFS, including design inputs, processes, outputs, changes, interfaces, and records.

Operating and maintenance procedures are prepared by individuals knowledgeable of the applicable process operations and are reviewed by cognizant management. Where appropriate, operating procedures are validated through a field test or dry run prior to initial use.

15.5.3 Use of Procedures

Plant procedures govern the conduct of operations involving IROFS and management control systems supporting those IROFS. Activities involving licensed SNM are conducted in accordance with approved procedures. Compliance with procedures is enforced, and operators are trained to report inadequate procedures and/or the inability to follow procedures.

Procedures either are available at work locations or are readily accessible where needed to perform work. Procedures specify that operations personnel must be notified prior to and following maintenance on IROFS.

15.5.4 Management Control of Procedures

Following approval, plant procedures are issued for use and entered into the configuration management system. The training program ensures that necessary personnel are trained in the use of the approved procedures. Change control for plant procedures is the same as for other items in the configuration management system. Procedures are modified, as appropriate, in

conjunction with plant or process modifications. Plant procedures are reviewed at least every five years to ensure their continued accuracy and usefulness. Emergency procedures are reviewed annually for the first two years of plant operation and biennially thereafter. If procedural inadequacy is identified as a root cause from an incident investigation, applicable procedures are reviewed and modified as necessary.

Provisions for temporary changes to plant procedures will be addressed in the license application for possession and use of SNM.

15.5.5 Preoperational Testing Program

DCS will develop a preoperational testing program for the MFFF. During the latter part of startup, depleted uranium and plutonium oxides will be used to test systems to the extent feasible.

Procedures for test control will be developed for the preoperational testing program. The procedures will provide criteria for determining when a test is required or how and when testing activities are performed. Tests will be performed under conditions that simulate, to the extent feasible, the most adverse design conditions as determined by analysis. Test results will be documented and evaluated, and their acceptability will be determined by a responsible individual or group.

Operating, administrative, maintenance, and emergency procedures will be developed during startup prior to the introduction of depleted uranium and plutonium oxides. Procedures will be validated during startup testing of the MFFF.

15.6 AUDITS AND ASSESSMENTS

15.6.1 General

15.6.1.1 Graded Approach to Audits and Assessments

DCS audits and assessments are performed in accordance with the DCS MPQAP requirements for SSCs and associated activities commensurate with their safety significance. Audits are addressed in MPQAP Section 18.0, "Audits," and assessments are addressed in MPQAP Section 2.4, "Management Assessments." The quality level is used to establish the frequency and rigor by which principal SSCs/IROFS are audited and assessed. MPQAP audit/assessment requirements focus primarily on principal SSCs/IROFS. Principal SSCs/IROFS receive the most oversight in the form of audits and assessments. Other SSCs and their associated activities are also audited and assessed but to a lessor rigor and frequency than IROFS, as determined by DCS management.

Audits and assessments provide DCS management feedback both on the technical adequacy of SSCs and activities by evaluating how well the DCS QA Program is being implemented and on QA program effectiveness in ensuring that SSCs are properly designed and constructed in accordance with applicable QA requirements.

15.6.1.2 Scheduling of Audits and Assessments

Audits/assessments of principal SSCs/IROFS are scheduled in a manner to provide coverage, consistency, and coordination with ongoing work and at a frequency commensurate with the project status and importance of the work. Functional areas performing work controlled by the MPQAP are audited at least once a year.

Results from audits, assessments, surveillances, deficiencies, and corrective action reports are used to determine the scope and frequency by which each functional area is subsequently audited. Audits are scheduled to begin as early in the life of the work as practical and scheduled to continue at intervals consistent with the schedule for accomplishing the work. As specified by NRC Regulatory Guide 1.28 (Rev. 3), *Quality Assurance Program Requirements (Design and Construction)*, external audits of principal SSC/IROFS suppliers are performed prior to contract placement, and these suppliers are evaluated annually and fully audited every three years after initial placement on the DCS Approved Suppliers List.

