Shaw | AREVA
MOX SERVICES, LLC

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U.S. Nuclear Regulatory Commission
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DCS-NRC-000230

Subject: Docket Number 070-03098
Shaw AREVA MOX Services
Mixed Oxide Fuel Fabrication Facility
Responses to Radiation Protection Safety
Requests for Additional Information

Reference: (A) Letter, D. Tiktinsky (NRC) to D. W. Gwyn (MOX Services), *Request for Additional Information Regarding the Review of the Radiation Protection Safety Aspects of the Mixed Oxide Fuel Fabrication Facility License Application Request*, November 3, 2008

Shaw AREVA MOX Services, LLC (MOX Services) hereby submits to the U.S. Nuclear Regulatory Commission (NRC) responses to the Reference (A) Request for Additional Information (RAI) concerning radiation protection safety aspects of the Mixed Oxide Fuel Fabrication Facility (MFFF).

Attachment 1 provides the detailed responses to Reference (A) and indicates corresponding changes to the License Application (LA). Attachment 2 provides the DRAFT LA page changes resulting from the RAI responses. Changes from the last LA submittal are denoted by vertical lines in the right margin (the pagination and page revision dating are not yet updated). A formal submittal of the LA changes will be included in the next MOX Services LA update.

If you have any questions, please feel free to contact me or Dealis W. Gwyn, Licensing and Regulatory Compliance Manager at (803) 819-2780.

Sincerely,

David Stinson
President and COO

DS/MAM

NMSS01

Attachments:

1 Responses to NRC's Requests for Additional Information Regarding Radiation Protection Safety of the MOX Fuel Fabrication Facility
2 DRAFT License Application Page Changes for Radiation Protection RAI Responses, Chapter 9, Radiation Safety; Chapter 10, Environmental Protection; Chapter 15, Management Measures

cc: (w/ attach.)
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Responses to NRC's Requests for Additional Information Regarding Radiological Protection Safety of the MOX Fuel Fabrication Facility

Management:

HP-1 LA section 9.0 generally addresses the purpose of the Radiation Safety Program. Consistent with regulatory Guide 8.8C.1.a&b, specifically describe the MFFF management commitment to implement the Radiation Protection Program, stating management policy and identifying responsibilities of key personnel, such as the Plant Manager, Radiation Protection Manager, Health, Safety and Environmental Director, Shift Supervisor and facility personnel.

Reply:

LA Section 9.2.2 has been revised to incorporate this request.

HP-2 LA section 9.2.1.1, under Management Commitment, states the responsibility for complying with radiological safety requirements and the maintaining of exposures As Low As Reasonably Achievable (ALARA) starts with the individual worker. Consistent with Regulatory Guide 8.10.C.1, describe the significance of the role of management, in addition to the individual worker, to set standards and provide positive leadership to ensure a robust and successful ALARA program.

Reply:

LA Section 9.2.1.1 has been revised in response to this request.

ALARA:

HP-3 The first sentence in LA section 9.2.1 states the licensee's purpose of the ALARA program is to maintain radiation exposures within regulatory limits. The purpose is not consistent with the definition of ALARA as stated in 10 CFR 20.1003 'ALARA.' In addition the second portion of the first sentence is circulatory since the word ALARA is used to define the ALARA program. Consistent with ALARA definition in 10 CFR 20.1003 and the requirements of 10 CFR 20.1101(b),

- Modify the purpose of the ALARA program to conform to the regulatory definition by ensuring doses will be maintained as far below regulatory limits as reasonable.
- Modify the second sentence in the first paragraph to indicate that management will ensure the work force is committed to this policy.
- Modify the first bullet of the description of the ALARA program to state that the ALARA principle will be incorporated, when appropriate, into the plant procedures involving radioactive material, rather than a separate set of ALARA procedures.

Reply:

LA Section 9.2.1 has been revised in response to this request.

HP-4 LA section 9.2.1.2 describes the roles of the ALARA Committee such as reviewing and conducting audits at least annually, but does not specify a time frame for how often the Committee meets. Consistent with 10 CFR 20.1101(c),

- Clarify how often the ALARA Committee will meet, and provide a minimum time between meetings,
- State whether the ALARA Committee is the "qualified organization" involved in the design reviews for modifications as described in the last paragraph of section 9.1.1.4 on page 9-3. If not, clarify who makes up the "qualified organization" mentioned in the same paragraph.
- The applicant states in section 9.1.1.1, design personnel are qualified in radiation protection design and ALARA concepts. Describe how personnel achieve qualification and the expected level of experience in radiation protection, radiation shielding and general radiation safety.

Reply:

LA Setions 9.1.1.1, 9.1.1.4 and 9.2.1.2 have been revised in response to this request for information.

HP-5 LA section 10.1 describes the ALARA goals to minimize release of radioactive material to the environment but does not specify if the radiation function is responsible for the radiological environmental monitoring program. Consistent with 10 CFR 20.1101(d),

- In LA section 10.1, state which function is responsible for conducting the radiological environmental monitoring program.

Reply:

LA Section 10.1 has been revised in response to this request.

HP-6 LA section 9.1.1.1 describes the responsibilities for the ALARA design, stating the design function is split between regulatory and engineering functions. The section also states the nuclear safety function provides design criteria associated with radiation protection. Clarify what the nuclear safety function is. Clarify if this function is overseen by the Radiation Protection Manager (RPM). If it is not, explain why the RPM is not included in ALARA design, consistent with regulatory Guide 8.8.C.b.(3).

Reply:

LA Section 9.1.1.1 has been revised in response to this request.

Experience:

HP-7 LA pages 9-18, 4th and 7th paragraphs describe the minimum experience and training requirements for the RPM. Consistent with 10 CFR 70.23(a)(2),

- In the 4th and 7th paragraphs of section 9.2.2 establish a commitment for a portion of the management experience to have been received at a nuclear facility (power plant, navy, fuel fabrication, etc.) (see ANSI/ANS Standard 3.1, section 4.3.3).
- Page 9-18 section 9.2.2 7th paragraph in the last sentence states, "Management may waive specific qualifications for the RPM when education, experience, certifications, and overall qualification of the supporting staff meet the above requirements." State that instances where management waives specific qualification requirements for the RPM will be evaluated on a case – by – case basis, approved and documented (see ANSI/ANS Standard 3.1, section 4.1.1.1 and 4.1.2.1).

Reply:

LA Section 9.2.2 has been revised in response to this request.

Procedures:

HP-8 LA section 15.5.4 page 15-13 states operating and maintenance procedures are reviewed every five years to verify their continued applicability and accuracy. There is no comparable commitment to conduct periodic reviews of radiation protection procedures. Consistent with 10 CFR 20.1101(c),

- State the periodic review of radiation protection procedures will be conducted in accordance with internal procedures
- State that respiratory protection procedures will be revised as necessary, wherever changes are made to the facility, process or equipment.

Reply:

LA Chapter 15, Section 15.5.4 has been revised in response to this request.

HP-9 LA section 9.2.3 page 9-19 second paragraph states RWPs are required for specific purposes only. The submittal does not provide any description of the criteria which determine when a RWP will be used. In addition, the last sentence of the last paragraph on page 9-19 indicates that RWPs are not required under certain unspecified conditions. Consistent with 10 CFR 70.22(a)8 and 70.23(a)4,

- Specify under what conditions an RWP will be required. State whether RWPs will be required for activities involving licensed materials not covered by operating procedures.
- Clarify the meaning of the first paragraph of section 9.2.3 regarding RWPs which states they are used to "control radiological work." The section seams [*sic*] to indicate an RWP must be used for every entry into the restricted area.

- State who may generate RWPs, and specify how long these documents are retained.
- LA section 9.2.3 page 9-19 last sentence of the last paragraph indicates that some organizational groups that use licensed materials are not required to use RWPs. Change the wording of the last paragraph on page 9-19 to clarify that RWPs are not required when established procedures exist.
- In LA section 9.2.3 the last paragraph on page 9-19 contains one sentence stating that "procedures that involve the use of licensed materials without an RWP require review and approval by the RPM." Expand upon this single sentence to describe that process for drafting, authorizing, and reviewing new or modified procedures, both RWP and non-RWP radiation procedures. State that major procedure modifications involving licensed material will be reviewed and approved by appropriate management, e.g., radiation protection manager.

Reply:

LA Section 9.2.3 has been revised in response to this request.

Training:

HP-10 LA page 9-22 section 9.2.4 last 3 sentences indicate that the radiation safety training program will be updated as items are identified. Consistent with the requirements in 10 CFR 19.12 and Regulatory Guide 8.29, section C,

- State which function (HS&E Manager, RP, etc.) will be responsible for reviewing/auditing and updating the radiation safety training program.
- Specify that the radiation safety training program will be reviewed and updated on some periodic basis consistent with Regulatory Guide 8.29 Section C (which states 3 years), to account for facility or process changes and ensure that the programs are current and adequate.
- Section 9.2.2 describes radiation safety training for general employees as well as visitors entering restricted areas. Consistent with 10 CFR 19.12, add a sentence committing to meet all the training requirements in 10 CFR 19.12. Consult Regulatory Guides 8.10, 8.13 and 8.29 for additional information on training criteria acceptable to the NRC.

Reply:

LA Section 9.2.4 has been revised in response to this request.

Ventilation:

HP-11 On LA page 9-5, section 9.1.2.2 the last sentence of the first paragraph states, "Airborne contamination and pressure are monitored to detect changes in containment barriers." Consistent with 10 CFR 20.1501 and 20.1701, state that differential pressure across HEPA filters will be checked on a periodic basis consistent with the manufacturer's specification or the filters will be connected to automatic monitoring or alarms.

Reply:

LA Section 9.1.2.2 has been revised in response to this request.

Respiratory Protection:

HP-12 LA page 9-28 section 9.2.10 describes the licensees Respiratory Protection Program. Consistent with 10 CFR 20.1703(c)4,

- State that written procedures will be used for the selection, fitting, issuance, maintenance, testing, training of personnel, monitoring and record-keeping for individual respiratory protection equipment.
- Consistent with 20.1703(c)f(viii), provide a commitment to maintain records of the respiratory protection program, including training for respirator use and maintenance.

Reply:

LA Section 9.2.10 has been revised in response to this request.

Surveys:

HP-13 LA section 9.2.6 contains a general description of the licensee's survey program but does not provide an explicit commitment to conduct the surveys according to planned and approved written procedures, nor does the section describe what function is responsible for conducting the survey program. Consistent with 10 CFR 20.1501(a),

- State that written procedures specific to the type of contamination will be followed for the survey program.
- Specify that the procedures will include such items as an outline of the program objectives, sampling procedures; data analysis methods; types of equipment and instrumentation to be used; frequency of measurements; record-keeping and reporting requirements.
- State the radiation Protection function is responsible for conducting the survey program.
- The third paragraph on page 9-24 in section 9.2.6 states that surfaces will be surveyed for contamination which exceeds the limits in Table 9.2-1. Yet, there are no commitments to conduct a cleanup within a specified time frame. Specify the corrective actions for contaminated surfaces and that removable contamination will be cleaned up in accordance with internal written procedures.
- Section 9.2.6 page 9-24 paragraph 3, last sentence states, "After historical data have been collected, the frequencies of surveys are adjusted to optimize resources." This "optimization of resources" is not well defined. Provide a commitment to conduct surveys on a frequency in accordance with RG-8.24 section 2 or specify a minimum frequency which demonstrates an equivalent program. Or, describe the program to collect historical data with sufficient detail to demonstrate the survey program will be representative. Include the

type of data collected, the length of time the data will be collected, how often the historical data is reviewed to ensure it remains representative, etc.
- Consistent with 10 CFR 20.2103, add a statement to the second paragraph on page 924 to document surveys and corrective actions and to maintain records on these items.

Reply:

LA Section 9.2.6 has been revised in response to this request.

Dosimetry:

HP-14 LA section 9.2.7 page 9-25 to 9-26 last partial sentence states, "Personal dosimeters are analyzed at a frequency described in approved procedures." Consistent with 10 CFR 20.1502, identify a maximum time frame for processing TLDs, such as at least quarterly.

Reply:

LA Section 9.2.7 has been revised in response to this request.

HP-15 In the middle of the first paragraph of LA section 9.2.12 page 9-32 states, "In that case, significant exposure dosimetry....." This reference to "significant exposure dosimetry" is unclear since it does not apply to the TLD or the electronic pocket dosimeter listed in the previous sentence. Consistent with 10 CFR 70.9,

- Define the term "significant exposure dosimetry," and clarify whether this refers to a pocket ionization chamber, personal dosimetry, portable survey equipment, CAMs, etc.
- Consistent with 10 CFR 20.1501(a), clarify which individuals will be required to carry this type of "significant exposure dosimetry." If a dose exceeds the electronic pocket dosimeter, state that internal procedures will define what actions will be taken. Provide a summary of these actions in the RAI response.

Reply:

Upon indication that an accident may have occurred, radiation protection personnel check the electronic dosimeter for exposure. If the reading is beyond the instrument's range of detection, the individual's security badge activation foils are surveyed for exposure. If the readings indicate excessive exposure, the TLD is pulled and immediately sent for reading; SRS medical staff is made aware of the situation and the individual is prepared for transport to SRS medical for evaluation. The SRS medical staff then will determine the appropriate actions to mitigate the exposure / contamination. The individual may be required to submit to bioassay sampling as well as whole body counting to further determine the course of action to mitigate the conditions.

With the aforementioned in mind, LA Section 9.2.12 has been revised to respond to this request.

HP-16 The last sentence in LA section 9.2.7 page 9-26 states, "Radiation protection program policies and approved procedures establish action levels for personal dosimetry analyses results." Although administrative control levels are listed in Table 9.1-2, the dosimetry section does not reference these action levels. Consistent with 10 CFR 20.1101 and 20.1201,

- Incorporate into section 9.2.7 a statement that the administrative limits in Table 9.1-2 apply to direct exposure control.
- Describe the corresponding follow up actions that will be required if direct reading dosimetry indicates the administrative limit has been exceeded.
- Identify any quarterly administrative limits and specify the associated action levels.

Reply:

LA Section 9.2.7 and Table 9.2-1 have been revised to respond to this request.

Bioassay:

HP-17 LA section 9.2.8 page 9-26 states that routine bioassay monitoring will be conducted for personnel likely to receive intakes resulting in a CEDE greater than 100 mrem. However, the last sentence in the preceding paragraph states that "the 100 mrem action level is difficult to achieve." These two statements taken together imply most staff at the MFFF are not required to undergo routing bioassay monitoring. Consistent with 10 CFR 20.1502(b)

- In LA section 9.2.5, modify your commitment to conduct bioassay to a percentage of the ALI (e.g. 2%) rather than 100mRem.
- Clarify what members of the MFFF staff will be required to undergo routing bioassay monitoring. Replace the term "personnel likely to receive intakes" with a more concrete criteria such as individuals handling radioactive material, individuals working in controlled areas, etc.
- State that the bioassay program will be conducted consistent with ANSI.HPSN 13.22 (1995) or provide sufficient description to demonstrate equivalence. Consistent with this standard, provide a maximum interval for conducting a routine bioassay, e.g., quarterly. Provide an overview of the types of bioassay measurements to be conducted, and provide sufficient description to demonstrate equipment and instrumentation have sufficient sensitivity for the type or types of radiation being measured.
- Describe the type of bioassay measurements. E.g., urinalysis, whole body scan, lung scan, etc.

Reply:

LA Section 9.2.8 has been revised to respond to this request.

Dose Limits:

HP-18 LA section 9.2.9 page 9-27 lists the types of doses that will be tracked. The section states the exposure limits listed in 10 CFR 20, but does not provide a commitment to sum internal and external doses. Consistent with 10 CFR 20.1202(a), state that external and internal doses will be summed when applicable. Commit to meeting Regulatory Guides 8.7 (NRC, 1992a) and 8.34 (NRC, 1992c). Or provide a commitment to maintain procedures in agreement with these Regulatory Guides.

Reply:

LA Section 9.2.9 has been revised to respond to this request.

Air Samples:

HP-19 The first five paragraphs of LA section 9.2.5 page 9-22 to 9-23 indicate air samples will be used if individuals are likely to receive 2% of the ALI. This section also refers to air sampling equipment and air monitoring equipment. In addition LA section 9.2.11.1.1 indicates airborne contamination surveys will be processed. Based on these sections, the licensee appears to be using CAMs to identify releases above a certain action level and air samples to monitor internal radiation levels. The submittal provides a thorough description of when CAMs will be used but insufficient information on air sampling. Consistent with 10 CFR 20.1204(a),

- Modify the third paragraph on LA page 9-23 to provide an overview of how CAMs and air samples will be used to calculate daily internal doses.
- State the frequency of air sample measurements; provide a description of the recordkeeping of air samples; and list the minimum detection levels.
- State that administrative limits are established for air contaminations at which actions are taken to investigate and correct the levels.
- Consider committing to conduct air sampling in accordance with industry standards such as Regulatory Guide 8.25 (NRC, 1992b); NUREG-1400 (NRC, 1991); and ANSI/Health Physics Society (HPS) Standard 13.1
- Specify how air samplers will be positioned so that sampled air is representative of inhaled air.
- LA section 9.2.8 describes how the licensee will monitor internal exposure. The section focuses on bioassay measurements, and does not include doses based on air sampling. Yet, the second paragraph indicates that bioassays will not be conducted unless "workplace monitoring" (undefined) identifies a potential intake. Modify the second paragraph of LA section 9.2.8 to clarify how the air sampling program is used in conjunction with the bioassay program to determine the internal dose. Clarify that air sampling will be used to track daily internal doses and bioassay will be used to verify these measurements on a periodic basis or in rare high exposure instances.

Reply:

LA Sections 9.2.5 and 9.2.8 have been revised to respond to this request.

Controlled Areas:

HP-20 Section 9.2.6 page 9-24 second full paragraph states, "Initially, contamination surveys (i.e., instrument, swipe and large-area wipes) are conducted in the Radiological Control Area established for the control of contamination, and other areas with the potential for becoming contaminated." In addition the second bulleted item on page 9-24 refers to "contamination, high contamination, and airborne radioactivity areas." The application makes multiple references to contamination and radiological areas which are not well defined in the application. Consistent with 10 CFR 70.9(a) and 10 CFR 20.1501(a),

- Add a paragraph to section 9.2.6 which defines a "controlled area," "Radiological Control Area," "contamination area," "high contamination area," and "radioactivity areas" with sufficient description to differentiate between each area.
- Section 9.2.6 discusses radiological control areas, restricted areas, contamination areas, high contamination areas and airborne radioactivity areas. There is no indication of how these areas will be posted. Consistent with 10 CFR 20.1902, add a description of each type of area listed in section 9.2.6 with sufficient detail to determine which areas correspond to radiation areas (RA), high radiation areas (HRA) and radioactive material storage areas. State how each area is posted.
- Provide an objective criteria for identifying "... areas with the potential for becoming contaminated."
- Once these various areas are defined, describe how they will be identified and demarcated.

Reply:

LA Section 9.2.6 has been revised to respond to this request.

HP-21 The last paragraph in LA section 9.2.6 describes Radiological Control Zones (RCZ). The location of the RCZ is stated to be at the work site rather than at the entrance/exit to the controlled area. Also, the current wording states individuals must change in the RCZ before entering the RCZ. Consistent with 10 CFR 20.1101(a),

- Eliminate the contradictory language concerning RCZs.
- State that change areas will be set up at the entrance/exit to radiation controlled areas.
- State that procedures are established to require staff to don appropriate personal protective equipment (PPE), conduct personal surveys, decontaminate, and contact HP staff for assistance if contamination warrants.
- LA section 9.2.6 page 9-23 first paragraph states, "The use of personnel monitoring equipment is required when personnel leave a known contamination area." The term "known contamination area" is not well defined or differentiated from other areas listed in LA section 9.2.6. State that RCZs are located between clean areas and potentially contaminated areas, and personnel and equipment will be properly surveyed and decontaminated when leaving these areas.

- State that procedures are established to handle the disposition of PPE and other contaminated items and provide a brief overview.
- Describe the dedicated facilities for managing contaminated personnel or used anti-contamination clothing. Provide a general description and state how effluent from decontamination would be managed.

Reply:

LA Section 9.2.6 has been revised to respond to this request.

Corrective Action Program:

HP-22 Corrective actions are mentioned in sections 9.2.6 page 9-24 – first full paragraph, LA section 9.2.11 page 9-29 – second full paragraph, and in LA section 9.2.14 on page 9- 33. Yet, there is not explicit commitment to require corrective actions if administrative limits are exceeded. Consistent with 10 CFR 20.1502 and RG 8.24,

- In LA section 9.2.7, "Direct Exposure Control" and 9.2.8, "Internal Exposure Control," state that internal procedures will define implementation of the facility's corrective action program when the results of personnel monitoring or contamination surveys exceed the applicant's administrative personnel contamination levels.
- LA section 9.2.6 third to the last paragraph on page 9-24 contains a commitment to decontaminate skin prior to exiting a controlled area. In LA section 9.2.6 third to last paragraph state that internal procedures will define RP approved contamination action levels for individuals exiting a controlled area. State that personnel will be aware of these action levels through postings or training.

Reply:

LA Sections 9.2.6, 9.2.7 and 9.2.8 have been revised to respond to this request.

HP-23 The emphasis of the corrective action program as described in LA section 15.7.1 is, "identifying, investigating, reporting, tracking, correcting, and preventing recurrence of conditions adverse to quality." Consistent with 10 CFR 20.1101(a), in you RAI response, clarify the meaning of this sentence since it seams to emphasize quality over safety. The corrective actions program for occupational exposures should be implemented to protect personnel safety, which may not have a direct impact on product quality.

Reply:

Chapter 15 is dedicated to management measures associated with IROFS for protection of workers, the public and the environment and as such it does not directly relate to normal operation occupational radiation protection.

LA Section 9.2.14, *Additional Program Commitments*, is revised to show MOX Services' commitment that the corrective actions program for occupational exposures will protect personnel safety regardless of impact on product quality.