Annually, the DCS Project Manager conducts a project assessment to determine the overall effectiveness of the DCS QA Program. Annually, each functional area performing work on principal SSCs/IROFS also performs an internal management assessment of its activities. Additional audits and assessments of specific functions (as directed by management to provide an adequate assessment of compliance and effectiveness) supplement regularly scheduled internal audits and assessments.

15.6.1.3 Procedures for Audits and Assessments

Internal and external audits and assessments are conducted using DCS-approved procedures that meet the MPQAP requirements for these activities. These procedures provide requirements for the following audit/assessment activities:

- Scheduling and planning of the audit/assessment
- Certification requirements of audit/assessment personnel
- Development of audit plans and audit/assessment/surveillance checklists
- Performance of the audit/assessment
- Reporting and tracking of findings to closure
- Closure of the audit/assessment.

The applicable project procedures emphasize timely reporting and correction of findings to prevent recurrence.

15.6.1.4 Qualifications and Responsibilities of the QA Manager and QA Verification Manager

The DCS QA Manager has overall responsibility for managing the DCS QA Program, including QA audits and assessments of quality-affecting activities. Reporting to this position is the QA Verification Manager, who is directly responsible for ensuring that QA internal and external audits and QA internal management assessments are conducted in accordance with the requirements of the MPQAP. The QA Verification Manager is responsible for the following:

- Establishing and implementing the Lead Auditor/Auditor Certification Program
- Managing the programs for internal/external audits, surveillance, supplier survey, and evaluation
- Promptly reporting findings to management
- Evaluating the effectiveness of implementation of the DCS QA Program
- Approving audit plans and audit/assessment/surveillance checklists
- Approving audit/assessment/surveillance reports
- Maintaining the DCS Approved Suppliers List
- Providing input for continuous program improvements.

The roles and responsibilities of the DCS QA Manager and the QA Verification Manager established at the start of the design phase will carry over into the construction and operations phases of the project. Both the DCS QA Manager and the QA Verification Manager have the education, formal training, and previous experience necessary to manage their assigned areas. This experience includes previous audit/assessment/surveillance management experience under the controls of an audit program.

15.6.1.5 Training, Qualifications, and Responsibilities of Audit/Assessment Personnel

Auditors, lead auditors, and assessment personnel are responsible for performing audits and assessments in accordance with the applicable QA procedures. Auditors and lead auditors hold certifications as required by the MPQAP to perform audits. Before being certified under the DCS QA Program, auditors and lead auditors must complete training on the following under the direct supervision of a lead auditor:

- DCS QA Program
- Audit fundamentals, including audit scheduling, planning, performance, reporting, and followup action involved in conducting audits
- Objectives and techniques of performing audits
- On-the-job training.

Certification of auditors and lead auditors is based on the QA Verification Manager's evaluation of education, experience, professional qualifications, leadership, sound judgment, maturity, analytical ability, tenacity, and past performance and completion of QA training courses. A lead auditor must also have participated in a minimum of five QA audits or equivalent verifications within a period of time not to exceed three years prior to the date of certification. Equivalent verifications include management assessments, pre-award evaluations or comprehensive surveillances (provided the prospective lead auditor took part in the planning, checklist development, performance, and reporting of the verification activities). One audit must be a nuclear-related QA audit or equivalent verification within the year prior to certification. Certification meets the requirements of Supplement 2S-3, "Supplementary Requirements for the

Qualification of Quality Assurance Program Audit Personnel," as required by ASME NQA-1-1994.

Personnel performing assessments are not required to be certified, but they are required to complete QA orientation training, as well as training on the management assessment project procedure.

Administration of audit and assessment training is addressed in MPQAP Section 15.4, "Training and Qualification of Plant Personnel."