Sealed Sources:

HP-24 Consistent with 10 CFR Subpart F, "Surveys and Monitoring," demonstrate that sealed sources will be leak-tested on a periodic schedule. Refer to NRC Branch Technical Positions: (1) "License Condition for Leak-Testing Sealed Byproduct Material Sources," April 1993, (2) "License Condition for Leak-Testing Sealed Plutonium Sources," April 1993, (3) "License Condition for Plutonium Alpha Sources," April 1993, (4) "License Condition for Leak-Testing Sealed Source Which Contains Alpha and/or Beta-Gamma Emitters," April 1993, and (5) "License Condition for Leak-Testing Sealed Uranium Sources," April 1993

Reply:

LA Section 9.2.3.6 has been revised to respond to this request.

Reports:

HP-25 The application contains limited language on the reporting of occupational exposures to the NRC such as section 9.2.13 and 10.1.1. Consistent with 10 CFR 20.2202, 20.2206(b), and 10 CFR 70.74,

- Modify the language in the second paragraph of section 10.1.1 on page 10-1 to make the commitment apply to normal and off-normal operations. The current language only applies to off-normal operations.
- In LA section 9.2.13, since the last sentence in the first paragraph of LA section 9.2.13 only commits to reporting overexposures, modify the section to also require an annual report of all the results of individual monitoring carried out by the licensee, as required by 10 CFR 20.2206(b).

Reply:

LA Sections 9.2.13 and 10.1.1 have been revised to respond to this request.

9. RADIATION SAFETY

The radiological protection program provides assurance that facility radiation safety measures protect the health and safety of workers and comply with the regulatory requirements of Title 10 of the Code of Federal Regulations (CFR) Part 20, *Standards for Protection Against Radiation,* and 10 CFR Part 70, *Domestic Licensing of Special Nuclear Material* during routine and nonroutine operations, including anticipated events. Public and environmental radiation protection is addressed in Chapter 10.

MFFF management is fully committed to implementing a quality radiation protection program consistent with Regulatory Guide 8.8 C.1.a &b. The program is supported throughtout the facility lifetime and it is documented in project documents. Emphasis is placed on the design and construction phases at this time with general commitments for radiation protection during facility operations.

The potential for occupational exposure at the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) exists primarily as a result of processing plutonium (i.e., potential internal exposure from inhalation) and secondarily as a result of proximity to photon and neutron radiation sources (i.e., direct external exposure). The primary design features that limit exposure in accordance with as low as is reasonably achievable (ALARA) goals are automated and remote systems operation, confinement systems (e.g., gloveboxes, process cells, and ventilation), monitoring, alarms, and radiation shielding.

The radiological protection program applies to MFFF activities that manage radiation and radioactive materials, and that may potentially result in radiation exposure to facility workers and the individual outside of the controlled area (IOC). The radiological protection program guides the actions of personnel involved in radiological work at the MFFF.

9.1 RADIATION SAFETY DESIGN FEATURES

The MFFF design objectives, along with the programmatic measures, ensure that operation of the MFFF is in accordance with 10 CFR Parts 20 and 70, and ALARA principles. Engineering design features and management controls implemented during operation ensure that occupational doses are ALARA.

9.1.1 ALARA Design Considerations

9.1.1.1 Responsibilities for ALARA Design

The design function is split between the regulatory and engineering functions. The nuclear safety function within the regulatory function provides design criteria associated with radiation protection. The nuclear safety function reviews the MFFF designs for radiation safety concerns including criticality, exposure as well as shielding considerations. These reviews provide the MFFF designers with the information necessary to ensure that operational exposures are maintained ALARA as a result of the design.

The Radiation Protection Manager is part of the design review process and evaluates the MFFF system and structural design to ensure that ALARA principals are incorporated. The review also

evaluates potential radiological concerns that can be mitigated during the design process so that operationally the design provides adequate radiation protection for personnel including maintenance activities.

The manager of the engineering function is responsible for implementation of radiation protection design criteria. Facility design engineers report to the manager of the engineering function. The nuclear safety function reviews the design, performs radiation protection analyses, and confirms that the design meets radiation protection design criteria.

Design personnel are qualified in radiation protection design and ALARA concepts, including personnel experienced in radiation protection, radiation shielding, and general radiation safety. Design personnel are trained to recognize potential radiation hazards and to minimize the effects of these hazards on operations.

The primary radiation analyses performed in support of the radiation protection design are radiation shielding calculations and occupational radiation dose assessments during routine and nonroutine operations.

9.1.1.2 MFFF Design and Design Activities

The MFFF design reflects ALARA principles. Specific ALARA considerations in the MFFF design include:

- Control of plutonium particulate to prevent inhalation by confining radioactive materials in process equipment and in gloveboxes
- Multiple-zone ventilation system design, sweeping from low to high potential contamination zones
- Continuous remote monitoring for airborne contamination in accessible areas with local and remote readout and alarm functions
- Use of automated and remotely operated equipment to minimize personnel exposure
- Provisions for removing radioactive material before most maintenance operations are included in facility maintenance procedures
- Shielding between radioactive sources and operators, according to the intensity, nature, and penetrating power of the radiation
- Design of structures, systems, and components (SSCs) that require a minimum of maintenance or repair, to minimize personnel stay time in radiation areas
- Shield wall penetrations between high radiation areas and personnel access areas are located and oriented so that there is no direct line of sight to the source(s), thus precluding streaming without reduction due to scatter
- Placement of piping containing radioactive fluids in nonaccessible pipe chases
- Placement of equipment requiring maintenance in separate shielded areas having a minimum of radioactive piping
- Placement of administrative, security, and radiation protection administrative activities away from radiation areas
- Areas of continuous occupancy are zoned to maintain dose rates at a low level while areas of higher dose rates are limited access
- Use of area radiation monitoring, with local and remote readouts and alarms to inform personnel of changing conditions.

9.1.1.3 Collective Dose Estimates

The design process includes an occupational dose assessment for the facility. Dose assessments are performed for each process unit with known personnel access requirements and are evaluated to determine reasonably achievable design enhancements to reduce exposures. Dose assessments were performed using guidance from U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 8.19, *Occupational Radiation Dose Assessment in Light-Water Reactor Power Plant — Design Stage Man-Rem Estimates*, and Regulatory Guide 8.34, *Monitoring Criteria and Methods to Calculate Occupational Radiation Doses.*

The dose assessments take into account both direct and internal dose. The direct dose assessment was determined by dose rate analyses and a dose assessment process called the ABAQUES Method (see Section 9.1.4.6). The internal dose assessment was determined based on the MFFF design and review of MELOX and La Hague experience. The internal dose and direct dose sum meet MFFF's design goals and are ALARA.

9.1.1.4 Design Review Process

Competent personnel are responsible for the review of, and concurrence on, preliminary and final designs. The design reviews incorporate experience from the MELOX and La Hague plants. Project design reviews include ALARA evaluations to a level of detail commensurate with the potential radiation hazard. Recommendations made in the ALARA evaluations are tracked to completion as part of the review of design products.

The MFFF design incorporates applicable radiation protection experience from MELOX and La Hague, such as the following:

- Descriptions of process unit operations
- Personnel access times
- Source configurations
- Radiation monitoring~~dosimetry~~
- Radiation exposure problem areas
- ALARA design features and performance
- Contamination estimates
- Radiation monitoring design and operations
- Process unit shielding design
- Ventilation system design.

MELOX and La Hague are reference facilities for the MFFF design. Much of the MFFF facility design is the same as that used at the reference facilities. Occupational exposures at the MFFF facility should be similar to occupational exposure at the reference facilities, with adjustments to account for differences in radiation source terms, differences in shielding design, and personnel access requirements.

Radiation protection design improvements that have been made at the MELOX and La Hague facilities are incorporated into the MFFF facility design. For example, the grinding unit vacuum system minimizes loose contamination in the glovebox. Project team members have direct experience with the MELOX and La Hague facilities, and design documentation ~~was~~ is available to the design team. Such improvements ~~were~~ are incorporated to the maximum extent practical in the MFFF facility.

Continuing radiation safety (ALARA) design reviews for facility or process modifications are conducted during construction and operations. An appropriately qualified organization is responsible for reviewing facility or process modifications for the express purpose of maintaining exposures ALARA.

9.1.1.5 Other Design Considerations

Experience from the MELOX and La Hague facilities is incorporated into the MFFF design to ensure that the occupational exposure from the MFFF is maintained ALARA. Airborne and loose surface contamination is prevented during normal operations by plutonium recovery operations, glovebox design, and ventilation system design, to maintain inhalation dose ALARA. Most of the aqueous polishing (AP) process is installed in process cells. Entry to those process cells is physically prevented.

Design features such as automation and remote controls reduce the time spent in radiation areas. MFFF zone classification (see Table 9.1-1) minimizes occupational radiation exposure through access control and shielding design to meet exposure criteria.

The design minimizes the distribution and retention of radioactive material throughout plant systems by:

- Designing the process equipment containing radioactive material to confine the material to the maximum extent practical to reduce glovebox contamination
- Designing the gloveboxes to prevent accumulation of contamination and allow easy access for cleaning
- Using a vacuum system in gloveboxes so that airborne dust is collected in dust pots and the radioactive material is recycled.

9.1.2 Facility Design Features

This section describes the primary design features and equipment that directly or indirectly reduce radiation exposure for facility workers and provide monitoring capability.

9.1.2.1 Drawings and Descriptions

Facility drawings, process descriptions, and other facility documents associated with the radiation protection design include:

- Scaled drawings of the general arrangement of the facility with superimposed radiation zones based on expected worker occupancy
- Radiation shielding calculations that use design drawings for locations and configurations of radiation sources, shielding and plant operators ~~that~~ in order to specify requirements for each process unit design
- A summary report of radiation protection design that provides definitions of the radiation sources, dose rates, and worker dose estimates for process units. The report identifies features relied on to reduce doses to ALARA, and shows how the design meets the requirements of 10 CFR Part 20 during routine and nonroutine operations including anticipated events.
- Location for radiation protection equipment both for fixed detectors and for storage of portable equipment

- General requirements and descriptions for radiation detectors and alarm systems

- Locations of permanent shielding and confinement design (e.g., penetrations, labyrinth seals, shield doors)
- Locations and access control points for radiation areas
- The controlled area, including the means to limit access to the controlled area as necessary
- The restricted area
- Change rooms, showers, and locker rooms
- Contamination control and waste minimization design features.

9.1.2.2 Radiation Sources and Exposure

The greatest potential for occupational radiation exposure at the MFFF is from plutonium inhalation. Therefore, the design incorporates multiple systems and barriers to prevent the release of radioactive material into personnel access areas. Depending on the stage in the process, confinement of radioactive material and worker protection is obtained by process vessels in cells (AP), gloveboxes (AP Sampling, Powder Area, and Pellet Process Area), or other sealed containers (fuel rods, containers). Gloveboxes are used to prevent personnel contamination. The gloveboxes are kept at a negative pressure with respect to the area occupied by personnel, to ensure that contamination will be contained in the event of a breach. A second ventilation system in the personnel access areas sends clean air through registers located near the ceiling toward the floor, providing a slow downwash of clean air at work stations, to minimize the potential for inhalation of contaminants. Airborne contamination in all C3b rooms is monitored using continuous air monitors and pressure ~~are~~ is monitored to detect changes in containment barriers. The ventilation system is equipped with differential pressure monitors and alarms as identified in Section 11.

A second source of potential occupational radiation exposure is from direct exposure to radiation sources within gloveboxes. Although previous exposure rates are low (MELOX and La Hague), various design features have been implemented to attenuate ionizing radiation and to further limit operator exposures, including (1) limiting exposure times through automation and remote control of production workstations, and (2) placing shielding between radiation sources and operators.

For process cells in the AP Area, the primary feature is remote operations capability, with few operations performed in radiation areas. System sampling and inspections are designed to be performed from access areas outside of high radiation areas. Sources of radiation often can be removed from the work area prior to extensive work being performed. Routine access to process cells is precluded. Radiation shielding consists of multiple barriers — including concrete cell walls and borated concrete panels around process equipment for neutron absorption.

Access is restricted to process rooms containing gloveboxes. Few operations are performed in the process rooms themselves, thus free access is not necessary. These areas are protected against direct radiation from process equipment by thick concrete walls. Radiation shielding is

included on the gloveboxes as necessary, and the facility is designed so that sources of radiation can generally be removed from the work area prior to extensive work being performed.

MOX Processing (MP) Area work is primarily performed in the process rooms, thus these rooms are routinely accessed. Radiation and pressure monitoring are performed to detect changes in the confinement barriers. Shielding is designed so that dose rates in radiation work areas are low, to accommodate required access. Existing data from the MELOX and La Hague facilities are used to estimate access requirements. Radiation shielding for both neutron and gamma sources is designed permanently into the glovebox system (inside the glovebox for large radiation sources when this does not impair operation, and outside the glovebox whenever practical). Shielding is separate from the confinement barrier to allow for changes, if needed, without the potential for spreading contamination. The radiation shielding concepts in the MFFF include the following:

- **AP cells** – thick concrete walls constitute the primary shielding
- **AP gloveboxes** – shielding on the gloveboxes as needed; limited access – primarily for sampling
- **MP gloveboxes** – shielding inside the gloveboxes when necessary; external shielding outside the gloveboxes in general based on access requirements
- **MP areas** – have separate areas for each process unit shielded by concrete and sealed to prevent the spread of contamination.

Standard shielding materials are used to attenuate radiation intensity at the worker. American National Standards Institute/American Nuclear Society (ANSI/ANS)-6.4.2-1985, R1997 is used as a reference for shielding material properties for performing calculations. Materials used for shielding include: leaded glass and plastic, borated polymers and plasters, carbon and stainless steel, cadmium, ordinary and borated concrete, and pourable plasters.

Glovebox design incorporates use of shielding to protect workers from direct radiation. Interior shielding is provided to ensure that radiation from specific sources is minimized. Glovebox walls incorporate appropriate shield materials to reduce worker exposures. Regular glovebox maintenance is conducted to preserve operability. Irregular, longer duration glovebox maintenance is scheduled at times when radiation sources are not present, to minimize radiation exposures to the maintenance personnel and to limit the potential for a release of airborne radioactive material.

Shielding design complies with 10 CFR §20.1406 requirements for the minimization of contamination and uses the MELOX and La Hague facility design experience for guidance. The design includes permanent shielding in the process rooms.

Project quality assurance applies to shielding design, procurement, installation, maintenance, and operation. Radiation shielding testing verifies the efficacy of installed shielding materials in meeting radiation shielding design goals and the direct dose regulatory requirements of 10 CFR Part 20.

Shielding materials are selected for the source term to effectively reduce dose rates to meet ALARA goals. Borated polymers are used for neutron attenuation, and stainless steel~~,~~ and leaded glass, ~~and plastic~~ are used for photon shielding in the glovebox units.

9.1.2.3 Ventilation Systems, Glovebox Design, and Waste Minimization

The design of ventilation systems and gloveboxes ensures that during routine and nonroutine operations and anticipated events, the airborne concentration in occupied operating areas remains well below the limits of 10 CFR Part 20, Appendix B. Engineering controls are preferred over the use of respiratory protection.

The MFFF process implements recycling and reuse for waste minimization. For example, the recycling process minimizes the quantity of plutonium in the final waste by using systems that return (recycle) radioactive material to previous steps of the main process. Liquid waste is minimized in the AP process by use of recycling to the maximum extent practical. Nitric acid is recovered by evaporation from the process and partly reused as reagent feedstock for the plutonium dissolution subprocess. Distillates from the evaporation process are collected and partly reused in the process. Spent solvent from the plutonium separation step is regenerated by washing with sodium carbonate, sodium hydroxide, and nitric acid to remove degradation products from organic compounds, including trace amounts of plutonium and uranium.

Solid waste is minimized by reuse of solid scrap material from fuel fabrication. Many other system design features perform contamination control, confinement, and associated waste minimization functions. The process design reduces the distribution and retention of radioactive materials throughout plant systems by using vacuum systems in the gloveboxes. Airborne dust is collected in dust pots in dedusting systems installed in the gloveboxes, and the material is recycled. These design features control contamination to ensure that secondary waste production is minimized during plant operation.

The air monitoring and warning systems are designed with a standby power supply. Uninterruptible power supplies are used to ensure air monitoring and warning systems are operable during a loss of power event. Alternatively, monitoring and warning systems will tolerate a temporary loss of power without loss of data.

9.1.2.3.1 Ventilation System Design

The ventilation (heating, ventilation, and air conditioning [HVAC]) system is designed to incorporate features that ensure workers are protected, to the greatest extent practical, from airborne radioactive material during normal and anticipated conditions. Many ventilation system design features described in this section also promote reduced airborne effluent releases, thus minimizing exposure to site workers and the IOC.

The HVAC systems maintain a negative pressure gradient between building confinement zones, and between the buildings and outdoors to ensure that airflow is from zones of lesser to greater contamination potential. Confinement zones are bounded by confinement system boundaries, across which a well-defined pressure gradient is maintained. This ensures that an air exchange, and consequently airborne contaminants, across a breach is also from zones of lesser to greater contamination potential. For example, air flows from clean areas (C1 or C2 zones) to the most contaminated areas (C4 zones) (e.g., gloveboxes), before being exhausted via high-efficiency particulate air (HEPA) filters to the plant stack. C4 zones are the primary confinement zones containing process equipment and enclosures. C3 zones are broken down into two levels

depending on the contamination hazard: C3a zones have a low occasional hazard, while C3b zones have a moderate hazard. C2 zones have a low occasional contamination hazard, and C1 zones have no potential for contamination.

In the AP and MP Areas, dynamic confinement of C4 zones is ensured by the Very High Depressurization Exhaust (VHD) system. In the AP Area, dynamic confinement of process cells within tertiary confinement is provided by the Process Cell Depressurization Exhaust (POE) system. In the AP and MP Areas, dynamic confinement of C3a and C3b zones within secondary confinement is provided by the High Depressurization Exhaust (HDE) system. In the AP and MP Areas, dynamic confinement of C2 rooms within tertiary confinement is provided by the Medium Depressurization Exhaust (MDE) system. For the AP process cells, the typical cascading sequence of pressure gradients between neighboring zones is as follows:

$$C1 \rightarrow C2 \rightarrow \text{process cells}$$

For the AP and MP Areas with gloveboxes containing dispersible material, the typical sequence is as follows:

$$C1 \rightarrow C2 \rightarrow C3a \rightarrow C3b \rightarrow C4$$

In both examples, leakage airflow is from high pressure to low pressure.

Airlocks for access are provided between zones. Cascading air from the cleaner areas through the airlock minimizes potential for migration of airborne contaminants into clean areas during personnel access.

Monitors and alarms indicate changes in confinement pressure to warn personnel so that appropriate action is taken. The instrumentation for a glovebox or enclosure ventilation system includes devices to indicate the differential pressure across the glovebox or enclosure, filter resistance, and the exhaust flow rate from the glovebox or enclosure. When glovebox or enclosure operations are not attended full time, an alarm will signify abnormal pressure at a location where operations personnel are stationed.

The ventilation systems operate continuously to protect personnel from exposure to airborne and transferable contamination. Redundancy ensures continuous operation of an HVAC system in the event of the failure of an active component (e.g., a fan or a damper) during normal or anticipated conditions. The Emergency Alternating Current (AC) Power system provides uninterruptible power to the VHD glovebox exhaust fans.

Room airflow in some rooms is designed to reduce the possibility of airborne radioactive materials being released in the vicinity of workers during abnormal conditions. Air is supplied above the worker and exhausted as close to floor level as possible. This design provides a "wash" across the worker, resulting in the air around the worker being maintained free of contaminants.

These design features minimize the potential that workers are exposed to airborne radioactive material during normal operations, maintenance, or anticipated events.

Airborne radioactivity monitoring and warning systems are provided for worker protection and safety. Systems are located near the glove ports and are placed to maximize sensitivity. The location was determined based on air flow characteristics. The monitoring and warning systems are connected to a data network, providing numerous communication links and readout capabilities. Alarms and instrument readouts are provided in the Health Physics Control Area (HPCA) of the Polishing and Utilities Control Room (PUCR), Emergency Control Rooms, and the Respiratory Protection and Health Physics Room (RM/HPR), which is used as the Operations Support Center during postulated events.

9.1.2.3.2 Glovebox System Design

The primary function of the glovebox is to protect workers from radioactive materials. The gloveboxes are considered primary confinement and are designed to meet ALARA objectives for both direct and internal radiation sources, and to ensure worker safety.

Glovebox design incorporates design techniques to minimize pockets and sharp corners. Smooth surfaces and rounded corners provide for ease of cleaning and recovery of material. This design reduces the localized collection of radioactive material and thereby reduces worker radiation exposure. Periodic cleaning inside the gloveboxes removes dust and minimizes contamination.

Gloveboxes are designed to withstand anticipated conditions (e.g., the design basis earthquake, over- or underpressure). The design ensures that, for anticipated conditions, personnel are provided appropriate protection from a release of radioactive material. Glovebox design is based on providing adequate airflow and sealing surfaces to preclude releases from the glovebox. Glovebox penetrations are designed with glove ports that are sealed to prevent release of contamination.

9.1.2.3.3 Design Features to Reduce Contamination and Waste Production

Many of the design features addressed in previous sections perform contamination control functions. In addition, the design reduces the distribution and retention of radioactive materials throughout plant systems by using a vacuum system in gloveboxes. Airborne dust is collected in glovebox dust pots, and the material is recycled. Contamination entrained in the C4 exhaust is collected on HEPA filters at the glovebox boundary. When the filters are replaced, particulate is recovered from the filters and returned to the process to minimize fissile material in the solid waste.

Design features control contamination so that secondary waste production is minimized. These design features ensure that contamination is confined to specific areas and that contamination is minimized at the time the plant license is terminated, to facilitate eventual deactivation. The design incorporates extensive recycling for the materials exiting the main process (i.e., secondary waste streams of the AP process, and scraps not meeting MP process specifications). This recycling process is designed to minimize the quantity of plutonium in plant waste.