15.6.1.6 Authority and Access of Audit/Assessment Personnel

The MPQAP and implementing audit and assessment procedures require that assigned auditors and assessment personnel be independent of any direct responsibility for performing the work being audited or assessed. Audit personnel have management-directed authority and organizational freedom to make the audit process meaningful and effective, including making recommendations for program improvements. DCS management directs line managers to grant the teams access to relevant information and personnel in order to properly audit or assess the assigned areas or activities.

15.6.1.7 Determination of Acceptable Performance

Procedures and audit/assessment checklists establish applicable acceptance criteria from which audit/assessment team members determine acceptable performance of principal SSCs/ IROFS. The QA Verification Manager concurs with the audit/assessment team determinations upon reviewing the QA internal/external audit and internal QA management assessment reports. Internal management assessment results and acceptance of performance results for each functional area are approved by the respective functional area manager who directs the performance of the assessment. The DCS Project Manager approves the results of the project management assessment, thereby concurring with performance acceptance determinations.

15.6.1.8 Use of Audit/Assessment Procedures and Checklists

Applicable project procedures detail the audit and assessment processes. These procedures establish the implementing steps required to be performed. Audit and assessment checklists identify the specific requirements to be verified during the audits/assessments.

The QA Verification Manager approves the checklists for internal/external audits and internal management assessments. The functional area managers approve the checklists used for the internal management assessments, and the DCS Project Manager approves the checklist for the project management assessment. The applicable project procedures and checklists, however, do not prohibit the audit/assessment teams from pursuing additional areas during the course of the audits/assessments, especially those areas discovered during the audit/assessment that appear not to meet established requirements.

15.6.1.9 Conduct of Audits and Assessments

Audits and assessments are conducted by:

- Using the approved audit/assessment checklist
- Interviewing responsible personnel
- Performing plant area walkdowns (which may include out-of-the-way or limited-access areas)
- Reviewing controlling plans and procedures
- Observing work in progress
- Reviewing completed QA documentation as applicable.

The nature of the principal SSCs/IROFS dictates what combination of these tools is used to evaluate the effectiveness of the item or activity being audited or assessed. The audit/assessment team leader determines the appropriate techniques. If findings result, the deficiencies are documented in sufficient detail to provide for accurate evaluation and timely corrective actions.

15.6.1.10 Immediate Correction of Audit/Assessment Deficiencies

Audit and assessment procedures allow for immediate correction of deficiencies found during the audit/assessment. If the deficiency appears to be an isolated event, typographical error, and/or easy to correct, line management may correct the deficiency in accordance with the applicable project procedures. In this case, the audit/assessment checklist and report reflect that the deficiency was corrected and provide documentation of the controlling procedure for the correction. Although no further action is required as a result of the identified corrected deficiency, the fact that it occurred is documented by the DCS QA organization for tracking and trending deficiencies. Corrected deficiencies, along with other identified deficiencies, are periodically evaluated for potential trends that may warrant further corrective actions to prevent recurrence.

15.6.1.11 Management Review

Management responsible for the areas being audited or assessed are briefed by the audit/assessment team leader on the results of the audit/assessment, including any deficiencies identified that require corrective action. Notification of any deficiencies allows management to investigate the deficiencies and to plan for corrective actions prior to the issuance of the formal audit/assessment report but will not inhibit prompt and complete documentation and reporting.

15.6.1.12 Audit/Assessment Reports and Timely Correction

The audit/assessment team leader is required to develop the audit/assessment report documenting the audit/assessment findings, observations, and recommendations for program improvement. These reports provide DCS management with documented verification of project performance against established performance indicators for principal SSCs/IROFS. These reports are developed, reviewed, approved, and issued following established formats and protocols detailed in the applicable project procedures. Responsible managers are required to review the reports and provide any required responses due to reported deficiencies.

Corrective actions following issuance of the audit/assessment report require compliance with the applicable project procedure for corrective actions as implemented in accordance with the requirements of MPQAP Section 16, "Corrective Action." Deficiencies are required to be evaluated and corrected in a timely manner. Audit and assessment reports are also required to contain an effectiveness evaluation and statement for each of the applicable QA program elements reviewed during the audit/assessment. The DCS QA organization verifies completion of corrective actions, and the audit/assessment is closed with the proper documentation as required by the applicable audit and assessment procedure.

15.6.1.13 Quality Trend Analysis and Deficiency Followup

Audit/assessment results are tracked by the DCS QA organization. These data are periodically analyzed for potential trends and needed program improvements to prevent recurrence and/or for continuous program improvements. The resulting trend is evaluated and reported to applicable DCS management. This report documents the effectiveness of management measures in controlling project activities, as well as deficiencies. Deficiencies identified in the trend report require corrective action in accordance with the applicable procedure. The DCS QA organization also performs followup reviews on identified deficiencies and verifies completion of corrective actions reported as a result of the trend analysis. Verification of completion of corrective actions is documented in accordance with the applicable project procedure for corrective actions.

15.6.2 Audits

15.6.2.1 Audit Teams

Personnel assigned to audit teams are independent of the areas and activities being audited. Audit personnel have sufficient authority and organizational freedom to make the audit process meaningful and effective. Audit teams are led by a DCS-certified lead auditor. The lead auditor is appointed by the QA Verification Manager to supervise the team, organize and direct the audit, prepare and coordinate issuance of the audit report, and evaluate responses. Audit team members may come from the line organization to assist in assessing the adequacy of technical processes. These "borrowed" team members are required to be independent of the assigned areas for the audit. They receive training in the audit procedure and QA orientation training, and they are certified by the QA Verification Manager as technical specialists in the areas needed for the assigned audit scope based on their individual areas of expertise.

15.6.2.2 Conduct and Reporting of Audits

The DCS QA organization audits and evaluates internal DCS MOX Fuel Project activities that are controlled by the MPQAP using applicable procedures. These audits cover both programmatic and technical requirements through compliance- and performance-based audit plans and checklists. External suppliers of items and services are evaluated using the applicable supplier evaluation project procedure.

Internal and external audit findings are reported to responsible DCS and/or supplier management at the exit interview and in the final audit/supplier evaluation report so that appropriate corrective actions may be initiated in a timely manner. The QA Verification Manager establishes response

dates in the audit report for the planned corrective actions. Followup reviews of evidence of completion of needed corrective actions are also performed to close out the audits and supplier evaluations.

Findings resulting from audits or supplier evaluations are closely tracked to completion. Routinely, DCS management receives a status report of open findings. This report is generated to keep management informed of the progress of the corrective actions and to provide management the opportunity to expedite completion of planned corrective actions.

Internal audits of DCS activities under the controls of the DCS MPQAP will change in regard to audit checklist attributes and the method of implementation as the project progresses through the construction, testing, operations/maintenance, and deactivation phases. Audit attributes shift from a compliance-based audit approach to a combination compliance- and performance-based audit approach as the MFFF enters the construction and operations phases of the project.

During construction, audits check as-built conditions against controlled drawings, installation specifications, and procedures based on committed construction codes and standards. During operations, audits verify that operating prerequisites are met, plant operations are within approved parameters, required surveillance testing is performed, approved acceptance criteria are met, and operating procedures are properly followed and their completion is documented in accordance with the DCS QA Program.

15.6.3 Assessments

15.6.3.1 Project and Management Assessments

The Project Manager conducts a project management assessment annually to determine if the DCS QA Program is effective on a corporatewide basis. The Project Manager appoints a team of DCS managers and/or supervisors/employees or uses outside contractors to conduct this assessment. The individual areas covered by each project assessment team member are assessed by individuals who have received training in the appropriate procedures and who have no direct responsibility for the items/areas being assessed. Functional area managers and the QA Manager also conduct an internal management assessment annually of QA activities under their control. Personnel assigned to do the internal management assessments are also trained in the appropriate procedures and do not have supervisory or management responsibility for the areas being assessed. The managers report the results of the internal management assessments to the Project Manager for review. The results of both the project and internal management assessments are reviewed by senior management to determine the adequacy of implementation of the DCS QA Program and to direct any needed changes for program improvements.