9.1.3 Radiation Protection Design Analysis

Potential occupational radiation exposure from external radiation sources is evaluated and minimized throughout the facility design process using general radiation zoning criteria, the ABAQUES dose assessment method, and design ALARA evaluations.

Each source of radiation within the facility is identified and included in the shielding analysis to estimate radiation dose-rate fields throughout the facility. Radiation sources are identified for each source configuration and "collapsed" for computer code input. Radiation transport codes are used to predict dose rates at work locations. Shielding is designed to meet radiation zone criteria and assures that exposures are below MFFF goals and ALARA.

Based on MELOX and La Hague operating experience, a residual source of contamination was conservatively estimated for loss-of-confinement and extremity dose analyses.

The occupational dose for normal operations and maintenance is assessed during the design phase. Significant occupational doses are evaluated for design enhancements to reduce the potential doses. ALARA analyses are performed to evaluate design alternatives to reduce occupational dose.

9.1.3.1 Source-Pertinent Information

Five primary radiation sources are used for radiation protection design: nonpolished plutonium, polished plutonium, raffinates, master blend, and final blend. Nonpolished plutonium, as received at the MFFF, contains daughter products from the original product that has decayed for about 40 years. As the facility nears the end of life, the original product received will have decayed about 70 years. These inventories are decayed to maximize the photon source term. Neutrons are produced by spontaneous fission and through alpha-neutron (α, n) reactions. Impurities associated with input materials are incorporated into the alpha-neutron (α, n) reaction for the unpolished source.

The sources identified ~~were~~ are used to:

- Evaluate consequences of nonroutine events for the radiation protection design
- Provide input to shielding codes used in the design
- Establish design features, along with controls and responsibilities for restricted, controlled, and unrestricted areas
- Develop plans and procedures
- Assess occupational dose.

9.1.4 Shielding Evaluations

MELOX and La Hague operating experience is used throughout the MFFF design process to minimize occupational and public radiation exposure. Operating experience that defines the occupancy for each of the process units is used to estimate the occupational exposures for each glovebox. Radiation sources are determined for the MFFF. The redesign of some process units for process reasons and/or to optimize radiation protection is taken into account in the analysis. These sources are used to calculate the dose rates and thus establish the radiation shielding requirements. Process units that result in higher occupational exposure are reviewed to maximize productivity, minimize maintenance, and thus minimize radiation exposures. The

types of MELOX and La Hague data used for the MFFF design for personnel access requirements are as follows:

- Description of activities
- Proximity to radiation sources
- Definition of radiation sources
- Duration of activities
- Duration of time that hands are in the gloveboxes.

Permanent shielding is designed in the facility to lower dose rates to comply with 10 CFR Part 20 during routine and nonroutine operations and anticipated events. Radiation zone drawings are used to locate equipment.

Design goals for internal and direct doses are based on fractions of 10 CFR Part 20 limits. These were developed by making use of the design features and experience of the MELOX and La Hague facilities. Exposure data and the difference in the source terms between MELOX, La Hague, and MFFF material are used in setting these design goals. The permanent and temporary shielding developed as part of this design meets these design goals.

The Total Effective Dose Equivalent (TEDE) is the effective dose equivalent from external exposures plus the Committed Effective Dose Equivalent (CEDE) from internal exposures. Design goals for TEDE were established early in the design process for individual workers and are applied to facility operations (see Table 9.1-2).

Design drawings and descriptions of the shielding for high and very high radiation areas clearly identify the penetrations, shield doors, and labyrinths incorporated to meet the shielding design criteria. Radiation shielding analyses are used to verify the shielding for each process room, including the dose rates for each position workers are required to take to perform routine and nonroutine maintenance. This design is based on experience and the design features of the reference facilities. A radiation shielding test program will be implemented prior to the start of operations for protection of personnel from high radiation dose rates.

Several standard industry computer codes were used in the shielding calculations (e.g., Monte Carlo N-Particle [MCNP], SCALE, Perceval, SN1D). ANSI 6.1.1-1977, *Neutron and Gamma-Ray Fluence-to-Dose Factors*, flux-to-dose conversion factors were used to estimate dose rates. The 1977 version is more conservative than ANSI 6.1.1-1992 for MFFF's photon spectra.

The shielding design complies with 10 CFR §20.1406 requirements for the minimization of contamination and uses the reference facilities' design experience for guidance. The MFFF minimizes waste of shielding materials. The design includes permanent shielding in the process rooms.

9.1.4.1 Shielding Information for Each Radiation Source

Shielding is specified in each radiation shielding calculation to reduce dose rates and occupational doses to below levels established in the radiation zone drawings and below administrative goals. For those areas with estimated exposures greater than administrative goals,

an ALARA evaluation is performed to determine if design changes should be implemented to reduce the dose.

9.1.4.2 Criteria for Penetrations

Penetrations in shielding for high radiation sources are minimized in the design. For lower dose-rate sources, the impacts are analyzed in shielding analyses and determined to meet the ALARA goal. Radiation protection guidelines are provided to the penetration designers to meet recommendations of Regulatory Guide 8.8, *Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable.*

9.1.4.3 Shielding Materials

Standard shielding materials are used to attenuate the radiation intensity at the worker. Materials such as leaded glass, ~~leaded polymers,~~ borated concrete, borated polymers, borated plasters, stainless steel, and ordinary concrete are used. ANSI/ANS-6.4.2-1985, R1997, *Specification for Radiation Shielding Materials*, is used as the reference for shielding material properties for performing calculations.

9.1.4.4 Dose Assessment and ALARA Evaluations

The general design requirements established for the various radiological attributes addressed below include those that maintain exposures ALARA during normal operation and minimize exposures during off-normal conditions.

Potential occupational radiation exposure from external radiation sources were evaluated and minimized throughout the facility design process using general radiation zoning criteria, the ABAQUES dose assessment method, and design ALARA evaluations.

9.1.4.5 Radiation Zoning

Radiation zoning (see Table 9.1-1) ~~was~~is developed based on estimates of the access required for each area and radiation dose limits for personnel from 10 CFR Part 20. Shielding for the process units and access areas ~~was~~ is designed to satisfy radiation zoning criteria. The final dose assessment verifie~~d~~s that the facility can be operated within the occupational exposure limits of 10 CFR Part 20 and ALARA principles.

Radiation zone drawings show the design occupancy for radiation zones as follows: Zone Z1 is a continuous occupancy area for staff and visitors. Zone Z2 is a continuous occupancy area for trained workers. Zone Z3 is a limited occupancy area in which routine maintenance may be performed by trained workers. Zone Z4 and zone Z5 are conservatively estimated and are expected to be higher radiation areas. Access to zone Z5 radiation area is controlled in accordance with 10 CFR §20.1601.

Radiation shielding design as documented in the shielding analyses satisfies radiation zone criteria for restricted access areas. The design criteria for occupational exposures inside the MFFF are supported by the radiation zone criteria.

In zones Z1 and Z2, residence time is not restricted. The design basis maximum area radiation dose rates shown on radiation zone drawings allow continuous occupancy. The design basis maximum area radiation dose rate limit is the only shielding design criterion. Residence time is restricted in zones Z3, Z4, and Z5 of the AP Area, and access is permitted only intermittently.

Access to zone Z3 process rooms in the process areas is necessary for normal operations and routine maintenance. The annual dose equivalent for workers was evaluated with reasonable assumptions (in the form of time-motion studies). Access to zones Z4 and Z5 is restricted to nonroutine maintenance or intervention.

9.1.4.6 The ABAQUES Method

The facility design and resultant occupational dose are evaluated using the ABAQUES dose assessment method, which is similar to that provided in Regulatory Guides 8.19 and 8.34. Radiation shielding is selected to minimize personnel occupational exposures based on facility occupancy for normal operations and facility maintenance. Personnel exposures are estimated based on facility experience for access requirements, and standard shielding methods are used to estimate radiation fields. The method is iterated to minimize the number of personnel that have the potential of receiving doses in excess of the design goal. The general equation used to satisfy this prerequisite is as follows:

$$\frac{\sum_i f_i \times t_i \times DER_i}{\sum_i f_i \times t_i} \leq \frac{\text{design objective for individual doses}}{T} \qquad \text{(Eq. 9.1.4.6-1)}$$

where:

f_i = the frequency of each task associated with a given process unit or group of process units

t_i = the time of exposure for the task

DER_i = the dose equivalent rate for the task

T = the worker average estimated annual working time in radiation areas

$\sum_i f_i \times t_i$ = the total yearly duration of the tasks performed by the same work group associated with the process unit or group of process units.

The *DER*s are adjusted by varying the shielding thickness, and/or the operating conditions (operation duration and frequency) are changed to reduce the exposures to below the design goal. *T* is an estimate of the average time an individual spends in the radiation area per year based on industry operating experience. This is approximately 50% of the total working time, or 1,100 hours per year. The remaining time is associated with training, administrative duties, and work in the facility but outside of the radiation area. This approximation gives a rough estimate of the

number of personnel required to perform normal operations and routine maintenance for each process unit.

9.1.4.7 ALARA Evaluations

This process includes a preliminary estimate of the occupational exposure, an ALARA evaluation of the activities that produce exposures, and recommendations for design enhancements to reduce occupational exposures. Lessons learned from facility operations and industry guidance are used to evaluate potential design enhancements. ALARA cost-benefit analyses were performed to support design enhancements using NUREG/CR-0446, *Determining Effectiveness of ALARA Design and Operational Features.*

Occupational exposure data based on data from MELOX and La Hague were estimated. These data were used during the design phase to evaluate occupational radiation exposures and to recommend potential enhancements to the design to effectively reduce doses. Final design shielding calculations were performed to estimate dose rates and doses using the ABAQUES dose assessment method.

Several areas were further examined for cost-effective design changes to reduce the estimated occupational dose. Examples include:

- The receiving area, where transport casks with feed material are received and processed for counting and storage ~~was~~ is evaluated. Impurities associated with the alternate feedstock feed material cause higher neutron radiation. Recommendations were made to reduce dose rates and personnel occupancy time to reduce potential doses.
- The assembly fabrication unit was evaluated for dose reduction. The MOX assembly is fabricated in a manner similar to a standard uranium fuel assembly. Design changes were made to automate the process as much as possible and to reduce worker time in the radiation area.
- The assembly packaging unit was extensively reviewed for ALARA design changes. Several design changes were made to reduce the dose rate and reduce the access time.

9.1.4.8 Predicted Occupational Doses

Estimated doses for operations meet 10 CFR Part 20 and ALARA criteria.

9.1.4.9 Dose Assessment Estimate

Occupational exposure was estimated for process units with expected occupancy for normal operations and preventive maintenance. MELOX and La Hague experience shows that outage maintenance contributes about 50% of the normal operating doses. The inhalation dose for MFFF is expected to be small.

9.1.4.10 Contribution from Internal Exposure

As previously noted, there are two primary sources of radiation risk to the MFFF worker: plutonium inhalation and direct radiation exposure. Plutonium inhalation is the most significant

potential hazard at the MOX facility. Design engineers are instructed on the risks and the methods of controlling plutonium contamination. Process units that handle powder have the greatest potential for generating respirable particulate, releasing contamination, and causing

worker inhalation exposure. The process areas for these units provide radiation protection through the following multiple system barriers and controls:

- The operations for the units are controlled remotely and are automated to minimize access to the work area.
- The plutonium is contained in a sealed glovebox. This internal environment is kept under negative pressure relative to the worker environment. A leakage would be into the glovebox, thus preventing the release of contamination.
- Pressure within the glovebox is monitored.
- Glove ports are provided for maintenance access to the process equipment.
- When practical, process material is removed prior to maintenance activities.
- Workers evacuate the area upon radiation monitoring alarms.

Events that are expected to occur over the lifetime of the facility and their consequence are estimated and added to occupational exposure estimates.

Design features and management measures at the reference facilities are similar to MFFF; thus, the normal internal exposure received at the reference facilities, which is a small fraction of the total dose, is assumed to represent a reasonable estimate for the MFFF.

9.2 OPERATIONAL RADIOLOGICAL PROTECTION

The radiological protection program implements the requirements of 10 CFR Part 20, *Standards for Protection Against Radiation*, and the appropriate sections of 10 CFR Part 19, *Notices, Instructions and Reports to Workers: Inspection and Investigations*, and 10 CFR Part 70, *Domestic Licensing of Special Nuclear Material*. The radiological protection program implements the programmatic requirements necessary to ensure that radiological work activities are performed in a manner that protects the health and safety of workers, the IOC, and the environment.

The radiological protection program ensures the following:

- The individual worker's exposure to radiological hazards is ALARA.
- Personnel responsible for performing radiological work are appropriately trained.
- Personnel responsible for implementing and overseeing the radiological protection program are well qualified.
- The ALARA process is incorporated into the facility design, modifications, and work processes.
- Line management is involved and accountable for radiological performance.
- Radiological measurements, analyses, worker monitoring results, and estimates of public exposure are accurately and appropriately conducted.

- Radiological operations are conducted in a manner that controls the spread of radioactive material and reduces exposure to the work force and the public, and a process is used that maintains exposure levels ALARA.
- Employees have the authority and responsibility to stop radiological work activities suspected of being unsafe.
- Oversight is provided for radiography activities.

Contracted radiation technical support and services (e.g., instrument calibrations, dosimeters) are subject to controls under the Quality Assurance Program, which is described in Chapter 15.

MFFF is operated in a manner to not exceed radiological dose limits and to meet the goals of ALARA, as defined in 10 CFR Part 20. Radiological work activities, including those performed by subcontractors, meet the requirements of the radiological protection program.

Actions taken to maintain doses ALARA are documented as part of the radiological protection program.

9.2.1 ALARA Program

The purpose of the ALARA program is to maintain exposure to the public and occupational radiation exposures as low as reasonable achievable by the use of sound engineering controls, radiation protection practices and radiation protection procedures~~within regulatory limits and ensure that radiation exposure is ALARA~~. Line management and the work force are committed to this policy and work to establish goals that are as far below the regulatory limits as reasonable. Management shall ensure that the work force is committed to the ALARA goals to take every reasonable effort to maintain exposures to radiation as far below the regulatory limits consistent with the plant operations, current technology, and benefits to the health and safety of personnel. Management will make every effort to ensure that plant personnel are aware and committed to the ALARA principles~~als~~.

The ALARA program is composed of the following:

- ALARA program description
- ALARA principles incorporation into plant procedures involving radioactive materials~~and procedures~~
- ALARA Committee
- ALARA Chairman
- ALARA program coordinator – An appointed member of the radiological protection staff who assists the ALARA Chairman in implementing the ALARA program.

9.2.1.1 Management Commitment

The responsibility for complying with radiological safety requirements and for maintaining radiation exposures ALARA starts with the individual worker and broadens as it progresses

upward through the organization. Line management is fully responsible for the radiological performance of their personnel and takes necessary actions to ensure that personnel are properly trained and that performance is monitored and corrected as necessary. As part of their commitment to radiological safety, senior management ensures that the ALARA program is implemented and that line management is held accountable.

Management commitment to ALARA principles is communicated to plant personnel through policy statements, instructions to personnel, and similar documents, as well as by direct communication, training, and inspection of the workplace.

Management ensures that personnel are made aware of the commitment to keep exposures ALARA through the use of audits of radiation work activities, evaluation of training programs, and evaluation of plant procedures. The results of the systematic review process provides for the communication of management expectations for maintaining exposures ALARA. Radiation protection audits include reviews of operating procedures, exposure records, inspections of radiologically controlled areas and interviews with radiation protection personnel and plant operating personnel. Training program reviews include classroom observation, evaluation of training content for regulatory requirements, incorporation of lessons learned information as well as on the job training for radiation protection staff and plant operating personnel. Plant procedure evaluations ensure that lessons learned are incorporated to achieve a strong position for ALARA concerns.

Management also takes an active role in the evaluation of maintenance and modification activities for the opportunity to have ALARA principals incorporated in maintenance operations. Management ensures that there is a well supervised radiation protection program that oversees the maintenance activities with the authority to enforce safe operations. Management empowers radiation safety personnel have the authority to take appropriate actions to prevent unsafe practices and communicates with senior management the concerns with the activities.

9.2.1.2 ALARA Committee

The ALARA Committee provides the focus and direction for improving the radiological protection program. The ALARA Committee includes the ALARA Chairman (who is a member of line management and nominated by senior management); the ALARA program coordinator; the manager of the radiological protection function; and personnel from line management, operations, engineering, criticality safety, and maintenance functions. ALARA Committee members are made up of personnel who have had an intimate role in the design of the facility as well as personnel with operating experience at the reference facilities and similar facilities within the United States. Radiological protection personnel act as advisors to the committee. All ALARA Committee members are qualified in their respective areas of expertise through training, experience and operational knowledge. In addition to the radiation protection personnel on the Committee, all members have experience in radiation protection through operational experience, training and formal education. The ALARA Committee meets ~~at a minimum of quarterly~~ frequently according to project procedures, and more often for the evaluation of upcoming maintenance activities, following abnormal events and unusual exposures to personnel. Reports on the status of the program are provided at least annually.

The ALARA Committee performs or receives the results of audits of the radiological protection program at least annually and reviews the results of the radiological protection organization's internal audits. The ALARA Committee evaluates major design activities, operations activities, or plant modifications that could affect radiation levels, doses, and radioactivity levels in liquid and gaseous effluents. The ALARA Committee considers the results of the Integrated Safety Analysis in determining whether further reductions in occupational radiation doses are reasonable. The ALARA Committee evaluates trend analyses and the adequacy and implementation of radiological performance (ALARA) goals. Reviews and recommendations of the ALARA Committee are tracked to completion.

9.2.1.3 Administrative Control Levels and Dose Limits

The objective of minimizing radiation exposure is to maintain individual radiation doses ALARA, but in all cases below regulatory limits. To accomplish this objective, administrative control levels are established below the regulatory limits to control individual and collective radiation dose (see Table 9.1-2). The administrative control levels are multi-tiered with increasing levels of authority required to exceed higher administrative control levels. Unless otherwise indicated, administrative control levels and dose limits are stated in terms of the TEDE.

9.2.1.4 Internal Audits and Assessments

Internal audits and assessments are performed under the Quality Assurance Program such that over a 12-month period, functional elements of the radiological protection program are evaluated for program compliance and implementation (10 CFR §20.1101(c), *Radiation Protection Programs*). The results of these evaluations provide valuable feedback to line management on those areas requiring additional management attention. Areas of review include, but are not limited to, access control (including proper posting, labeling, and operability of access controls), proper identification of restricted areas to prevent the spread of contamination, numbers and

appropriate locations of step-off pads, change facilities, personal protective equipment facilities, personnel monitoring equipment, contamination and overexposure events, Radiation Work Permits (RWPs), instrumentation, and respiratory protection.

Radiological protection program performance is periodically evaluated using performance indicators measured against specific goals. These indicators are collective dose (person-rem), skin and clothing contaminations (number), radioactive material intakes (number), radioactive waste (volume), and airborne radioactive releases (curies). Trends in these areas provide information on the performance of the radiological protection program.

9.2.2 Radiological Protection Organization and Administration

The radiological protection function is independent of the operations and maintenance functions and has direct access to senior management through the Vice President of Environmental Health and Safety. The radiological protection function provides relevant support to facility operations. The radiological protection function develops policies and procedures to ensure compliance with 10 CFR Part 20, and to ensure that the policies and procedures are implemented as necessary for compliance with 10 CFR §20.1101(b).

The radiation protection program oversight is under the responsibility of the MFFF senior plant management. Senior management is responsible for ensuring that the radiation protection organization is provided with adequate resources to manage an effective program and maintain exposures ALARA. Senior management also supports the radiation protection program by re-enforcing the ALARA principals throughout the MFFF organization. Senior management participate in the establishment of administrative goals and limits, evaluation of ALARA goals, and the review of information (exposure records, waste minimization, etc) concerning meeting MFFF goals.

Individuals responsible for developing and implementing measures necessary for ensuring compliance with the requirements of 10 CFR Part 20 have the appropriate education, training, and skills to discharge these responsibilities. The radiological protection function, working with facility management, ensures adherence to the radiological protection program in operations and provides the required radiological support to the facility organization.

The manager of the radiological protection function (RPM) is responsible for setting radiological protection policy and for implementation of this policy and reports to the Vice President for Environmental Health and Safety.~~:~~

~~In addition,~~ ~~T~~the RPM has the responsibility for:

- ~~P~~planning, administering, and maintaining the radiological protection program — with support from line management — and reviews facility modifications and operations activities. ~~The RPM~~

- E~~e~~nsures that radiological protection program elements are appropriately implemented and maintained through radiological policies, procedures, and documents. ~~The RPM~~

- ~~—~~A~~a~~pproves radiological protection policies and procedures.

-

- ~~The RPM~~ E~~e~~nsures that staffing for the radiological protection function is adequate to conduct routine radiation functions in a timely manner and ensures radiation requirements can be met during routine operations and non-routine operations, such as anticipated events and accidents.

- Participation in design reviews for radiation protection concerns

- Identification of potential areas and operations that may be a significant source of radiation exposure
- Participation in the development of training programs to ensure all MFFF personnel are knowledgeable of the radiation protection programs, concerns and ALARA policies
- Participation on the ALARA Committee and develop ALARA policies
- Supervision of the radiation protection surveys, radiation work activities and the collection of data and information concerning radiation and contamination
- Supervision of training of the radiation protection staff
- Ensuring adequate radiation protection staffing to support MFFF operations and maintenance

The RPM is an experienced professional in radiological protection and is familiar with the design features and operations of the facility that affect the potential for exposures of persons to radiation.

The RPM has the technical competence and experience to establish effective radiological protection programs and the supervisory capability to direct the implementation and maintenance of the radiological protection program.

The RPM has a minimum of a Bachelor's degree, or equivalent, in science, health physics, or engineering, and has at least ~~five~~ four years of experience in radiological protection. Certification by the American Board of Health Physics or an additional ~~five~~ four years of relevant experience provides equivalency to the degree requirements. Experience should include supervisory or management and operational nuclear power plant operations including operation at power above 20% and routine refueling outages. ~~(~~Management may waive specific qualifications for the RPM on a case by case basis when education, experience, certifications, and overall qualification of the supporting staff meet the above requirements.~~)~~

The senior staff of the radiological protection function includes health physicists and other professionals with four-year degrees in science, engineering, or equivalent (as defined above for the RPM) and at least one year of experience in applied radiological controls at an operating nuclear facility.

The RPM is supported by a staff of radiation protection technicians assigned to various shift activities so as to provide around the clock radiation protection coverage. Each shift is managed by a Senior Technician or Supervisor who represents the RPM in all activities so that there is a continuity of radiation protection management for all MFFF operations. The Senior Technicians are responsible for the operation of the radiation protection program when the RPM is absent and have the authority to act in the absence of the RPM.

Radiological support personnel provide radiological protection and radiological engineering, dosimetry, bioassay, independent oversight, instrumentation and calibration functions. These personnel have a high school diploma or equivalent, and technical qualifications pertinent to their assigned duties.

9.2.3 Radiation Safety Procedures and Radiation Work Permits

The primary methods used to control workplace exposure are operating procedures and facility and equipment design features. These controls are augmented with the use of area entry/exit requirements to control access to and from radiological areas, and RWPs to ~~control radiological work~~provide specific requirements for all work within the radiologically controlled areas. ~~Proposed maintenance and modification plans are reviewed to identify and incorporate radiological protection requirements.~~All personnel entering the radiologically controlled areas are required to read and understand the RWP requirements and monitor their exposures during the conduct of their activities.

RWPs are issued and controlled in accordance with approved radiological protection procedures ~~that require RWPs to be used for specific purposes only, and are reissued when there are significant changes in the task, or changes that affect the safety of workers~~for all activities conducted within the radiologically controlled areas. RWPs may be general in nature for normal access and rounds, daily operations and activities that do not require access into high or very high radiation areas.

Specific tasks such as maintenance activities require RWPs for that individual task to provide specific requirements and documentation of exposures for those workers. Maintenance work packages will include the specific RWP for that activity and all personnel working on the activity are required to read, understand and control their work according to the RWP.

RWPs are initiated by the individual or group that intends to perform an activity (operations, maintenance, laboratory, etc.) and provide the location of the work, duration and specific information concerning the activity such as the work package detailing the maintenance activity. The radiation protection staff provides the radiological conditions of the work areas, establishes stay times, protective clothing requirements, shielding (if required), dosimetry requirements, etc. The Radiation Protection Manager ~~or representative~~ reviews and approves the RWP. Other RWP approvals may include other organizational groups' reviews and/or approvals, when appropriate, to ensure that provisions of the RWP or related documentation address potential hazards (including non-radiological hazards) and compliance with applicable regulations. The radiation protection staff reviews the RWP with the associated work group to ensure that personnel are aware of all the requirements to ensure exposures are minimized.

RWPs include a list of safety requirements for authorized work, and include at least the following, as applicable:

- The identification of personnel working on the task
- Expected radiological conditions (radiation, contamination, and airborne levels)

- Type and frequency of monitoring and dosimetry (e.g., continuous air monitor [CAM], self-alarming dosimetry)
- Estimated doses for the authorization
- Limiting doses for the authorization
- Allowable stay times
- Special instructions or equipment (e.g., mockup required, special shielding required)
- Hold points or monitoring points, if applicable
- Personnel protective equipment requirements
- Authorization signature and date
- Actual doses, time, or other information resulting from the completed work authorization recorded on the RWP
- Expiration/termination date of the RWP
- Sufficient information on RWPs to allow independent inspection and reconstruction of the circumstances necessitating the RWP, the factors included, and the results.

Specific operations such as calibrations using licensed and non-licensed sources may not require the use of a RWP. ~~Radiological protection staff designated by the RPM review and approve RWPs. Other RWP approvals may include other organizational groups' reviews and/or approvals, when appropriate, to ensure that provisions of the RWP or related documentation address potential hazards (including nonradiological hazards) and compliance with applicable regulations. Other organizational group~~ Pprocedures that involve the use of licensed or non-licensed radioactive materials without an RWP require review and approval by the RPM and include equivalent information as identified in a RWP. The RPM reviews procedures that require the use of licensed or non-licensed radioactive materials for the inclusion of requirements for the control of personal radiation exposure and any protective measures.~~.~~

Administrative controls (RWP expiration/termination date) ensure RWPs are not used past their termination dates. Procedures define the types of records to be kept, retention time for these records, and the final disposition of the RWP. The record system allows independent auditors to reconstruct the circumstances necessitating the RWP, the factors included, and results. Routine (e.g., long-duration maintenance) RWPs are reviewed periodically to identify improvements in worker protection.

Procedures and administrative controls ensure current copies of radiological protection procedures and RWPs are provided to appropriate personnel.

Radiological protection procedures and RWPs are developed, maintained, and used under quality assurance (QA) controls.

9.2.3.1 Radiological Work Planning

Work planning is the responsibility of line management, with support from the radiological protection organization. Radiological surveys are used to develop radiological protection requirements and are documented on the RWP. Specific radiological controls based on the surveys, and from formal ALARA reviews that were performed because established planning thresholds were exceeded, are incorporated into the work documents.

9.2.3.2 Radiation Area Access Control

Specific requirements for entering and exiting radiation areas are established. Radiation safety training commensurate with the hazards and required controls is required before unescorted access to radiation areas is permitted. The primary control for entry into radiation areas is the RWP, which is augmented by signs and barricades.

Administrative procedures implement radiation area access controls. These procedures address measures implemented to ensure the effectiveness and operability of entry control devices, such as barricades, alarms, and locks. Periodic inspections of the physical access controls to high and very high radiation areas are made to verify controls are adequate to prevent unauthorized entry. Worker access controls for high and very high radiation areas meet the requirements of 10 CFR §20.1601 and §20.1602.

9.2.3.3 Radiological Work Controls

Positive control of personnel is established through RWPs. Only trained and qualified personnel who have the information available to properly respond to the radiological conditions that they will encounter during the work activity are allowed to enter the restricted area unescorted. In special circumstances, specialists who have not completed unescorted access training may be allowed escorted access to perform specific tasks, with permission granted by the RPM.

The RWP is the administrative mechanism used to establish radiological controls for intended work activities. The RWP informs employees of area radiological conditions and entry requirements, and provides a mechanism to relate employee exposure to specific work activities.

9.2.3.4 Posting and Labeling

Posting and labeling of radiation areas, high radiation areas, and radiologically contaminated areas, equipment, and material are used to alert personnel to the radiological status of the item or area, and to prevent an inadvertent dose to the worker. This includes the use of the standard radiological posting and labeling to meet the requirements of 10 CFR Part 20 Subpart J, and posting signs that are clear and conspicuous. As stated in Chapter 1, an exemption request has been submitted related to container labeling requirements.

9.2.3.5 Release of Materials and Equipment

Material and equipment that are contaminated or potentially contaminated are considered contaminated until they are surveyed and released. This ensures that no contaminated material or equipment is inadvertently released. Movement of material and equipment from contamination areas, and between controlled areas and release of material and equipment from controlled areas, and from the site, is controlled. See Table 9.2-1 for contamination limits.

9.2.3.6 Sealed Radioactive Source Accountability and Control

Radioactive sealed sources are controlled by accountability and monitoring requirements to prevent loss or unintentional exposures. Sealed sources are leak tested in accordance with procedures that include limits and actions to be taken if limits are exceeded. Frequency of leak testing is no less than annually and is described in program documentation. Sealed sources in excess of limits in 10 CFR §20.1601 or §20.1602, when not in use, are kept in locked storage areas where access is controlled by the RPM.

9.2.3.7 Receipt of Packages Containing Radioactive Material

MFFF ensures that appropriate controls are implemented from the time of package receipt to final destination. Receipt and offsite transfer of radioactive materials is conducted in accordance with 10 CFR 20.1906, 10 CFR 71 and 49 CFR 171 – 178. Unauthorized access to packages is prevented to ensure that radiation dose is ALARA.

9.2.4 Radiation Safety Training

Radiation safety training is commensurate with the employee's duties. Standardized courses are used to the extent practical and are supplemented by facility-specific information. Personnel and visitors entering restricted areas receive either radiation safety training, or are provided a general indoctrination in site-specific safe practices and are escorted by an individual who has received such radiation safety training. To be granted unescorted access to the MFFF restricted area, individuals are required to pass site-specific general employee training.

Radiation safety training addresses the following topics, to the extent appropriate to each individual's prior training, work assignments, and degree of exposure to potential radiological hazards:

- Risks of exposure to radiation and radioactive materials, including prenatal radiation exposure, health risks, effects of exposure, internal and external exposure, fatality risks, cancer risks, and embryo / fetus risks
- Background exposure
- Regulatory limits and Planned Special Exposures
- Administrative limits
- Basic radiological fundamentals and radiological protection concepts
- Controls, limits, policies, procedures, alarms, and other measures implemented at the facility to control doses, including both routine and emergency actions
- Identification of potential loss of confinement events
- Individual rights and responsibilities as related to implementation of the facility radiological protection program
- Individual responsibilities for implementing ALARA measures
- Individual exposure reports that may be requested.

Individuals likely to receive an occupational dose in excess of 100 mrem in a year will be instructed on procedures and equipment used to maintain exposure ALARA. All MFFF personnel will receive training commensurate with the requirements of 10 CFR 19.12, Instruction to Workers.

Examinations are used to demonstrate satisfactory completion of theoretical and classroom material. Examinations are written; however, the RPM may approve alternatives to accommodate special needs. Alternative examinations are equivalent in content to written examinations. Trainees acknowledge in writing that the training was received and understood. Records of the most recent training and testing are maintained.

All MFFF radiation protection training courses are reviewed as a minimum on a three year cycle by the RPM for applicability, modification of the MFFF, and revisions to regulatory positions. Each course includes a portion on lessons learned and is updated on an annual basis to ensure that information is accurate on the conditions within the MFFF.

Training addresses both normal and abnormal situations in radiological protection.

General employee training is completed annually. Changes to the program are incorporated as they are identified and a decision made if retraining prior to the annual period is needed.

Radiological worker retraining also is completed annually.

MFFF site-specific general employee training and refresher training includes changes in requirements and updates of lessons learned from operations and maintenance experience and occurrence reporting for the MFFF site.

9.2.5 Air Sampling

Airborne radioactivity monitoring uses air samplers and/or CAMs, with usage based on working conditions. Frequency of air sampling is based on area conditions and planned activities. Counting techniques, action levels, and alarm setpoints are described in radiological programs and procedures. Controls minimize internal exposure to the radiation workers as part of the overall ALARA program. The estimation of internal dose is based on airborne radioactivity concentrations. In the event of suspected high exposure, the internal dose is verified from bioassay data.

Air monitoring equipment is used in situations where airborne radioactivity levels can fluctuate and early detection of airborne radioactivity could prevent or minimize inhalation of radioactive material by personnel. Selection of air monitoring equipment is based on the specific job being

monitored. Air monitoring equipment includes portable and fixed air sampling equipment, and CAMs.

Air sampling equipment is used in occupied areas where, under normal operating conditions, a person is likely to receive an annual intake of 2% or more of the specified annual limit on intake (ALI) value (40 Derived Air Concentration [DAC]-hours).

Continuous air monitors (CAMs) are installed in rooms where radioactive materials are handled or there is a need to ensure that there is no airborne contamination present. The CAM system consists of Work Station CAMs, Area CAMs and Duct CAMs as well as Mani Stack Exhaust CAMs. The Work Station CAMs are movable and are used by the operator when working within a glovebox or on an open system. The CAM is placed so as to detect the air passing the operators breathing zone (down draft across the face of the glovebox). Area CAMs are placed close to the room exhaust to sample the air exiting the room and detect any minute release of material that may escape the Work Station CAM detection. To further sample the potential airborne contamination, specific Duct CAMs are installed to detect leakage in inaccessible rooms (Process Cells). These CAMs sample a combined duct work so that individual cells may be sampled using installed sample ports. The Main Exhaust Stack CAMs provide for immediate notification of potential releases from the MFFF.

When specific maintenance activities are being conducted, portable CAMs or air samplers are placed within the work area to detect any airborne contamination. Air samples are taken upon opening systems and periodically during the maintenance. CAMs provide both an active alarm when specific set points are exceeded and a sample that is analyzed under laboratory conditions to determine the gross activity as well as the specific isotopes of concern. Air samples are also performed in conjunction with radiation and contamination surveys to validate the installed CAMs or to ensure rooms without installed CAMs are free of airborne contaminants.

In addition to the CAMs, personnel who perform work with radioactive materials are equipped with lapel air samplers. These samples are analyzed upon completion of the work shift or if the individual is in a room when a CAM alarm is activated. The combination of the CAM air filter analysis and the lapel air sample are used to calculate an individual's internal exposure if required.

All CAM, air samples and lapel air samples are recorded including the location, date, time of sample, volume, activity, isotopic concentration (if required), instrument used to analyze the sample, calibration date and name of the individual performing the analysis.

Laboratory analytical equipment minimum detection levels are based on the specific instrument, background radiation, type and sixe of the detector and counting times. Each instrument will be calibrated and have an established minimum detection level.

~~Real-time (or continuous) air monitors~~CAMs are used to provide early warning to individuals of events that could lead to substantial unplanned exposures to airborne radioactivity. Such exposures could result from a breakdown of engineered controls or improper establishment of boundaries during work that creates airborne radioactivity. Real-time air monitoring detects and provides warnings of airborne radioactivity concentrations that warrant immediate action to

terminate inhalation of airborne radioactive material. Radiation protection procedures define the immediate actions upon receipt of a CAM alarm (8 DAC-hours) including the process of investigating and determining the cause of the alarm, the levels of contamination and processes for mitigating the release.

Air sampling equipment is positioned to measure air concentrations to which persons are exposed.

Air monitoring equipment is calibrated and maintained at a frequency specified in the radiological protection program. CAMs are capable of measuring 1 DAC when averaged over 8 hours (8 DAC-hours) under laboratory conditions.

Continuous air monitoring equipment has sufficient sensitivity to alert personnel that immediate action is necessary to minimize or terminate inhalation exposures.

The proper operation of continuous air monitoring equipment is verified by performing an operational check. Operational checks include positive air-flow indication, non-zero response to background activity, and internal check sources (or electronic checks when available). Continuous air monitoring equipment is verified by checking for instrument response with a check source.

Air sample results are evaluated as quickly as practical for evaluation of the need for respiratory protection, area evacuation (if necessary), worker intake, and worker relief from respirator use.

9.2.6 Contamination Monitoring and Control

Contamination monitoring and control measures prevent the movement of radioactive contamination from controlled areas to uncontrolled areas, and "clears" personnel and equipment when leaving contaminated areas. Radioactive contamination is controlled by using engineering controls, by containing contamination at the source, by monitoring, and by promptly decontaminating areas that become unintentionally contaminated. The use of personnel monitoring equipment is required when personnel leave a ~~known contamination area~~potentially contaminated area such as a C3b ventilation controlled room (glovebox room). All C3b rooms are provided with airlocks containing personnel contamination monitors in the form of hand and foot monitors and "friskers." Personnel use the installed equipment to self-monitor prior to exiting the airlock. Personnel are considered contaminated if contamination levels are detected in excess of levels given in Table 9.2-1. When the self-monitoring results in an alarm, the alarm is recorded in the Polishing and Utilities Control Room and radiation protection personnel are dispatched to assist in decontamination efforts for the personnel as well as the room.

A controlled area is any area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason to protect individuals from exposure to radiation and/or radioactive materials. Individuals who enter only the controlled area without entering radiological areas are not expected to receive a total effective dose equivalent of more than 0.1 rem (0.001 sievert) in a year. Controlled areas are posted in accordance with 10 CFR 20.1900

A radiological control area / radiologically controlled area (RCA) is an intermediate area established to prevent the spread of radioactive contamination and to protect personnel from radiation exposure. Radiologically Controlled areas are posted in accordance with 10 CFR 20.1900

A contamination area is any area where the loose surface and / or fixed contamination levels exceed those of Table 9.2-1. Contamination areas are barricaded and posted in accordance with 10 CFR 20.1900 until the contamination levels are reduced below the established limits.

A high contamination area is any area where the loose surface of fixed contamination levels exceed ten (10) times the levels established in Table 9.2-1. High contamination areas are barricaded and posted in accordance with 10 CFR 20.1900 until the contamination levels are reduced below the established limits.

A radioactivity area is any area where there is a natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy from their nuclei and, thus, change (or decay) to atoms of a different element or to a lower energy state of the same element. Radioactivity areas are posted in accordance with 10 CFR 20.1900.

A radiation area is an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. Radiation areas are posted in accordance with 10 CFR 20.1900

A high radiation area is an area, accessible to individuals, in which radiation levels could result in an individual receiving a deep- dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source. High Radiation areas barricaded and locked to prevent entry and are posted in accordance with 10 CFR 20.1900

An Airborne Contamination area is an area where the concentration of airborne radioactive materials, composed wholly or partly of licensed material exist in concentrations in excess of the derived air concentrations specified in appendix B to 10 CFR 20 or where an individual present in the area without respiratory protection could exceed an intake of 0.6 percent of the annual limit of intake. Airborne Contamination areas are barricaded and posted in accordance with 10 CFR 20.1900 until the contamination levels are reduced below the established limits.

A radioactive material area is an area or structure where radioactive material is used, handled or stored. Radioactive materials areas are isolated, barricaded and posted in accordance with 10 CFR 20.1900.

Within the MFFF there are areas where materials are handled within gloveboxes that are under a lower air pressure that the surrounding room. These rooms could become contaminated if there is a failure of the glovebox or the glovebox ventilation system. However there areas are not contaminated as a result of the normal operations

All areas which are identified as being controlled for radiological concerns (radiation, radioactive materials, airborne contamination, etc.) are posted in accordance with 10 CFR 20.1900.

To monitor and control contamination, instrumentation appropriate for the contaminant is used; most often this will be an alpha-sensitive instrument. Some beta / gamma instruments will be used in areas where there is sufficient design information (source terms) that would indicate that these instruments will provide adequate survey results. Tritium contamination surveys will be conducted tin those areas that have been determined to have a potential for tritium leakage.

Radiation and contamination surveys are performed on a continuous basis of all areas within the MFFF Radiation Controlled Area and well as selected areas outside the controlled areas. Survey frequencies are based on the engineering design of the ventilation system where the air flow is from the uncontrolled areas to areas where there is a potential for contamination. Radiologically controlled areas that have a high occupancy rate are surveyed on a frequent basis of normally once per week. Areas where there is an infrequent entry are surveyed on a less frequent basis normally monthly or quarterly. Access and egress areas are surveyed daily to ensure the control of any potential contamination. Areas such as lunch rooms, change rooms and offices are surveyed on a quarterly basis since they are located outside the radiologically controlled areas. Survey frequencies may be changed based on experience and historically information derived for the performance of the survey program.

All surveys are performed in accordance with approved procedures that encompass the objectives of the survey, methodology of the survey, expected equipment necessary to perform the survey, general survey frequencies, type and format of the survey records, review and approval of survey results, reporting of survey results and document of the surveys.

The radiation protection organization is responsible for all radiation and contamination surveys except personnel contamination surveys using installed monitoring equipment in the airlocks and at the egress points of the radiologically controlled areas.

Surveying contaminated areas is performed to determine the level of contamination. Survey results are also used to determine if postings are correct, if additional controls are required, and to determine the appropriate personnel protective equipment.

Contamination surveys, investigations, corrective actions, and reviews (along with deficiencies) are documented. These records are maintained for historical purposes including decommissioning activities. The radiological protection organization reviews this documentation for possible trends and needed corrective actions. Contaminated areas and contamination levels are tracked as part of ALARA goals along with decontamination efforts and results.

A surface is considered contaminated if either the removable or total surface contamination is above the levels in Table 9.2-1. Contamination surveys incorporate techniques to detect both removable and fixed contamination. Contamination survey results that indicate surface contamination above the levels of Table 9.2-1 are isolated, personnel are notified of the area isolation, and clean up activities initiated as soon as practical. Contaminated areas are posted and controls established to limit access until decontamination efforts are complete. Additional surveys are taken to validate the decontamination work.

Initially, contamination surveys (i.e., instrument, swipe and large-area wipes) are conducted in the Radiological Control Area established for the control of contamination, and other areas with the potential for becoming contaminated. After historical data have been collected, the frequencies of surveys are adjusted based on the need to perform surveys in those specific areas. Survey frequencies require sufficient historical data that ensures the less frequent survey frequency will ensure adequate determination of cleanliness. Survey frequencies will not

adjusted less than annually or at least ten consecutive surveys with no identified changes in radiation levels and no detectable contamination.

Radiation and contamination surveys records contain the individual area radiation readings including any locations that are in excess of the general area radiation levels, contamination locations including the level of contamination, the type and serial number of the instruments used in the performance of the survey, the name of the technician performing the survey, date and time of the survey, actions taken to mitigate and contamination levels, and the signature of the individual performing the review of the results. ~~to optimize resources.~~

To prevent internal contaminations, procedures and policies restrict eating, drinking, and smoking within the Radiological Control Area.

The MFFF design is an enclosed system and features low contamination estimates, which allows protective clothing requirements to be optimized. Depending on the contamination at the work location, the minimum type of clothing is either a lab coat for lab areas, or plastic (disposable) coveralls for minor maintenance.

Personnel wear protective clothing during the following activities:

- Handling contaminated materials with removable contamination in excess of prescribed levels
- Work in contamination, high contamination, and airborne radioactivity areas
- As directed by the radiological protection organization, or as required by an RWP.