15.6.4 DCS Provisions for Continuing Assurance

The DCS QA Program is maintained current through deactivation of the MFFF. Audit and assessment procedures and the MPQAP are kept current as the project progresses, and appropriate changes are made based on any of the following:

- Lessons learned from audit/assessment findings

- Program improvements identified from analysis of trends
- Changes due to regulations, commitments, reorganizations, revised project schedule, or program improvements from continuous review of oversight results and process improvement initiatives.

The DCS audit and assessment procedures and resulting program will be updated to reflect any necessary changes that occur between the DCS MFFF construction approval and the license application for possession and use of SNM. Any necessary changes to audit/assessment programs are reviewed and approved in accordance with the DCS procedure for controlling the MPQAP and its implementing project procedures.

15.7 INCIDENT INVESTIGATIONS

15.7.1 Incident Investigation and Corrective Action Process

The DCS incident investigation and deficiencies/corrective action process in use during the design and construction phases of the MFFF is described in MPQAP Section 16, "Corrective Action," and is implemented by the applicable procedures. The process for design, construction, and operations includes management controls to:

- Promptly identify incidents/findings
- Evaluate the need to stop work
- Assign an independent individual or teams to investigate incidents/findings
- Evaluate the significance of the incident/finding
- Evaluate the root cause for significant incidents/findings
- Plan needed corrective actions
- Obtain management approval of planned actions
- Implement acceptable corrective actions
- Complete planned corrective actions
- Verify completion of corrective actions
- Track and evaluate incidents/findings for adverse trends.

Corrective/deficiency action reports and incident investigation reports are maintained as QA records. These records are used for evaluating lessons learned, periodically evaluating potential trends, and determining additional QA program improvements to prevent recurrence.

15.7.2 Corrective Action Process Administration

The DCS Incident Investigation and Deficiencies Corrective Action Process is administered by the DCS QA organization during the design and construction phases of the MFFF. This process will be modified prior to startup testing to include the additional specific actions that are needed to support an operating facility. In addition, results from the corrective action process will be compared against the ISA to ensure it adequate reflects or bounds real incidents. Changes to the facility will be controlled under the configuration management program.

The license application for possession and use of SNM will contain a detailed description of this process for operations. The resulting program will address the prompt investigation of incidents that:

- Makes use of appropriately qualified investigative teams, as necessary, to evaluate operational incidents, determine root causes and generic implications (commensurate with the severity of the incident) using systematic procedures, and recommend corrective actions in a timely manner
- Provides for monitoring and documenting of corrective actions (including effectiveness) through completion, including tracking/trending as appropriate of results to facilitate improvements to future operations
- Describes the plan and methodology for investigating incidents, including identification of roles and responsibilities and scope of authority of investigation teams
- Ensures investigators are appropriate independent and appropriately qualified in the applicable processes and in root cause analysis, as appropriate
- Establishes appropriate documentation and records requirements.

15.8 RECORDS MANAGEMENT

15.8.1 Records Management Program Description

DCS has implemented a records management program for controlling records management responsibilities and the generation, review, approval, classification, verification, indexing, storage, protection, maintenance, correction, retrieval, and disposition of QA records as described in the MPQAP. The DCS Records Management Program complies with Basic Requirement 17 and Supplement 17S-1 of NQA-1-1994 Part I as revised by Regulatory Guide 1.28 (Rev. 3). The DCS Records Management Program consists of the following:

- Applicable project procedures
- Dual-facility records storage using an electronic data management system (EDMS) and storage of backup tapes in a fireproof safe
- Use of fireproof filing cabinets or vault protection for documents that cannot be placed in the EDMS due to size, content, or record media (e.g., radiographs, pictures, microfilm, and magnetic media).

Classified records are maintained separately from QA records and in accordance with procedures that satisfy the requirements of the DCS Security Plan.