In cases of skin contamination, decontamination is performed by radiological protection technicians, with wounds treated by the medical staff. As a minimum, nonabrasive methods, such as soap and water, are used. In cases of dry contamination or nondiscrete radioactive particles, masking tape is used. Personnel decontamination methods are provided as part of the radiation worker training and prior to the commencement of any actual decontamination effort.

Once materials or equipment have entered the Radiological Control Area, surveys are required before releasing material or equipment. See Table 9.2-1 for contamination limits.

When specific work activities are to be performed, areas are established around the work site so as to limit the spread of contamination. The area may be a small site covering only the component being worked on or may consist of the complete room where the work is being performed. In all cases a step off pad will be installed along with a buffer area where work personnel are able to remove protective clothing and check themselves for contamination. Normally the airlock self-monitoring equipment is use by the work force to survey themselves prior to exiting. However, if the work area is small, portable monitoring equipment may be installed to ease monitoring and movement of personnel.

Hampers are placed at the step off pads for the placement of used protective clothing upon removal. Additional protective clothing is available in the case of an individual becoming contaminated in the process of removing the clothing.

All protective clothing is stored in the Technical Support Building adjacent to the fuel fabrication structure. Personnel entering to perform maintenance will obtain the protective clothing as defined on the Radiation Work Permit and proceed to the work site. At the work site personnel will don the protective clothing and proceed to perform the work. Upon completion of the work or a break period, personnel will remove the protective clothing and place it in the designated hampers then self-monitor and proceed out of the fuel fabrication building.

Procedures are established for the donning and removal of protective clothing and personnel are trained as part of radiation worker training. Included in radiation worker training, personnel are instructed in the proper methods of self-monitoring and what actions to take should they determine that they are contaminated. Specific personnel decontamination procedures are established to provide basic decontamination with other methods provided by SRS medical department in the case of gross contamination beyond the capabilities of the MFFF.

If an individual becomes contaminated in the process of performing any maintenance or normal activities, they are provided with a decontamination / first aid station in the Shipping and Receiving Building on the third floor between the personnel contamination monitoring rooms. This facility provides for the removal of contamination. If the contamination is of such a extent that there is a potential medical concern, SRS medical will be contacted and the individual transported to site medical for further decontamination. Decontamination liquids are contained and disposed of as liquid waste within the normal facility waste systems.

Dirty protective clothing is bundled for cleaning and laundry in accordance with established procedures. The dirty protective clothing is removed on an as needed basis for large work activities and at the end of the shift for small activities consuming small amounts of clothing. Clothing is bagged, surveyed for loose surface contamination on the exterior of the bag and transported to the waste handling area for placement in drums. The drums are then counted for activity, concentrations and weighted. The drums are then staged for transportation to the laundry facility.

~~Radiological Control Zones (RCZs) are set up at work sites where personnel change into appropriate protective clothing prior to entering the RCZs. Used clothing is deposited in containers at the RCZs, and personnel check themselves for contamination prior to exiting the work area.~~

9.2.7 Direct Exposure Control

Personnel working at the MFFF are exposed to both photon and neutron radiation. The criteria for personal dosimetry are to:

- Measure both photon and neutron radiation from the primary isotopes of plutonium, uranium, and americium
- Provide reproducible results.

The direct exposure controls provide the following:

- Exposure monitoring
- Dosimeters and their processing
- Dose determinations
- Dose record maintenance
- Dose reporting
- Records maintenance.

The purpose of direct exposure controls is to ensure that the radiation worker doses do not exceed dose limits. Controls include:

- Measurement of the direct radiation dose received by workers using a dosimeter
- Control, as practical, of personnel who have received radiopharmaceuticals
- Planned special exposures
- Exposure limit for minors and the public
- Radiological protection for an embryo/fetus.

Personnel dosimetry is required for the following:

- Personnel who are expected to receive an annual external whole body dose greater than 100 mrem, or an annual dose to the extremities, or organs and other tissues (including lens of the eye and skin), greater than 10% of the corresponding limits specified in Table 9.1-2
- Declared pregnant workers who are expected to receive from external sources a dose equivalent of 50 mrem or more to the embryo/fetus during the gestation period
- Visitors, and public expected to receive an annual external whole body dose equivalent of 50 mrem or more in a year
- Minors for whom access and monitoring requirements are approved by the RPM
- Neutron dosimetry provided when a person is likely to exceed 100 mrem annually from neutrons.

Administrative goals are established to minimize the direct exposure of individuals. The Administrative goals are specified on Table 9.1-2. Individuals who in the course of their work approach the administrative limits are evaluated as to the continuation in the performance of that

specific task that exposes the individual. In order that the possibility of exceeding the annual administrative goals is minimized, the goals are further subdivided into quarterly goals for ease of monitoring. The Radiation Protection Manager in coordination with the Vice President of Environmental Safety and Health may upon a through review authorize the individual to exceed the administrative limits.

When an individual's exposure exceeds the administrative limits, a condition report will be initiated in accordance with MFFF procedures to ensure that the cause of the exposure is identified and corrective actions are implemented.

~~Thermoluminescent~~Thermoluminsent Dosimeters (TLDs) and Albedo (reflected) TLDs are the primary measuring devices at the MFFF. These dosimeters have the appropriate range and sensitivity to accurately measure exposures from plutonium and the other primary isotopes. Personal dosimeters are

analyzed at a frequency described in approved procedures but not less than quarterly. Dosimetry is processed and evaluated by a processor accredited by the National Voluntary Laboratory Accreditation Program. TLDs are the source of exposure information for records. See Section 9.2.13 for exposure records. Radiation protection program policies and approved procedures establish action levels for personal dosimetry analyses results.

9.2.8 Internal Exposure Control

Internal exposure controls monitor workplace activities for potential and actual intakes of radioactive material. Both discretionary and nondiscretionary bioassay sampling are employed to monitor internal uptakes and to determine the quantity of the uptake. The bioassay program is conducted consistent with ANSI.HPSN 13.22 criteria.

Baseline bioassay monitoring of personnel who are likely to receive intakes resulting in a CEDE greater than 100 mrem is conducted before they begin work that may expose them to internal radiation exposure. The 100 mrem action level is difficult to achieve; therefore, workplace monitoring is also used to identify potential intakes so that special bioassay monitoring can be initiated. All personnel who have or might receive more that 10% of the Annual Limits on Intake (ALI) will be subject to routine bioassay monitoring.

All personnel who in the course of their work have entered or been in a room where a CAM has alarmed or their lapel air sampler indicates that there is a potential uptake of material will be required to undergo bioassay monitoring upon indication of a potential uptake. The CAM air sample analysis or lapel air sample will be used to track the uptake and validate the results of the bioassay.

Routine bioassay monitoring methods and frequencies are established for personnel who in the course of their work handle radioactive materials or perform maintenance on radioactive systems.~~are likely to receive intakes resulting in a CEDE greater than 100 mrem.~~ As a minimum personnel in the routine bioassay program will be required to submit bioassay samples (urinalysis and / or fecal as necessary) and receive whole body scans annually. If an individual is determined to have potentially received an uptake, additional bioassays will be required.

Termination bioassays are required when a person who participated in bioassay monitoring terminates employment.

When an individual is suspected of receiving an uptake, a condition report will be initiated in accordance with MFFF procedures to ensure that the cause of the exposure is identified and corrective actions are implemented.

Bioassay analyses are also performed when any of the following occurs:

- Facial or nasal contamination is detected that indicates a potential for internal contamination

- Airborne monitoring indicates the potential for intakes exceeding 100 mrem committed effective dose equivalent
- Upon direction of the radiological protection organization when an intake is suspected.

Levels of intakes that warrant the consideration of medical intervention are based on site-specific radionuclides. The effectiveness of medical intervention, such as blocking or chelating agents, is documented using bioassay results.

A preliminary assessment of the intakes detected is conducted prior to permitting an employee to return to radiological work.

Internal dosimetry relies on radionuclide standards from, or traceable to, the National Institute of Standards and Technology (NIST).

Summation of the internal dose includes the methodology that evaluates the doses from inhalation, oral ingestion, and an intake through wounds or absorption through skin.

Interpretation of bioassay results and subsequent dose assessments includes the following:

- Characteristics of the radionuclide, such as chemical and physical form
- Bioassay results and the person's previous exposure history
- Exposure information, such as route of intake, and time and duration of exposure
- Biological models used for dosimetry of radionuclides
- Models to estimate intake or deposition and to assess dose
- Minimal Detection Levels for the potential primary contaminants – plutonium, uranium, and americium – based on implementation of American National Standard HPS N13.30-*1996 Performance Criteria for Radiobioassay*
- Coordination between the radiological protection organization and medical personnel for doses that may require medical intervention
- DAC and ALI values – presented in Table 1 of 10 CFR Part 20, Appendix B; used to determine the individual's dose and to demonstrate compliance with occupational dose limits
- In estimating exposure of individuals to airborne radioactive materials, the respirator protection factor for respiratory protection equipment worn is considered.

Radiation protection policies and approved procedures establish action levels for internal contaminations. Bioassays are documented in accordance with the QA controls. Bioassays analytical quality control is described in the appropriate laboratory manual. Analytical procedures are consistent with national or international consensus standards or have equivalent or superior performance to such methods based on industry accepted methodologies. Analytical instrumentation is standardized and calibrated in accordance with the manufacturer's recommendations. Calibration standards are traceable to NIST.

9.2.9 Summing of Internal and Direct Exposure

The maximum doses allowed for occupationally exposed workers are contained in 10 CFR §20.1201. These limits apply to radiation workers 18 years of age or older. These limits are expressed in units of dose equivalent (DE) in rem and Sv. Internal dose to a specific organ is given as committed dose equivalent (CDE), while the internal dose relative to a whole-body exposure is given as CEDE. Direct dose is expressed as deep dose equivalent (DDE), shallow dose equivalent (SDE), and lens of the eye dose equivalent (LDE). Extremities are considered to be the hand, elbow, arm below the elbow, foot, knee, and leg below the knee.

In accordance with 10 CFR 20.1202, the internal and external exposures will be summed when applicable. Recording and reporting of radiation exposures will be conducted as provided for in Regulatory Guide 8.7, Instructions for Recording and Reporting Occupational Radiation Exposure Date. Monitoring of occupational exposures will be conducted in accordance with Regulatory Guide 8.34, Monitoring Criteria and Methods to Calculate Occupational Radiation Doses. Specific radiation protection procedures provide for the implementation of these Regulatory Guides.

The annual occupational exposure limits from 10 CFR Part 20 are:

- Total (CEDE + DDE) = TEDE 5 rem (0.05 Sv)
- Lens of Eye (LDE) 15 rem (0.15 Sv)
- Other Organs (CDE + DDE) 50 rem (0.5 Sv)
- Skin or Extremity (SDE) 50 rem (0.5 Sv).

9.2.10 Respiratory Protection

Using ALARA concepts, the use of respiratory protection is minimized to ensure that the TEDE dose is optimized for the work activity. Specialized training and a medical evaluation are required for individuals required to wear respiratory protection. Procedures direct the supervision and training of respirator users, fit testing, respirator selection, inventory and control, storage, issuance, repair, testing and quality control of respiratory equipment, recordkeeping and limitations on respirator use and duration. Respiratory protection records include the training of the individual user, duration of use, type of respirator, including the cartridge if required, and respirator maintenance.

It is MFFF policy to limit the intake of hazardous material by its workers to ALARA. Engineering and process controls (contamination control, use of containments, ventilation, and other technology) are used to the extent practical to minimize airborne hazards. When these are not practical to control levels below the appropriate limits for a hazard, the radiological protection organization will limit intake by control of access, limitation of exposure times, and use of respiratory protection equipment.

Respiratory protection is worn (unless ALARA analysis indicates TEDE for an operation would be lowered by not wearing respiratory protection) when air sample analysis indicates concentrations equal to or greater than the 20% of the DACs listed in 10 CFR Part 20, Appendix B.

Respiratory protection is selected to give a protection factor greater than the multiple by which the peak concentration exceeds the DACs listed in 10 CFR Part 20, Appendix B.

Use of respiratory protection is reduced to the minimum practical by implementing engineering controls and work practices to contain radioactivity at the source.

Equipment used is within limitations for type and mode of use and provides proper visual, communication, and other special capabilities (such as adequate skin protection), when needed.

Adequate numbers and locations of respiratory protection equipment are available.

9.2.11 Instrumentation

Fixed and portable radiological protection instrumentation used for the radiological protection program are calibrated and maintained to ensure accurate and reproducible results.

MFFF radiological protection equipment comprises a broad spectrum of analytical instruments used to determine the presence of radioactive material and to quantify the amount of contamination. Instrumentation ranges from gross measurements to specific isotopic analytical analyzers that can determine the constituents and quantity of each isotope. The instrumentation also includes installed personnel monitors and hand-held survey equipment.

Airborne contamination monitors are installed to detect barrier failure. These monitors are placed in each room where either personnel access is allowed or that contains the first confinement barrier. In rooms with no routine personnel access, airborne contamination

monitors obtain air samples taken from the ventilation exhaust ducts exiting rooms (cells) as appropriate.

To ensure that workers are provided adequate monitoring, there may be more than one CAM in a room. The actual number of CAMs is determined based on the anticipated number of operations

and the potential for an uptake. Where there is a potential for airborne contamination, a monitor is installed so that the workers are provided coverage. The initial number and location of monitors is based on MELOX and La Hague experience.

A person working in a glovebox (i.e., hands/arms extended into glovebox gloves) has an airborne contamination monitoring device (i.e., CAM) located in close proximity to the breathing air zone. To ensure coverage at glovebox workstations, some CAM sample heads are movable. In addition to the CAMs provided for workstations, CAMs are also strategically placed in routinely occupied areas surrounding gloveboxes. Readout and alarm monitors are located in the PUCR and the RM/HPR. The system also provides an alarm in the glovebox room and in the airlocks for the glovebox room if the airborne contamination exceeds preset limits. Portable CAMs are available for use during maintenance and provide additional coverage.

Alarm setpoints are provided at two distinct levels to enable the worker to take appropriate action if a release should occur. The lower (first) setpoint provides a local warning of increasing airborne contamination so that the worker can exit the room or don appropriate respiratory protection equipment. This alarm also warns other workers outside the room that there is an increase in airborne contamination and that they should not enter the room without respiratory equipment. The higher (second) alarm setpoint provides local alarm and readout, indicating that personnel are in danger and that immediate actions are required to provide protective measures to the workers. This setpoint is less than the 10 CFR Part 20, Appendix B limit, but above the warning level. The alarms have remote readouts in the PUCR and the RM/HPR so that the process can be terminated and corrective actions can be initiated to stop the release.

During maintenance activities when a glovebox or a system boundary is opened, portable air samplers are used to monitor personnel inside contamination control enclosures. The use of portable monitors allows for closer supervision of the airborne activity in the area of the work.

The radiation monitoring system is designed to monitor MFFF workspaces, through the use of general area radiation monitors (ARMs) and airborne radiation monitors, to protect the health and safety of personnel. This design is accomplished by identifying occupancy requirements and their respective environments (i.e., considering the potential for elevated airborne radioactivity or changes to workspace radiation levels).

The MFFF radiation monitoring system consists of general ARMs (neutron and gamma) and airborne alpha contamination monitors. This combined monitoring system allows for the detection of the possible radiation that a worker may be exposed to during normal and abnormal operations. The system also provides trending information so that increasing radiation levels may be determined to facilitate removing the sources of radiation exposure or limiting the time that a worker might be in the general area.

The radiation monitoring system monitors and tracks area background radiation levels for trending purposes. The CAMs take representative and timely measurements of radioactivity concentrations in air at workstations and general work areas to maintain worker exposures ALARA.

General area ARMs are provided to monitor the neutron or gamma radiation levels in rooms containing gloveboxes, production units, and the laboratory. ARMs are also placed where radiation workers are likely to be stationed or perform routine operations. These monitors detect and warn workers of an unexpected increase in the radiation level of the general area. Either a neutron or gamma area monitor is provided, depending on the primary source of radiation. The monitors detect increases in radiation environments caused by significant variations in quantities of radioactive materials, including radiation from nearby gloveboxes and conveyors, loss or failure of shielding, or an unexpected source of direct radiation.

ARMs inform radiological protection personnel and control room personnel of radiation in excess of the limit designated for an area (i.e., radiation zone limit) and/or a limit determined to be ALARA. Also, direct personnel monitoring may be performed through the use of worker-alarming dosimeters.

Gamma and/or neutron ARMs monitor the intensity of radiation in areas where significant quantities of plutonium are stored and/or handled. Selected monitors have pre-selectable trip settings with audible annunciation and provide electronic signals for remote alarms.

9.2.11.1 Types of Instrumentation

9.2.11.1.1 Alpha/Beta Counters

Due to the nature of plutonium, the ability to detect minute quantities of plutonium requires the use of sensitive equipment. The MFFF radiological protection equipment is capable of detecting extremely low levels of alpha contamination in a relatively short counting-time cycle.

The radiological protection laboratories, MP Area, and AP Area are equipped with alpha/beta counters to enable the processing of swipes and airborne contamination surveys on a continuous basis. Additional counters are located as necessary to support incoming radioactive material and shipments of waste, fuel, and excess materials.

9.2.11.1.2 Isotopic Analytical Equipment

The laboratories are equipped with instrumentation capable of quantifying the radioactive material on swipes, air samples, and other sample configuration. When necessary, the detector portion of the instruments is installed in counting shields to reduce the background effects and minimize background counts.

9.2.11.1.3 Personal Surveys Between Contaminated Areas

At transitions between contaminated areas, personnel are monitored for contamination. Personnel monitoring equipment is placed as close to the source as practical to ensure that contamination is controlled close to the source.

9.2.11.1.4 Whole Body Contamination Monitors

Prior to exiting MFFF production areas, personnel are surveyed at control points by multidetector personnel contamination monitors to ensure that no contamination leaves the area.

9.2.11.2 Instrument Calibration

Radiological instruments are used only to measure the radiation for which their calibrations are valid and follow the requirements contained in ANSI N323 for radiological instrumentation calibration. Calibration sources are traceable to NIST.

Calibration procedures are developed for each radiological instrument type and include frequency of calibration, pre-calibration requirements, primary calibration requirements, periodic performance test requirements, calibration record requirements, and maintenance requirements.

Radiological instruments are calibrated based on instrument performance and manufacturer's recommendations. The effects of environmental conditions, including interfering radiation, on an instrument are known prior to use. Operational checks are performed on continuously operating radiation protection instruments at a frequency based on instrument performance and manufacturer's recommendations.

When necessary to use an instrument in an application other than that envisioned by the manufacturer, the instrument is adjusted, calibrated, and labeled to identify the special conditions and used only under the special conditions for which it was calibrated.

Instruments bear a label or tag with the date of calibration and date calibration expires.

Instruments whose "as found" readings indicate that the instrument may be out of calibration are reported to the radiological protection organization. The radiological protection organization reviews surveys performed with the instrument while it was out of calibration.

Calibration facilities perform inspections, calibrations, performance tests, and calibration equipment selection in accordance with the recommendations of ANSI N323, *Radiation Protection Instrumentation Test and Calibration*, and take the following actions:

- Locate calibration activities in a manner to minimize radiation exposure to operating personnel and to personnel in adjacent areas
- Minimize sources of interference, such as backscatter and non-ionizing radiation, during the calibration of instrumentation and correct for interference as necessary
- Operate in accordance with the referenced standards
- Generate records of calibration, functional tests, and maintenance in accordance with the referenced standards.

9.2.11.3 Instrument Maintenance

The radiological protection program includes preventive and corrective maintenance of radiological instrumentation. Preventive and corrective maintenance are performed using components and procedural recommendations at least as stringent as those specified by the manufacturer of the instrument. Radiological instruments undergo calibration prior to use and following preventive or corrective maintenance, or adjustment that voids the previous calibration. A battery change is not considered maintenance.

9.2.11.4 Radiological Protection Work Areas and Labs

The radiological protection working spaces consist of radiological protection laboratories and a radiological protection storage room, which contain instruments and areas where technicians may prepare their survey results and store hand-held instruments. These laboratories contain multisample alpha/beta counters, as well as hand-held survey instruments, portable air samplers and isotopic analyzers. The space allows personnel to perform surveys, count the samples, perform isotopic analyses, and record results.

Level 3 of the Shipping and Receiving Area contains the access control point into the Radiological Control Area, which serves as the egress point for both the MP and AP Areas. This area has the personnel contamination monitors and the Decontamination Area / Contaminated First Aid Area. The Decontamination Area / Contaminated First Aid Area contains a shower and sinks to perform minor decontamination of individuals, and supplies to treat minor injuries.

The Technical Support Building has three rooms dedicated to radiological protection activities:

- **RM/HPR**– Houses the respiratory equipment and issue area for the MFFF. This room provides for the minor repair of respiratory protection and storage of spare equipment and emergency supplies.
- **Clean Anti-Contamination Storage Room** – Provides storage for anti-contamination clothing to be used during maintenance activities.
- **Locker Room Area** – Contains storage racks for respiratory protection and dosimetry devices. Space is provided for an increase in staff during maintenance outages.

In the HPCA and the RM/HPR, there are visual displays of alarms and radiation levels for the MFFF radiation monitoring equipment. These visual displays provide identification of specific alarms and the locations of the radiation monitors in the workplace.

The radiation monitoring system uses trending software to identify increasing direct radiation levels over a period of time. The system provides the initial warning of increasing radioactivity in gloveboxes and production rooms and releases to the environment.

9.2.12 Significant Exposure or Contamination Response Capabilities

All pPersonnel assigned to MFFF have dosimetry (activation foils installed in the SRS security badges) that can be used to determine if significant exposures have occurred. Personnel within the MFFF process areas wear a TLD, and an electronic pocket dosimeter. The electronic pocket dosimeter may be exposed to an excessive amount of radiation beyond the capabilities of the instrument. In that case, significant exposure dosimetry will be used to quickly identify personnel with high levels of exposure. Response personnel are trained to survey personnel, including significant exposure dosimetry, for indications of significant exposures. TLDs can be rapidly processed for a more accurate exposure determination. The combined readings are then used to determine the necessity of long-term medical treatment.

Personnel involved in a significant exposure event will initially be transported to the Decontamination / First Aid Room located in the Shipping and Receiving Building. MFFF radiological protection staff will then initiate treatment and decontamination efforts to remove gross amounts of contamination as necessary.

Savannah River Site (SRS) staff physicians and nurses are trained in the proper treatment of high levels of exposure and contamination. The SRS is equipped with medical facilities, ambulances, and technicians to rapidly provide appropriate medical treatment.

MFFF radiation protection procedures direct personnel to specific actions if an accident occurs and personnel are exposed to extremely high levels of radiation and/or contamination. In coordination with the SRS medical personnel, mitigating actions will be implemented as soon as possible. Personnel will be transported to the SRS medical facilities or designated off site hospitals following initial efforts to remove gross amounts of contamination.

9.2.13 Exposure Records

Complete and accurate radiological protection records of areas, including the records of individuals who work in or visit them, are maintained in accordance with 10 CFR Part 20, Subpart L. Reports are formatted in accordance with 10 CFR §20.2110. These records are used to document the radiation exposures of individuals and are available as prescribed by the Privacy Act of 1974. These records are also used for (1) evaluation of the effectiveness of the radiological protection program, (2) demonstration of compliance with regulations and requirements, and (3) personnel records. These dose records are sufficient to evaluate compliance with applicable dose limits, and monitoring and reporting requirements. Occupational exposures ~~in excess of regulatory limits~~ are reported annually to the NRC as required by ~~regulations~~10 CFR 20.2206(b) as well as reporting exposures of individuals exceeding dose limits in accordance with 10 CFR 20.2205.

As a minimum, exposure reports are provided to individuals under the following conditions:

- Upon request from an individual terminating employment, records of exposure are provided to that individual when the data become available.
- If requested, a written estimate of radiation dose, based on available information at the time of termination, is provided.
- Annual radiation dose reports are provided to individuals monitored during the year.
- If requested, detailed exposure information is provided.
- Reports are provided to individuals when required to report to the NRC pursuant to occurrence reporting and processing, or planned special exposures.

9.2.14 Additional Program Commitments

Occupational exposures in excess of prescribed limits are referred to the corrective action program (See Section 15.7.1).

Internal audits of the radiological protection program shall be conducted such that over a one-year period, all functional elements are assessed for program performance, applicability, content and implementation. The audits may be performed by the radiation safety staff or the quality assurance organization.

The following functional elements shall be in the assessment program:

- Personnel dosimetry and dose assessment
- Portable and fixed instrumentation
- Contamination control
- Radiological monitoring (area and item monitoring)
- As-Low-As-Reasonably-Achievable (ALARA) program
- Accident and emergency dose controls
- Radioactive material control, including sealed radioactive source control and material release
- Entry controls
- Training
- Posting and labeling
- Records and reports
- Radiological design and administrative controls

Concerns identified in the assessments shall be incorporated into the MFFF corrective action program.

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Tables

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Table 9.1-1. MFFF Radiation Zoning Criteria

Zone	Design Basis Maximum Area Radiation Dose Rate (mrem/hr)
Z1 - High access area	<0.05
Z2 - Intermediate access area	<0.25
Z3 - Low access area	<5.0
Z4 - Very low access area	<100
Z5 - Restricted access area	>100

Table 9.1-2. Summary of Dose Limits and Goals

	10CFR20 Limits	Administrative Goals
General Employee: Whole Body (internal CEDE + external EDE) (TEDE)	5 rem/yr	0.5 rem/yr or 0.125 rem/qtr
General Employee: Lens of Eye ~~15 rem~~ (LDE)	15 rem/yr	10 rem/yr or 2.5 rem / qtr
General Employee: Skin and extremities (external shallow dose) (SDE)	50 rem/yr	10 rem/yr or 2.5 rem /qtr
General Employee: Any organ or tissue ~~50 rem~~ (other than lens of eye) and skin	50 rem/yr	5 rem/yr or 1.25 rem / qtr
General Employee: Soluble uranium intake	10 mg/week	1 mg/week
Declared Pregnant Worker: Embryo/Fetus (TEDE)	0.5 rem/gestation period	0.5 rem/gestation period

Notes:

1. The annual limit of dose to "any organ or tissue" is based on the committed dose equivalent to that organ or tissue resulting from internally deposited radionuclides over a 50-year period after intake plus any deep dose equivalent to that organ from external exposures during the year.
2. Exposures due to background radiation, as a patient undergoing therapeutic and diagnostic medical procedures, and participation as a subject in medical research programs shall not be included in either personnel radiation dose records or assessment of dose against the limits in this table.
3. Whole body dose (TEDE) = effective dose equivalent from external exposures + committed effective dose equivalent from internal exposures.
4. Lens of the eye dose equivalent = dose equivalent from external exposure determined at a tissue depth of 0.3 cm.
5. Shallow dose equivalent = dose equivalent from external exposure determined at a tissue depth of 0.007 cm
6. The soluble uranium intake limit is in consideration of the chemical toxicity.
7. Minors (below age 18) are allowed to enter radiation areas only with RPM permission. Dose limits for minors will be in accordance with 10 CFR §20.1207.

Table 9.2-1. Summary of Contamination Values

Radionuclide[1]	Removable[2] (dpm/100 cm^2)	Total[3] (Average) (dpm/100 cm^2)
U-natural, ^{235}U, ^{238}U, and associated decay products	1,000 alpha	5,000 alpha
Transuranics (including Pu isotopes), ^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac	20	100
Th-nat, ^{232}Th, ^{223}Ra, ^{224}Ra, ^{232}U	200	1000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission). Includes mixed fission products containing ^{90}Sr [4,5]	1,000 beta-gamma	5,000 beta-gamma
Tritium and tritiated compounds	10,000	N/A

Notes:

1. Except as noted in Footnote 5 below, the values in this table apply to radioactive contamination deposited on, but not incorporated into the interior of, the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha- and beta-gamma-emitting nuclides apply independently.
2. The amount of removable radioactive material per 100 cm^2 of surface area shall be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note: The use of dry material may not be appropriate for tritium.) For objects with a surface area less than 100 cm^2, the entire surface shall be swiped, and the activity per unit area shall be based on the actual surface area. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.
3. The levels may be averaged over 1 square meter provided the maximum activity in an area of 100 cm^2 is less than three times the values in the table.
4. This category of radionuclides includes mixed fission products, including the ^{90}Sr, which is present in them. It does not apply to ^{90}Sr that has been separated from the other fission products or mixtures where the ^{90}Sr has been enriched.
5. These values shall be applied to total $^{90}Sr/^{90}Y$ activity resulting from the presence of ^{90}Sr in mixed fission products.

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10. ENVIRONMENTAL PROTECTION

The components of the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) Environmental Protection Program include:

- Radiation safety controls to assess the level of radioactive releases to the environment, maintain public dose as low as is reasonably achievable (ALARA), minimize facility and environmental contamination, facilitate eventual deactivation, and minimize waste generation
- Effluent monitoring to measure and monitor radioactive effluents released from the facility during normal and off-normal operations
- Environmental surveillances to monitor environmental impact from operations during normal and off-normal operations.

10.1 RADIATION SAFETY

This section describes the methods used to maintain dose outside the Restricted Area Boundary (RAB) ALARA, in accordance with Title 10 of the Code of Federal Regulations (CFR) §20.1101. Facility radiation safety is described in Chapter 9.

The radiation protection organization is responsible for the analysis of the MFFF Main Exhaust Stack samples. The radiation protection organization is also responsible for sampling all internal areas of the MFFF for airborne contamination, analyzing the radioactive liquid waste prior to transfer to the Savannah River Site facilities, and providing the surveys of the solid waste drums prior to shipment.

10.1.1 ALARA Goals for Effluent Control

Calculations performed in accordance with 10 CFR §20.1302(b)(1) using the guidance provided in Regulatory Guide 4.20, Section 2.2, demonstrate that the Total Effective Dose Equivalent (TEDE) to an individual outside of the RAB likely to receive the highest dose from licensed operation does not exceed 100 mrem/yr, as required in 10 CFR §20.1301(a)(1).

The ALARA goal for TEDE to the individual outside of the RAB likely to receive the highest dose from air emissions of radioactive material to the environment during normal operations, excluding ^{222}Rn and its daughters, is less than 10 mrem/yr, which is 10% of dose stated in 10 CFR §20.1301(a)(1) and is consistent with 10 CFR §20.1101(d). Reports are made in accordance with 10 CFR §20.2203 if the 10 mrem/yr dose constraint is exceeded during ~~off-normal operations~~all operating conditions.

No radioactive liquid effluents are predicted or anticipated for normal operations.

Dose estimates are monitored and compared to ALARA goals. Shaw AREVA MOX Services LLC (MOX Services) management is apprised of data in accordance with the ALARA program.

10.1.2 Effluent Controls

Effluent controls, consisting of airborne, liquid, and solid waste management, reduce exposure to individuals outside of the RAB and minimize releases to the environment.

10.1.2.1 Control of Airborne Emissions

Airborne emissions are controlled by the heating, ventilation, and air conditioning (HVAC) system and the Offgas Treatment (KWG) unit ventilation system that removes radionuclides, nitrous fumes, and other hazardous materials from the Aqueous Polishing (AP) process systems offgas. Airborne waste from MFFF processes is routed through the HVAC system. The HVAC system is designed to handle the expected volume of potentially radioactive waste, compartmentalize the airborne waste to reduce the potential for cross-contamination, safely handle the chemical characteristics of the airborne waste, achieve an acceptable decontamination factor for each radionuclide, and be capable of safe shutdown consistent with the operating status. Several design features of the HVAC system support specific areas of the facility, such as the MOX Processing (MP) and AP Areas. These features include items relied on for safety (IROFS) to provide for confinement of radioactive materials. Ventilation exhaust from contaminated gloveboxes is passed through multiple banks of filters, including high-efficiency particulate air (HEPA) filters. The arrangement and control of IROFS ensure that contaminated exhaust does not bypass confinement controls.

Airborne emissions are monitored and controlled to maintain dose outside the RAB ALARA.

Trending results from effluent monitors, samplers, and other MFFF airborne monitoring equipment provide early indication of increased radioactivity in ventilation exhaust. Procedures identify evaluations and actions to be taken when the concentrations of airborne radioactivity exceed prescribed limits.

10.1.2.2 Liquid Waste Management

The AP process uses recycling to the maximum extent practical to minimize liquid waste. Liquid waste management is integrated into the fluid transport systems. The fluid transport systems are designed to handle the maximum expected volume of potentially radioactive waste, compartmentalize the liquid waste to reduce the potential for cross-contamination, safely handle the chemical characteristics of the liquid waste, and be capable of safe shutdown consistent with the operating status. Liquid radioactive waste is transferred to U.S. Department of Energy (DOE) facilities at the Savannah River Site (SRS) in a manner consistent with the SRS Waste Acceptance Criteria (WAC) for appropriate storage and disposition. SRS will take possession of the waste prior to reaching the RAB and is responsible for the safe movement of the waste.

Liquid radioactive wastes and liquid nonradioactive wastes are collected and managed in separate systems that have no opportunity for interconnection. Radioactive process fluids are maintained within at least two levels of confinement. Radioactive process fluids are transferred using means such as gravity flow, airlifts, air jets, and steam jets, when practical. Drains within the radiation control area are routed to the liquid waste system. Liquid radioactive wastes are collected in the aqueous liquid waste system or the solvent liquid waste system, and are sent to SRS for disposition. Outside the radiation control area, liquid nonradioactive wastes are collected and sent to SRS for disposition. Systems containing nonradioactive hazardous fluids are of fully-welded construction and are accessible for inspection.

Prior to transfer to SRS, liquid wastes from storage tanks are sampled and analyzed to ensure that waste transfers meet the SRS WAC.

10.1.2.3 Solid Waste Management

Solid wastes are transferred to SRS for disposition. MFFF quantifies the activity in radioactive solid waste containers to ensure that waste shipments meet the SRS WAC.

Hazardous solid waste is waste that is, or contains, a listed hazardous waste, or that exhibits one of the four U.S. Environmental Protection Agency (EPA) hazardous waste characteristics (i.e., ignitability, corrosivity, reactivity, and toxicity). Hazardous waste includes nonradioactive laboratory wastes. Mixed low-level waste is waste that is radioactive and contains chemical components regulated by EPA as hazardous waste, while mixed transuranic waste is waste that meets the criteria for transuranic waste and contains chemical components regulated by EPA as hazardous waste.

Mixed low-level waste and mixed transuranic waste are packaged and transferred to SRS in a manner consistent with the SRS WAC for processing and disposal within 90 days of generation. SRS will take possession of the waste prior to reaching the RAB and is responsible for the safe transfer of the waste. To the extent practical, commingling of waste from streams requiring different treatment technologies is prevented. Containers of hazardous waste known or suspected to be contaminated with radioactive material are uniquely labeled and tracked through storage and shipping.

10.1.3 ALARA Reviews and Reports to Management

Reports summarizing the ALARA program are provided to MOX Services management. They include trending information, so that analytical results can be compared to ALARA goals. Emission and effluent radionuclide concentrations and radionuclides transferred to SRS as liquid and solid waste are included in trend analyses. Abnormal increases in the trend of analytical results are reported to MOX Services senior management as soon as practical. To ensure that releases are maintained ALARA, MOX Services management is informed quarterly of the trends measured against ALARA goals. ALARA goals are reevaluated annually, and new goals are established for the upcoming year as appropriate. Recommendations are made to MOX Services senior management, as needed, for changes in facilities and procedures to achieve ALARA goals. Effluent controls are reviewed annually as part of the radiological protection program annual review to ensure public doses are ALARA.

If an adverse trend is noted, an evaluation is made to determine if a detrimental effect is evident in the environment or the surrounding biota. The evaluation considers the information provided by the environmental surveillance network. Based on facility operating history and the data obtained from environmental surveillances during operations, the sampling and/or analysis programs are adjusted to optimize reliability.

10.1.4 Waste Minimization and Pollution Prevention

Waste management is guided by the principles of ALARA, waste minimization, and pollution prevention. Waste minimization is accomplished through a design that reduces the potential for

waste generation, and an operations philosophy that minimizes the introduction of excess materials that can become contaminated.

The MFFF process implements recycling and reuse for waste minimization. For example, the recycling process minimizes the quantity of plutonium in the final waste by using systems that return (recycle) radioactive material to previous steps of the main process. Liquid waste is minimized in the AP process by use of recycling to the maximum extent practical. Nitric acid is recovered by evaporation from the process and partly reused as reagent feedstock for the plutonium dissolution subprocess. Distillates from the evaporation process are collected and partly reused in the process. Spent solvent from the plutonium separation step is regenerated by washing with sodium carbonate, sodium hydroxide, and nitric acid to remove degradation products from organic compounds, including trace amounts of plutonium and uranium.

Solid waste is minimized by reuse of solid scrap material from fuel fabrication. Many other system design features perform contamination control, confinement, and associated waste minimization functions. The process design reduces the distribution and retention of radioactive materials throughout plant systems by using vacuum systems in the gloveboxes. Airborne dust is collected in dust pots in dedusting systems installed in the gloveboxes, and the material is recycled. These design features control contamination to ensure that secondary waste production is minimized during plant operation.

Waste minimization procedures will require separation and segregation of solid and liquid wastes and the removal of packing and shipping materials prior to entry into contaminated areas. Waste minimization reduces worker and public exposure to radiation and to radioactive and hazardous materials.

Waste minimization programmatic documentation includes a statement of senior management support and identification of management, employees, and organizational responsibilities for waste minimization. Waste minimization includes periodic characterization of waste and assessment of waste management practices to identify opportunities to enhance waste minimization. Goals for waste minimization are established based on operational data. To ensure that waste generation is minimized, management is informed quarterly of the trends measured against waste minimization goals. The goals are reevaluated annually, and new goals are established for the upcoming year as appropriate. Recommendations are made to MOX Services senior management, as needed, for changes in facilities and procedures to achieve waste minimization goals.

The MFFF process implements recycling and reuse for waste minimization. For example, the recycling process minimizes the quantity of plutonium in the final waste by using systems that return (recycle) radioactive material to previous steps of the main process. Many other system design features perform contamination control, confinement, and associated waste minimization functions. These design features control contamination to ensure that secondary waste production is minimized during plant operation.

10.2 EFFLUENT MONITORING

10.2.1 Air Emissions

The maximum annual concentrations of radioactive airborne effluents are expected to be much less than the values in 10 CFR Part 20, Appendix B, Table 2. Estimated isotopic distribution of emissions is shown in Table 10.2-1. MOX Services does not plan to request U.S. Nuclear Regulatory Commission (NRC) approval to adjust effluent concentrations shown in 10 CFR 20 Appendix B; therefore, physical and chemical properties are not described here.

10.2.1.1 Discharge Locations

Exhaust from MFFF processes is filtered and discharged to the environment via a stack located on top of the MOX Fuel Fabrication Building.

10.2.1.2 Sample Collection, Frequency, and Analytical Methods

Based on Regulatory Guide 4.16, Revision 1, a representative sample of the particulate effluent from the stack is continuously collected during operations. The representative sample is collected on a filter for determination of quantities and average concentrations of principal radionuclides that are released. The analytical methodologies used to characterize airborne emissions are listed in Table 10.2-2.

To investigate abnormal stack releases and/or anomalies, sample connections are installed at key locations in process area ventilation ducts. The placement and use of sample connections are based on minimizing the risk to facility workers, site personnel, and members of the public. The potential for leakage from process systems, equipment, and confinement is also considered. The evaluation focuses on the equipment and spaces with the highest potential for leakage of airborne contaminants. During MFFF operations, elevated readings from continuous air monitors (CAMs) and/or fixed air samplers are used to identify the need to perform maintenance, or to take other action to reduce effluent releases. To quantify the contribution from each source, CAMs sample the discharged air from the MP and AP process areas and, as appropriate, other areas that are not used for processing special nuclear material.

Analytical quality control methodology is described in the appropriate laboratory manual and is subject to Quality Assurance controls. Analytical procedures are consistent with national or international consensus standards or have equivalent or superior performance to such methods. Analytical instrumentation is standardized and calibrated in accordance with the manufacturer's recommendations. Calibration standards are traceable to the National Institute of Standards and Technology.

10.2.2 Liquid Effluents

Liquid radioactive waste is collected by the liquid aqueous liquid waste system or the solvent liquid waste system and transferred to SRS for disposition. The MFFF does not discharge radioactive liquid to the environment during normal and off-normal operations. The expected nonradioactive liquid release is from stormwater that is released to the storm drains and water from HVAC noncontact condensate that is released to the sanitary sewerage facilities system.

10.2.2.1 Discharge Locations

The MFFF does not discharge process effluents. The National Pollutant Discharge Elimination System (NPDES) discharge for stormwater runoff is designated in South Carolina Department of Health and Environmental Control (SCDHEC) NPDES General Permit and related documents (e.g., Storm Water Pollution Prevention Plan).

10.2.2.2 Leak Detection Systems for Ponds, Lagoons, and Tanks

The MFFF does not use wastewater treatment ponds, lagoons, or other process water holding ponds. The only pond on the MFFF site is the stormwater detention basin, which does not receive process liquid discharges from the MFFF. Tanks used for storage of radioactive material are located inside MFFF buildings and are equipped with drip pans and leak detection.

10.2.3 Recording/Reporting Procedures

Data from the sampling and monitoring are reviewed on a regular basis. Radionuclide activities are trended over a period of time at each sampling location for each media to determine the effects of facility operation. If an increasing trend is noted, an evaluation is made to determine if a detrimental effect has been seen in the environment or in the surrounding biota. The appearance of an increasing activity trend in itself is not cause for action. Based upon the operating history of the facility and operational data, sampling and/or analysis programs are adjusted as necessary.

MOX Services submits a summary of the effluent monitoring to the NRC semiannually.

10.3 ENVIRONMENTAL SURVEILLANCES

Environmental surveillances assess the environmental impact of licensed activities, which include preoperational and operational environmental monitoring activities. Radionuclide analyses are performed more frequently if there is an unexplained increase of gross radioactivity in airborne emissions, or when a process change or other circumstance might cause a variation in radionuclide concentration.

Radiological impacts to the environment from airborne emissions during operation of the MFFF are expected to be minimal. Because the MFFF does not discharge radioactive liquids directly to the environment, the environmental surveillances focus on the environmental media impacted by the airborne pathway for the anticipated types and quantities of radionuclides released from the facility.

10.3.1 Pathway Analysis Methods to Estimate Public Dose

As noted above, the MFFF does not release radioactive effluents to the aquatic environment. Consequently, the pathways for radionuclides to reach the public or environment are associated with airborne emissions. The dominant pathway for MFFF releases to reach human consumption is inhalation of airborne emissions. Deposition of airborne particulates on crops and ingestion of the contaminated agricultural products is a secondary pathway for radionuclides to reach the environment and human consumption. However, because the MFFF is located on a DOE

reservation, there are no consumable crops within 5 miles of the MFFF. A tertiary pathway is deposition of airborne particulates to water, or contaminated runoff to nearby streams and ingestion of the water or fish. Again, since the MFFF is on a DOE reservation, the importance of this pathway is significantly reduced. The analysis of public dose considers inhalation uptake, external exposure to the airborne plume, ingestion of terrestrial foods and animal products, and inadvertent soil ingestion.

10.3.2 Environmental Media to be Monitored and Sample Locations

The environmental surveillances track each pathway for the release of MFFF radioactivity to the environment. Environmental surveillances include monitoring of airborne particulates and deposition of particulates on surrogates for crops, such as grass and soil, and nearby streams. Environmental surveillances evaluate the effects of both short-term and long-term deposition.

Locations and sampling frequencies during operations phase monitoring are adjusted, based on the results of the preoperational surveillances or operational emissions monitoring results.