The DCS Records Management Program was established during the design phase of the MFFF with ample flexibility to be used during the construction and operations phases as well. As the project progresses into each phase, the records management system will be modified to include the necessary electronic "folders" to properly store and retrieve records. Records that become contaminated during facility operation are handled in accordance with DCS procedures. The following records will also be stored in this system:

- Records controlled under the DCS configuration management system for the design, construction, and operation of the MFFF
- Training records
- Dosimetry, effluent, operations, and maintenance records.

15.8.2 Record Generation

DCS project procedures control the content, generation, review, and approval of DCS records. Once verified as complete by the originating organization, records are transmitted to DCS records management.

15.8.3 Receipt of Records

Records personnel review the transmitted documents for completeness, legibility, correct file storage designation, and suitability for scanning. If acceptable, the record copy is entered into the electronic systems and then checked against the transmitted hard copy. Records personnel also issue the document under a controlled distribution, as required, to those individuals identified by the document owner/originator as needing a controlled copy.

15.8.4 Record Storage, Preservation, and Safekeeping

Acceptable documents are placed in the electronic records location identified by the generator. The records are also linked to interfacing records when applicable. DCS has elected to retain all documents submitted under the controls of the DCS QA Program for the lifetime of the project (i.e., through deactivation and termination of the license), thereby classifying all DCS QA records as "lifetime records."

Records personnel maintain authorizations for placing records into and accessing records from the records systems. Stored files are "read only" files to protect the records against tampering, theft, or loss. Records are routinely backed up, and the backup is stored in a fireproof safe. Access controls also prevent unauthorized access.

Records personnel also control hard-copy storage of records that cannot be stored electronically. These hard-copy records are stored in access-controlled fire-proof cabinets. Computer codes and computerized data used for IROFS are stored in the electronic systems with documentation of the version of code used for the specific data.

15.8.5 Record Correction

Records requiring correction or revision are retrieved by authorized individuals as established in the applicable procedures for generating the record. Corrections of records are limited to minor changes (e.g., editorial changes) in accordance with the appropriate procedure. When revision is required, the change requires creation of a new document with the next assigned revision number. The original record is retained, and the revision is processed in accordance with the applicable project procedures. Once approved, this new record is transmitted to records management.

15.8.6 Record Retrieval

DCS establishes file locations (or folders) needed for its scope of work. These file folders, plus interfacing links to associated documents/records, are structured to ensure timely retrievability of needed records.

15.8.7 Disposition of Records

All "lifetime" records are stored for the operating life of the MFFF. If DCS reclassifies any "lifetime" QA records to "nonpermanent" record status, the following conditions are required to be met in accordance with the MPQAP and the records management project procedures:

- Verification that the record was retained for a minimum of three years
- Verification that associated regulatory requirements are met
- Verification that the MFFF status allows document disposal
- Verification that associated MPQAP requirements are met
- Written concurrence from the DCS QA Manager allowing record disposal.

15.8.8 Records Management Program Changes

The DCS QA organization routinely performs audits, surveillances, and assessments of document control and records management functions to evaluate the implementation of the DCS QA Program. Such oversight may produce findings and observations, which could result in changes to the DCS Records Management Program. DCS monitors document control and records management activities for program improvements. Any changes to the program are administered through revisions to the applicable procedure. Procedure revisions are reviewed and approved in accordance with the applicable procedure.

15.8.9 DCS Provisions for Continuing Records Management

The DCS Records Management Program procedures are kept current for the duration of the project. Revisions to the records management procedures can result from any of the following:

- Lessons learned during implementation
- Corrective actions due to internal and external audits, surveillances, and assessments
- Needed program improvements due to analysis of trends
- Changes due to regulations, commitments, reorganizations, revised project schedule, or program improvements from process improvement initiatives.

The DCS Records Management Program will also be updated to reflect any needed changes that occur between the DCS MFFF construction approval and the license application for possession and use of SNM.

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