10.3.3 Preoperational Surveillances

The DOE has monitored the SRS site for many years. MFFF preoperational environmental surveillances provide a link between the long-term DOE data and the MFFF operational environmental surveillances. Preoperational environmental surveillances begin approximately two years prior to production of commercial fuel. The objectives of the preoperational environmental surveillances are:

- Establish a baseline of existing radiological and biological conditions at and nearby the MFFF site
- Evaluate procedures, equipment, and techniques used in the collection and analysis of environmental data, and train personnel in their use
- Determine the presence of contaminants that could be a safety concern for personnel.

Preoperational surveillances establish a baseline for operational environmental surveillance for radioactivity levels of environmental media (e.g., air, soil, sediments, and vegetation), as appropriate, with analyses for uranium, plutonium, and other radionuclides of interest.

10.3.3.1 Air Sampling and Analysis

Preoperational air quality sampling establishes the baseline to be used during the operational monitoring period. The airborne monitoring provides a comprehensive baseline of radiological conditions related to airborne emissions in the environs of the MFFF. Three air sampling locations monitor exposure at the RAB to the east, southwest, and northwest of the MFFF building. The airborne radiological monitoring program, including the sampling locations, is outlined in Table 10.3-1.

Three additional air sampling locations, corresponding to existing SRS monitoring points, monitor exposure at the SRS boundary and are identified in Table 10.3-1. These sampling

locations assist in estimating dose to the offsite public, conservatively assuming a member of the offsite public spends all their time at the SRS boundary. Air quality monitoring points are subject to emissions from not only the MFFF, but also from other SRS operations. Environmental observations are evaluated in conjunction with MFFF emissions data and atmospheric transport and dispersion modeling projections. Preoperational monitoring is used to establish the baseline for both isotopic composition and concentrations, which are then compared to observations during MFFF operations.

Analytical methods and lower limit of detection (LLD) for analyses of airborne isotopes are listed in Table 10.3-2. For rainwater samples, the rainwater is evaporated and then the dry material is counted. Sufficient volumes of samples are collected to ensure the attainment of LLD thresholds in the analysis. Samples are processed and packaged in a manner to ensure the integrity of each sample.

10.3.3.2 Water Sampling and Analysis

The MFFF does not discharge process water to the environment. Deposition rates of airborne contaminants to water bodies are estimated based on airborne environmental surveillances and confirmed by water and sediment sampling.

10.3.3.3 Terrestrial Sampling and Analysis

Preoperational terrestrial radiological monitoring is outlined in Table 10.3-3. It provides a comprehensive baseline of radiological conditions related to airborne emissions in the environs of the MFFF.

Soil samples are collected, using hand augers or equivalent devices, from uncultivated and undisturbed areas. Grassy vegetation is collected at locations adjacent to the soil sample by hand picking vegetation.

Analytical methods and LLDs for terrestrial environmental samples are listed in Table 10.3-4. Sufficient volumes of samples are collected when available, using accurate sample collection methods to ensure the attainment of LLDs in the analyses. Samples are processed and packaged in a manner to ensure the integrity of each sample.

10.3.4 Operational Monitoring

Locations and sampling frequency during the operational monitoring period may be altered based on the results of the preoperational monitoring or operational emissions monitoring results. The frequency of the monitoring described in this section may be reduced when a consistent radionuclide composition in effluents is established.

10.3.4.1 Air Sampling and Analysis

Operational air quality sampling is based on the results of preoperational and emission monitoring. The operational airborne radiological monitoring is outlined in Table 10.3-5.

Analytical methods and LLDs are listed in Table 10.3-6. For rainwater samples, the rainwater is evaporated and then the dry material is counted. Sufficient volumes of samples are collected to ensure the attainment of LLDs in the analyses. Samples are processed and packaged in a manner to ensure the integrity of each sample.

10.3.4.2 Water Sampling and Analysis

The MFFF does not discharge process water to the environment. Deposition rates of airborne contaminants into water bodies are estimated based on airborne environmental surveillances and confirmed by water and sediment sampling.

10.3.4.3 Terrestrial Sampling and Analysis

Operational terrestrial radiological monitoring is outlined in Table 10.3-7. It provides an evaluation of radiological impacts related to deposition of airborne emissions in the environs of the MFFF. Terrestrial samples are collected in the vicinity of the air quality monitors to allow association of the particulate and rainwater analyses with vegetation analyses.

Soil samples are collected, using hand augers or equivalent devices, from uncultivated and undisturbed areas. Grassy vegetation is collected at locations adjacent to the soil sample by hand picking vegetation.

Analytical methods and LLDs for analyses of terrestrial environmental samples are listed in Table 10.3-8. Sufficient volumes of samples are collected when available, using accurate sample collection methods to ensure the attainment of LLDs in the analyses. Samples are processed and packaged in a manner to ensure the integrity of each sample.

10.3.5 Action Levels and Actions

Title 10 CFR §20.1301 establishes regulatory limits for dose to the public. To ensure that the regulatory limits are not exceeded, MOX Services has established administrative limits and action levels as shown in Table 10.3-9. If an action level is exceeded for sampling, an investigation is performed to determine the source of the elevated activity. Emission data are trended as an analytical tool.

10.3.6 Recording/Reporting Procedures

Data from the sampling are reviewed on a regular basis.

Radionuclide activities are trended at each sampling location for each media to determine the effects of facility operation. If an increasing trend is noted, an evaluation is performed to determine if a detrimental effect has been seen in the environment or in the surrounding population.

Based upon the operating history of the facility and operational data, sampling and/or analysis programs are adjusted as necessary.

Results of the environmental surveillances are summarized annually.

Reports and notifications of theft or loss of licensed material are submitted as required. Reports and notifications of concentrations of principal radionuclides released are provided, and include the minimum detectable concentration for the analysis. Reports and notifications of exposure incidents above acceptable levels are submitted as required.

10.3.7 Monitoring Procedures, Analytical Methods, and Instrumentation

Analytical quality control is described in laboratory procedures and is consistent with the MOX Project Quality Assurance Plan. Analytical procedures are consistent with national or international consensus standards or have equivalent or superior performance to such methods. Analytical instrumentation is standardized and calibrated in accordance with the manufacturer's recommendations. Calibration standards are traceable to the National Institute of Standards and Technology.

10.4 ENVIRONMENTAL PERMITS

Table 10.4-1 lists the environmental permits and plans that are required prior to operation of the MFFF.

Tables

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Table 10.2-1. Estimated Radiological Releases from the MFFF during Normal Operations

Isotope	Airborne Radiological Releases (μCi/yr)
^{3}H	3.0E+6 [1]
^{237}Np	7.2E-04
^{236}Pu	1.3E-08
^{238}Pu	8.5
^{239}Pu	91
^{240}Pu	23
^{241}Pu	101
^{242}Pu	6.1E-03
^{241}Am	48
^{234}U	5.1E-03
^{235}U	2.1E-04
^{238}U	0.012

Note 1: Value is based on revision of feedstock specifications

Table 10.2-2. Analytical Methods for Characterization of Airborne Emissions

Parameter	Analytical Method	Lower Limit of Detection[1] (µCi/ml)
Gross alpha	Gas-flow proportional counter	1.0E-15 [2]
Gross beta	Gas-flow proportional counter	1.0E-15 [2]
^{3}H	Liquid scintillation	5.0E-09
^{237}Np	Alpha spectrometer	5.0E-16
^{241}Am	Alpha spectrometer	1.0E-15
^{238}Pu	Alpha spectrometer	1.0E-15
^{239}Pu, ^{240}Pu	Alpha spectrometer	1.0E-15
^{235}U	Alpha spectrometer	3.0E-15
^{238}U	Alpha spectrometer	3.0E-15

Note 1: Lower limit of detection values are 5% of the values in 10CFR20, Appendix B, Table 2
Note 2: It is estimated that this LLD can be met based on design basis, which is susceptible to change.

Table 10.3-1. Preoperational Airborne Radiological Monitoring

Location	Description of Monitor Location	Frequency	Collection Methodology	Analyses
A-01	SW corner of MFFF site about 700 ft from BMF	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-02	East of MFFF stack about 700 ft from BMF	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-03	NW of MFFF about 700 ft from BMF	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-05	400-D, SRS boundary in the principal wind direction	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np

Table 10.3-1. Preoperational Airborne Radiological Monitoring (continued)

Location	Description of Monitor Location	Frequency	Collection Methodology	Analyses
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-06	West Jackson - SRS boundary at centerline to nearest residence	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-07	Aiken Barricade - SRS boundary in the 2nd principal wind direction	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H

Table 10.3-2. Preoperational Methodology and Lower Limits of Detection for Airborne Environmental Samples

Analyte	Method	Lower Limit of Detection[1] (μCi/ml)
Particulate		
Gross alpha	Gas-flow proportional counter	1.0E-13 [2]
Gross beta	Gas-flow proportional counter	5.0E-13 [2]
^{3}H	Liquid scintillation	5.0E-09
^{237}Np	Alpha spectrometer	5.0E-16
^{241}Am	Alpha spectrometer	1.0E-15
^{238}Pu	Alpha spectrometer	1.0E-15
^{239}Pu, ^{240}Pu	Alpha spectrometer	1.0E-15
^{235}U	Alpha spectrometer	3.0E-15
^{238}U	Alpha spectrometer	3.0E-15
Rainwater		
Gross alpha	Gas-flow proportional counter	9.0E-09
Gross beta	Gas-flow proportional counter	1.5E-08
^{3}H	Liquid scintillation	5.0E-05
^{237}Np	Alpha spectrometer	1.0E-09
^{241}Am	Alpha spectrometer	1.0E-09
^{238}Pu	Alpha spectrometer	1.0E-09
^{239}Pu, ^{240}Pu	Alpha spectrometer	1.0E-09
^{235}U	Alpha spectrometer	1.5E-08
^{238}U	Alpha spectrometer	1.5E-08

Note 1: Lower limit of detection values are 5% of the values in 10CFR20, Appendix B, Table 2
Note 2: Lower limit of detection value is based on potential contractor minimum detectable activity.

Table 10.3-3. Preoperational Terrestrial Radiological Monitoring

Location	Description of Monitor Location	Media[1]	Frequency	Analyses[2]
VS-01 (A-01)	SW corner of MFFF site about 700 ft from BMF	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-02 (A-02)	East of MFFF stack about 700 ft from BMF	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-03 (A-03)	NW of MFFF about 700 ft from BMF	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-05 (A-05)	400-D, SRS boundary in the principal wind direction	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-06 (A-06)	West Jackson - SRS boundary at centerline to nearest residence	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-07 (A-07)	Aiken Barricade - SRS boundary in the 2nd principal wind direction	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H

Note 1: V = Vegetation; S = Soil
Note 2: For terrestrial radiological monitoring ^{3}H is only analyzed for in vegetation.

Table 10.3-4. Preoperational Methodology and Lower Limits of Detection for Terrestrial Environmental Samples

Analyte	Method	Lower Limit of Detection[1] (pCi/g)
Soil		
^{237}Np	Alpha spectrometer	6.0 E-03
^{241}Am	Alpha spectrometer	8.0E-03
^{238}Pu	Alpha spectrometer	6.0 E-03
^{239}Pu, ^{240}Pu	Alpha spectrometer	6.0 E-03
^{235}U	Alpha spectrometer	8.0E-03
^{238}U	Alpha spectrometer	8.0E-03
Vegetation		
^{3}H	Liquid scintillation	5.0E-03
^{237}Np	Alpha spectrometer	4.0E-03
^{241}Am	Alpha spectrometer	4.0E-03
^{238}Pu	Alpha spectrometer	4.0E-03
^{239}Pu, ^{240}Pu	Alpha spectrometer	4.0E-03
^{235}U	Alpha spectrometer	2.0E-03
^{238}U	Alpha spectrometer	2.0E-03

Note 1: Lower limit of detection values are based on potential contractor minimum detectable activity.

Table 10.3-5. Operational Airborne Radiological Monitoring

Location	Description of Monitor Location	Frequency	Collection Methodology	Analyses
A-01	SW corner of MFFF site about 700 ft from BMF	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-02	East of MFFF stack about 700 ft from BMF	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-03	NW of MFFF about 700 ft from BMF	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H

Table 10.3-5. Operational Airborne Radiological Monitoring (continued)

Location	Description of Monitor Location	Frequency	Collection Methodology	Analyses
A-05	400-D, SRS boundary in the principal wind direction	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-06	West Jackson - SRS boundary at centerline to nearest residence	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H
A-07	Aiken Barricade - SRS boundary in the 2nd principal wind direction	Air filters collected biweekly	Air particulate samplers using glass fiber filters	Gross alpha/beta
		Air filters monthly composite	Air particulate samplers using glass fiber filters	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np
		Monthly	Rainwater collected and passed through ion exchange columns in the field	Gross alpha/beta, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
		Biweekly	Silica Gel	^{3}H

Table 10.3-6. Operational Methodology and Lower Limits of Detection for Airborne Environmental Samples

Analyte	Method	Lower Limit of Detection[1] (μCi/ml)
Particulate		
Gross alpha	Gas-flow proportional counter	1.0E-13[2]
Gross beta	Gas-flow proportional counter	5.0E-13[2]
^{3}H	Liquid scintillation	5.0E-09
^{237}Np	Alpha spectrometer	5.0E-16
^{241}Am	Alpha spectrometer	1.0E-15
^{238}Pu	Alpha spectrometer	1.0E-15
^{239}Pu, ^{240}Pu	Alpha spectrometer	1.0E-15
^{235}U	Alpha spectrometer	3.0E-15
^{238}U	Alpha spectrometer	3.0E-15
Rainwater		
Gross alpha	Gas-flow proportional counter	9.0E-09
Gross beta	Gas-flow proportional counter	1.5E-08
^{3}H	Liquid scintillation	5.0E-05
^{237}Np	Alpha spectrometer	1.0E-09
^{241}Am	Alpha spectrometer	1.0E-09
^{238}Pu	Alpha spectrometer	1.0E-09
^{239}Pu, ^{240}Pu	Alpha spectrometer	1.0E-09
^{235}U	Alpha spectrometer	1.5E-08
^{238}U	Alpha spectrometer	1.5E-08

Note 1: Lower limit of detection values are 5% of the values in 10CFR20, Appendix B, Table 2
Note 2: Lower limit of detection value is based on potential contractor minimum detectable activity.

Table 10.3-7. Operational Terrestrial Radiological Monitoring

Location	Description of Monitor Location	Media[1]	Frequency	Analyses[2]
VS-01 (A-01)	SW corner of MFFF site about 700 ft from BMF	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-02 (A-02)	East of MFFF stack about 700 ft from BMF	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-03 (A-03)	NW of MFFF about 700 ft from BMF	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-05 (A-05)	400-D, SRS boundary in the principal wind direction	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-06 (A-06)	West Jackson - SRS boundary at centerline to nearest residence	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, $^{23}5U$, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H
VS-07 (A-07)	Aiken Barricade - SRS boundary in the 2nd principal wind direction	V, S	Annual	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{235}U, ^{238}U, ^{241}Am, ^{237}Np, ^{3}H

Note 1: V = Vegetation; S = Soil.
Note 2: For terrestrial radiological monitoring ^{3}H is only analyzed for in vegetation.

Table 10.3-8. Operational Methodology and Lower Limits of Detection for Terrestrial Environmental Samples

Analyte	Method	Lower Limit of Detection[1] (pCi/g)
Soil		
^{237}Np	Alpha spectrometer	6.0E-03
^{241}Am	Alpha spectrometer	8.0E-03
^{238}Pu	Alpha spectrometer	6.0E-03
^{239}Pu, ^{240}Pu	Alpha spectrometer	6.0E-03
^{235}U	Alpha spectrometer	8.0E-03
^{238}U	Alpha spectrometer	8.0E-03
Vegetation		
^{3}H	Liquid scintillation	5.0E-03
^{237}Np	Alpha spectrometer	4.0E-03
^{241}Am	Alpha spectrometer	4.0E-03
^{238}Pu	Alpha spectrometer	4.0E-03
^{239}Pu, ^{240}Pu	Alpha spectrometer	4.0E-03
^{235}U	Alpha spectrometer	2.0E-03
^{238}U	Alpha spectrometer	2.0E-03

Note 1: Lower limit of detection is based on potential contractor minimum detectable activity.

Table 10.3-9. Administrative Limits and Action Levels for Air Emissions

Parameter	Action Level[1] (μCi/ml)	Action
Alpha activity	3.2 E-14	Recount sample(s), including full isotope spectroscopy and compare to individual isotope regulatory limits
Alpha activity	6.4 E-14	Evaluate operations for possible source of positive activity
Alpha activity	3.2 E-13	Releases are potentially above allowable 10 CFR Part 20, Appendix B, Table 2 effluent limits. Initiate orderly shutdown of associated processes for repair or correction.

Note 1: Calculated values at the MFFF BMF stack.

Table 10.4-1. Status of Federal, State and Local Licenses, Permits and Approvals

Requirement	Status	Comments
Federal Laws and Enabling Regulations		
Negative declaration on cultural resources from the State Historic Preservation Officer (SHPO) 43 CFR Part 7; 36 CFR Parts 60, 61, 63, 65, 67, 68	Completed	SHPO approved mitigation plan on 11 April 2001. Mitigation completed August 2002.
Negative declaration on endangered species from the U.S. Fish and Wildlife Services (USFWS) 50 CFR Parts 13, 17, 222, 226, 227, 402, 424, 450-453	Completed	USFWS issued negative declaration on 20 June 2001.
Negative declaration on prime or unique farmlands from U.S. Natural Resources Conservation Service (USNRCS) 7 CFR Part 658	Not required	USNRCS does not identify SRS as prime farmlands because the land is not available for agricultural production.
Negative declaration on 404 Permit from U.S. Army Corps of Engineers (COE)	Not required	No jurisdictional wetlands exist on MFFF site.
Floodplain Assessment	Completed	Floodplain Assessment incorporated into the design basis.
Construction Environmental Plans and Permits		
Construction Emissions Control Plan (CECP) 40 CFR 60 South Carolina Regulation 61.62-6	Completed	CECP was completed and does not need to be approved by SCDHEC.
Bureau of Air Quality (BAQ) Construction Permit 40 CFR 60 South Carolina Regulation 61.62-5	Completed	BAQ Construction Permit for BMF Stack, Diesel Generators, and Diesel Fuel Tanks has been received from SCDHEC in 2006. BAQ Construction Permit for Concrete Batch Plant will be drafted after vendor selection in Spring 2007.

Table 10.4-1. Status of Federal, State and Local Licenses, Permits and Approvals (continued)

Requirement	Status	Comments
BAQ National Emission Standard for Hazardous Air Pollutants (NESHAP) Construction Permit 40 CFR 61 Subpart H 10 CFR 20 South Carolina Regulation 61.62-5	Completed	Alternative Calculation methodology approved by EPA Region IV and SCDHEC in April 2002. Exemption from NESHAP Construction Permit granted.
Bureau of Water Quality (BWQ) Construction NPDES General Permit 40 CFR 122 South Carolina Regulation 61-9 South Carolina Regulation 61-68 South Carolina Regulation 72-300 through 72-316 (GR)	Completed	Access to BWQ General Permit granted in May 2005 upon acceptance of Notice of Intent (NOI) and SWPPP by SCDHEC.
BWQ Sanitary Wastewater Construction Permit 40 CFR 122 South Carolina Regulation 61-9 South Carolina Regulation 61-67	In progress	Permit from tie-in to interface point has been received. Permit from interface point to MFFF has been drafted and will be submitted to SCDHEC in 2007.
BWQ Construction Storm Water Pollution Prevention Plan (SWPPP) 40 CFR 122 South Carolina Regulation 61-9 South Carolina Regulation 61-68 South Carolina Regulation 72-300 through 72-316 (GR)	Completed	Accepted by SCDHEC with NOI in May 2005. BWQ SWPP for Concrete Batch Plant will be drafted after vendor selection in Fall 2006.
BWQ Domestic Water Distribution Construction Permit 40 CFR 141 South Carolina Regulation 61-58 South Carolina Regulation 61-71 South Carolina Regulation 61-101	In progress	Permit from tie-in to interface point has been received. Permit from interface point to MFFF has been drafted and will be submitted to SCDHEC in 2007.
Bureau of Land and Waste Management (BLWM) Underground Storage Tank (UST) Installation Permit 40 CFR 112 40 CFR 280 South Carolina Regulation 61-92	In progress	BLWM UST Permit has been drafted and will be submitted to SCDHEC in 2007

Table 10.4-1. Status of Federal, State and Local Licenses, Permits and Approvals (continued)

Requirement	Status	Comments
Waste Minimization and Pollution Prevention Plan 40 CFR 261 40 CFR 262 40 CFR 264 40 CFR 268 South Carolina Regulation 61-66 South Carolina Regulation 61-79 South Carolina Regulation 61-99 South Carolina Regulation 61-104	Completed	Issued in 2006.
Operational Environmental Plans and Permits		
BAQ Air Operating Permit 40 CFR 71 South Carolina Regulation 61.62-70	In progress	BAQ Air Operating Permit will be completed approximately 2 years prior to MFFF operations.
Risk Management Plan 40 CFR §68.130 Tables 1 & 3 South Carolina Regulation 61.62-68	Not required	MFFF will impose administrative limits on 40 CFR §68.130 and South Carolina Regulation 61.62-68 extremely hazardous chemicals, which will preclude the need for a Risk Management Plan.
BWQ Utility Water Permit 40 CFR 122 South Carolina Regulation 61-9 South Carolina Regulation 61-67	In progress	BWQ Utility Water Permit will be completed approximately 2 years prior to MFFF operations.
BWQ Sanitary Wastewater Operating Permit 40 CFR 122 South Carolina Regulation 61-9 South Carolina Regulation 61-67	In progress	BWQ Sanitary Wastewater Permit will be completed approximately 2 years prior to MFFF operations.
BLWM UST Operating Permit 40 CFR 112 40 CFR 280 South Carolina Regulation 61-92	In progress	BLWM UST Operating Permit will be completed approximately 2 years prior to MFFF operations
Spill Prevention Control and Countermeasures (SPCC) Plan 40 CFR 112 Section 110 South Carolina Regulation 61-9	In progress	SPCC Plan will be completed approximately 2 years prior to MFFF operations
BWQ Domestic Water Distribution Operating Permit 40 CFR 141 South Carolina Regulation 61-58 South Carolina Regulation 61-71 South Carolina Regulation 61-101	In progress	BWQ Domestic Water Permit will be completed approximately 2 years prior to MFFF operations.
BLWM Resource Conservation and Recovery Act (RCRA) Generator Identification Number South Carolina Regulation 61-79	In progress	BLWM RCRA Generator ID number will be obtained approximately 2 years prior to MFFF operations.

Table 10.4-1. Status of Federal, State and Local Licenses, Permits and Approvals (continued)

Requirement	Status	Comments
Bureau of Land and Waste Management **RCRA Part B Permit** South Carolina Regulation 61-66 South Carolina Regulation 61-79 South Carolina Regulation 61-99 South Carolina Regulation 61-104	Not required	Generated hazardous waste will be stored and accumulated for less than 90 days prior to being sent to SRS, which will preclude the need to obtain a RCRA Part B Permit.
Waste Minimization and Pollution Prevention Plan 40 CFR 261 40 CFR 262 40 CFR 264 40 CFR 268 South Carolina Regulation 61-66 South Carolina Regulation 61-79 South Carolina Regulation 61-99 South Carolina Regulation 61-104	In progress	Construction Waste Minimization and Pollution Prevention Plan will be updated approximately 2 years prior to MFFF operations.
Emergency Planning and Community Right-to-Know Notifications 40 CFR 355 40 CFR 372	Completed	MFFF expects to report as part of the SRS program.

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15. MANAGEMENT MEASURES

Shaw Areva MOX Services, LLC (MOX Services) has established an administrative and programmatic framework to ensure that facility systems, structures, and components are available and reliable to perform their function when needed, and that work is conducted efficiently and in a manner that protects workers, the public, and the environment. This framework includes configuration management, maintenance, training and qualification, procedures, audits and assessments, incident investigations, and records management. Within this framework are the administrative and programmatic measures implemented for Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) items relied on for safety (IROFS) to ensure safety. This chapter describes the management measures implemented for MFFF IROFS. These management measures are implemented in accordance with a quality assurance (QA) program established in accordance with Title 10 of the Code of Federal Regulations (CFR) Part 50, Appendix B.

This chapter makes frequent reference to the MOX Services QA program described in the MOX Project Quality Assurance Plan (MPQAP), because management measures are closely related to quality assurance requirements. The MPQAP has previously been approved by the U.S. Nuclear Regulatory Commission (NRC).

15.1 QUALITY ASSURANCE

MOX Services implements the QA program described in the MPQAP. As noted above, the MPQAP has been approved by the NRC. A change that would reduce the commitments of the NRC approved QA program is submitted with written justification to the NRC for acceptance, prior to implementation by MOX Services. MOX Services implements the requirements of 10 CFR Part 21, *Reporting of Defects and Noncompliance,* for design, construction, procurement, testing, and operations of Quality Level 1 structures, systems, and components (SSCs) (i.e., IROFS SSCs). MPQAP Section 4, *Procurement Document Control*, requires that 10 CFR Part 21 be invoked for procurements of IROFS, unless the procurement is for a Commercial Grade Item.

15.2 CONFIGURATION MANAGEMENT

15.2.1 Configuration Management Policy

MOX Services implements configuration management (CM) processes to maintain effective control of the MFFF as-designed and as-built arrangement and operation. This provides reasonable assurance that IROFS safety functions are properly controlled, and that changes to the facility are properly addressed, evaluated, and approved, so as not to inadvertently create an unanalyzed condition.

15.2.2 Implementation of Configuration Management

Configuration management is implemented as an essential part of the design control process meeting the requirements of MPQAP Section 3, *Design Control*. The engineering function generates design documents according to approved procedures that meet the requirements of

MPQAP Section 5, *Instructions, Procedures, and Drawings,* and MPQAP Section 3, *Design Control.* Design documents are distributed for use according to the requirements of MPQAP Section 6, *Document Control.* Completed design documents are maintained in the records

management system according to the requirements of MPQAP Section 17, *Quality Assurance Records*. Configuration control of installed SSCs, for example, is assured through MPQAP Sections 7 and 8, *Control of Purchased Material, Equipment, and Services,* and *Identification and Control of Materials, Parts, and Components*, respectively. Audits of the CM program are performed in accordance with MPQAP Section 18, *Audits*. Configuration management processes maintain the design requirements, the design basis documentation, and the facility to as-designed and evaluated-for-safety conditions. Changes to the MFFF are documented, reviewed, and processed in accordance with the requirements of 10 CFR §70.72, as described in Chapter 5.

15.2.3 Organization

The MFFF organization is described in Chapter 4. The plant manager is responsible for ensuring the overall successful implementation of the CM program. This includes development and approval of plans and policies necessary to provide overall program direction within MOX, Services including identification of management expectations.

The production function has primary responsibilities for the performance of CM program requirements.

15.2.4 Scope of CM Program

The MOX Services CM program applies to SSCs and associated documentation whose alteration or modification could affect the facility's licensed design or operation.

Configuration management requirements are implemented through use of procedures and other MOX Services implementing documents as described in Section 15.5.

15.2.5 Training

Personnel training requirements are described in Section 15.4.

15.2.6 Change Control

Configuration change control manages changes to approved documents and also is used to manage changes to physical and operational configurations.

15.2.6.1 Identification of Changes

Proposed changes that can lead to a temporary or permanent change in design requirements or physical configuration are identified. These changes may result in document changes, facility modifications, maintenance changes, or operational changes. Changes to documents controlled under the MOX Services CM program are described adequately to support technical reviews, management reviews, and approvals. Design changes are initiated and processed in accordance with procedures.

Documents included in the CM program are subject to an approval process that includes revision control. Original issue and revisions to documents in the CM program are approved and

controlled in accordance with procedures that address design control. MOX Services documents prepared by organizations other than the engineering function that are included in the CM program are also subjected to an approval process that includes a revision control process.

15.2.6.2 Review and Approval of Changes

The MOX Services CM program requires that changes to documents included in the CM program receive an evaluation and approval of the change prior to implementation. A technical review allows for evaluation of safety, environmental, and operational impacts of the change, as well as the identification of affected SSCs and facility documentation. Management review of changes considers design, performance, cost and schedule, compliance with safety requirements, operational effectiveness, logistics support, environmental requirements, and training.

15.2.6.3 Implementation of Changes

Proper identification of procedures and organizational interfaces are major elements of configuration management during the change process. To validate that changes meet the acceptance criteria and are compliant with the design requirements, verification of change implementation is a requirement of configuration control.

15.2.7 Document Control

15.2.7.1 Storage of Documents

Approved documents included in the CM program are stored in the MOX Services electronic data management system (EDMS). The EDMS is a tool capable of reporting the status of documents. Records not suitable for storage in this system are stored in conjunction with dual storage provisions and maintained as hard copy.

15.2.7.2 Identification of Documents

Capabilities to track and retrieve current documents included in the CM program, historical records, and other information by multiple attributes (e.g., document number, document subject, component number, component name, status, etc.) are accomplished in accordance with approved procedures.

To ensure uniformity in the MOX Services CM program, the MFFF document control function has the following responsibilities as they relate to configuration management:

- Receipt, electronic filing, and controlled release of approved documents
- Development of reports to identify approved documents, including those documents released for construction, procurement, or fabrication
- Documents supplied by other, external sources (e.g., vendor or supplier documentation, design input documents) are identified and included in the CM program

15.2.8 Audits and Assessments

Audits and assessments are used to help define facility configuration management needs and to measure the implementation of the basic relationships between design requirements, physical configuration, and the operational configuration information. Compliance with CM requirements is then verified through QA audits and assessments as described in the MPQAP Section 18, *Audits*.

15.3 MAINTENANCE

MOX Services implements a Maintenance Program that includes provisions for planned, scheduled, and unplanned maintenance to ensure MFFF equipment will be available and reliable to perform their designed functions in accordance with the integrated safety analysis (ISA).

The Maintenance Program uses a graded approach to maintenance of MFFF equipment where the level of maintenance applied is commensurate with the importance of the equipment and functions. The two categories of MFFF equipment are IROFS and non-IROFS.

Maintenance for IROFS is developed and conducted to maximize availability and reliability for assurance that the designed safety functions and ISA requirements will be achieved, when needed. This maintenance is performed under strict procedural controls and the resultant records are maintained as proof of compliance to safety requirements.

Non-IROFS equipment will be maintained commensurate with designed functions. In general, non-IROFS maintenance will be performed to standard industrial practices.

The following sections describe the primary elements of the MFFF maintenance program.

The maintenance function is responsible for implementing the maintenance program, working closely with operations. Maintenance is developed using information from such sources as equipment suppliers, reference plants and, lessons learned from other appropriate facilities. A work management group is assigned to plan, schedule, coordinate, track work activities through completion, and maintain the associated records for analysis and trending of equipment performance and conditions. This information is assessed for indicators of areas for adjustments and improvements to methods and frequencies. Should an incident investigation be initiated in accordance with the MFFF Incident Investigation Program, recommendations and corrective actions identified are assessed by the work management group and applied to the respective portions of the Maintenance Program.

Procedures used to perform maintenance use the applicable requirements of the design and safety analysis documents and meet the requirements of MPQAP Section 5, *Instructions, Procedures, and Drawings*. Where applicable, grading of QA controls is performed in accordance with requirements of MPQAP Section 2.1.2, *Graded Quality Assurance*. Spare and replacement parts are procured, received, accepted, stored, and issued according to the requirements of MPQAP Section 4, *Procurement Document Control*, Section 7, *Control of Purchased Material Equipment, and Services*, Section 8, *Identification and Control of Materials, Parts, and*

Components, and Section 13, *Handling, Storage, and Shipping*. Required special processes are performed to meet the requirements of

MPQAP Section 9, *Control of Special Processes*. Equipment used to measure and record maintenance and inspection parameters is calibrated in accordance with the requirements of MPQAP Section 12, *Control of Measuring and Test Equipment*. Nondestructive examination, inspection, and test personnel are qualified and certified in accordance with MPQAP Section 2.2.6, *Personnel Indoctrination, Training, and Qualification*. Inspections are performed to meet the requirements of MPQAP Section 10, *Inspection*, and testing required after maintenance conforms to the requirements of MPQAP Section 11, *Test Control*. Maintenance activities meet the requirements of MPQAP Section 14, *Inspection, Test, and Operating Status*. Completed records of maintenance are maintained in the records management system, which meets the requirements of MPQAP Section 17, *Quality Assurance Records*.

15.3.1 Maintenance Categories

Maintenance activities generally fall into the following categories:

- Surveillance
- Preventive maintenance
- Corrective maintenance
- Functional tests.

These maintenance categories are discussed in the following sections.

15.3.1.1 Surveillance

Surveillances are planned and scheduled systematic procedures conducted at required intervals to monitor the performance of IROFS equipment for assurances they continue to meet their performance specifications, including availability and reliability goals. Surveillances may consist of measurements, inspections, functional tests, and calibration checks. The results of surveillances are monitored, and when degradation appears, appropriate corrective action is taken, which may include adjustments to the surveillance or preventive maintenance methods and frequencies.

Surveillance procedures prescribe compensatory measures, when required, that are applied during the performance of the surveillance activities.

15.3.1.2 Preventive Maintenance

Preventive maintenance activities are preplanned and scheduled for performance with approved procedures at specified time intervals. Preventive maintenance may include refurbishment, partial or complete overhaul, inspections, and instrument calibrations to ensure the equipment's designed functions, which include availability and reliability goals, will respond as designed. Post maintenance functional tests are performed, as necessary, to confirm equipment functions have been restored to normal conditions.

15.3.1.3 Corrective Maintenance

Corrective maintenance is performed to repair or replace equipment that has unexpectedly degraded below performance requirements or failed. Due to the variety of degraded performance and failures possible, specific procedures may not exist for all possibilities. For this reason, the degraded condition or failure mechanism is evaluated to prescribe the appropriate maintenance procedures necessary to correct the problem, including compensatory measures that may apply during the performance of this maintenance. This maintenance then restores the faulted equipment to the required conditions necessary to perform the designed functions. Restored functions are confirmed with appropriate post maintenance functional tests. Corrective maintenance activities are performed with approved procedures in accordance with the QA program.

15.3.1.4 Functional Tests

In general, functional tests of equipment and controls are performed based on the extent of the maintenance activity to ensure that the disturbed functions have been properly restored to their design and safety basis. Functional tests may be used as a surveillance technique, and are applicable to the corrective and preventive maintenance functions. Functional tests are conducted using approved procedures.

15.3.2 Work Control

Maintenance work, as described above, is performed through a coordinated and structured work control process that integrates with ongoing production activities and requirements and is managed by the Maintenance Work Management Group. The purpose of this structure is to minimize challenges to safety requirements, minimize challenges to production requirements, and maximize work efficiency. This work control process includes representation from functions, such as radiation protection, safety, operations and others, as necessary, for complete pre-planning of the required work. Work support functions coordinated include such items as work requests, procedures, schedules, radiation work permits, and lockout/tagout requirements.

Should modifications be identified to plant structures, systems, or components, the change will be prepared in accordance with the Configuration Management process. A modification package will be prepared that will contain the description and rationale for the change and the applicable instructions for implementation. Implementation of the modification is done through the work control process for consistency in implementing work activities in the MFFF.

15.3.3 Relationship of Maintenance Elements to Other Management Measures

The maintenance elements, as described above, interface with other management measures, for example:

- Configuration Management, for obtaining the current approved and controlled documents necessary to support the maintenance activity, such as drawings, specifications, and procedures

- Training and Qualification to ensure maintenance personnel are trained to perform their assigned tasks
- Plant Procedures for the applicable operating and maintenance procedures pertinent to support the maintenance activity

15.4 TRAINING AND QUALIFICATION

Training and qualification of plant personnel is essential to the safe and successful design, construction, testing, and operation of the MFFF. Training of plant personnel is commensurate with the complexity of assigned tasks. Personnel are trained in the specific project and plant procedures identified by their supervisors as being needed for their assigned tasks. Training and retraining (e.g., to maintain proficiency or when changes to work methods, technology, or job responsibilities occur) meet the requirements of MPQAP paragraph 2.2.6, *Personnel Indoctrination, Training, and Qualification.* Training records are maintained in the records management system in accordance with the requirements of MPQAP Section 17, *Quality Assurance Records.*

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 function provides support to line managers by facilitating the planning, direction, development, conduct, evaluation, and control 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.

Lesson plans are used for classroom and on-the-job training as required to assure consistent presentation of 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.

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 or Qualification

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

The training function consults with relevant subject matter 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 assessment 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

the MFFF reference facilities of MELOX and La Hague, and other United States fuel cycle facilities. Entry-level criteria (e.g., education, technical background, experience, and/or physical fitness requirements) for these positions are contained in position descriptions. Exceptions from training requirements may be granted when justified and documented in accordance with the approved MFFF procedure.

15.4.4 Basis for and Objectives of Training

Learning objectives identify the training content 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 learning objectives, which are based on job performance requirements. Lesson plans and other training guides are developed under guidance by the training function. Lesson plans are reviewed by the training function and, generally, by the organization responsible for the subject matter. Lesson plans are approved prior to issue or use.

15.4.6 Evaluation of Trainee Learning

Trainee mastery of learning objectives is evaluated through observation/demonstration, or oral or written tests. 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 selected activities when appropriate. On-the-job training is conducted by personnel who are competent in the technical aspects of the job being performed. Completion of on-the-job training is demonstrated by task performance, where feasible and appropriate. When the actual task cannot be performed in the work environment (e.g., conflicting plant operations), a simulation of the task is conducted, with the trainee explaining task actions in consideration of the conditions that would be encountered during actual performance of the task. This simulation ("walk-through") would use references, tools, and equipment appropriate for 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 periodically and systematically evaluated to measure the program's effectiveness in producing competent employees. Trainees provide feedback after completing their classroom training as their evaluation for program improvements. These evaluations identify program strengths and weaknesses, determine if 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 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 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 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. Qualification requirements for key management positions are given in Chapter 4.

15.4.10 Provisions for Continuing Assurance

Personnel performing activities relied on for safety are evaluated at least every two years to verify that 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.

15.5 PLANT PROCEDURES

This section describes the procedures used for control of overall facility operations, including IROFS. Activities involving special nuclear material (SNM) will be conducted in accordance with approved procedures. Management policies require strict adherence to procedures when performing work. In the event that a procedure cannot be executed as written, personnel are required to notify their supervisor. Stop-work authority within MOX Services is vested in each

MOX Services employee, with respect to work within their scope of responsibility, whenever the health and safety of workers, the public, or the environment is involved, or when continued work will produce results that are not in compliance with the MOX Services QA Program.

Plant procedures are developed and controlled under the requirements of the MPQAP. Specifically, the associated activities are implemented by personnel who are trained in accordance with the requirements of MPQAP Section 2, *Quality Assurance Program.* Plant maintenance, testing, and operating procedures meet the requirements of MPQAP Section 5, *Instructions, Procedures, and Drawings.* Plant procedures are distributed and otherwise controlled in accordance with the requirements of MPQAP Section 6, *Document Control.* When completed, procedure results (e.g., sign-offs, checklists, data sheets) are maintained in the records management system in accordance with the requirements of MPQAP Section 17, *Quality Assurance Records.*

15.5.1 Types of Procedures

Plant procedures are broadly categorized as either administrative procedures or operating procedures. Administrative procedures apply to functions or specific interfaces with other organizational functions. Operating procedures provide specific direction for functional task-based work. Operating procedures can apply MOX Services-wide or to a specific organization.

15.5.1.1 Administrative Procedures

Administrative procedures specify controls that apply to specific functions or specific interfaces with other organizational functions. They address administration and conduct of process activities in the following areas:

- Training and qualification
- Reporting
- Quality Assurance
- Equipment control (lockout/tagout)
- Shift turnover
- Work control
- Procedure management
- Nuclear criticality safety
- Fire safety
- Radiation protection
- Radioactive waste management
- Environmental protection
- Chemical process safety
- Calibration control

15.5.1.2 Operating Procedures

Operating procedures provide specific direction for functional task-based work within an organizational function. Operating procedures include production, maintenance, and emergency

procedures. The results of the ISA are used to identify specific IROFS Administrative Controls that are developed.

Operating procedures include operating limits and controls, and specific IROFS Administrative Controls to ensure: nuclear criticality safety, chemical safety, fire protection, emergency planning, and environmental protection. If needed, safety checkpoints (e.g., hold points for radiological or criticality safety checks, QA verifications, independent operator verification) are identified at appropriate steps.

Operating procedures, with different types of documents, are organized to a consistent architecture, which include:

- Overall Operating Rules – General rules for production, maintenance, operational safety, security, emergency planning, and environmental protection
- Unit Operating Instructions or Maintenance Instructions – Provide instructions for operating and maintaining process units, systems, and/or equipment

The scope of these procedures is as follows:

- Production procedures – startup, operation, shutdown, off-normal, alarm response, control of process and laboratory operations, and recovery after a process upset condition
- Maintenance procedures – preventive and corrective maintenance, calibration, surveillance, functional testing, and work control
- Emergency procedures – response to a criticality event, a hazardous chemical release, or an emergency external to the MFFF that may affect the MFFF

15.5.1.2.1 Production Procedures

Production procedures control process operations and apply to utility, workstation, and control room operations identified in the MFFF ISA as IROFS.

Production procedures contain the following elements, as applicable:

- Purpose of the activity
- Policies and guidelines governing the procedure
- Type of procedure
- Steps for each operating process phase
- Normal operations
- Off-normal operations
- Temporary operations
- Emergency shutdown
- Emergency operations
- Normal shutdown
- Startup following an emergency or extended downtime
- Hazards and safety considerations

- Operating limits
- Precautions necessary to prevent exposure to hazardous chemicals or SNM
- Measures to be taken if contact or exposure occurs
- Safety controls and their functions that are associated with the process
- Specified time period or other limitations on the validity of the procedure

15.5.1.2.2 Maintenance Procedures

Where appropriate, maintenance procedures include requirements for pre-maintenance activities involving reviews of the work to be performed, work controls, and reviews of procedures. Maintenance work requires clearance from the operations function to begin work, as well as notification when the work and associated post-maintenance functional testing are complete. Maintenance activities will be monitored/assessed in accordance with the MPQAP.

15.5.1.2.3 Emergency Procedures

Emergency procedures address the preplanned actions of operators and other plant personnel in response to an incident, criticality event, hazardous chemical release, or external emergency that may affect MFFF.

15.5.2 Preparation of Procedures

MFFF procedures are prepared using a consistent format, and are clear, concise and comprehensive in addressing the procedure subject. MFFF procedures are well organized, and may include (approved) checklists or data sheets as documented records of completion.

15.5.2.1 Identification and Preparation

The results of the ISA and other processes are used to identify specific operating and administrative procedures that are developed. Plant procedures are prepared by qualified individuals assigned by functional management responsible and accountable for the associated operation.

15.5.2.2 Review/Approval

Operating and administrative procedures are reviewed and approved by management responsible and accountable for the associated operation. The functional management may specify a review to be performed by another functional group. Prior to initial use or after major revisions, production and maintenance procedures are verified and validated.

15.5.2.3 Revisions

Procedure revisions, including temporary changes, are prepared and approved in the same manner as the original. The procedure change process shall be defined in a MFFF procedure.

15.5.3 Use of Procedures

Compliance with operating and maintenance procedures is required, and operators and technicians are trained to report inadequate procedures or the inability to follow procedures. Dependent on the nature of the procedure and work location, procedures are either available at work stations, or are readily accessible where needed to perform work.

15.5.4 Control of Procedures

Following approval, plant procedures are processed for entry into the EDMS and issued for use. The MFFF training program, addressed in Section 15.4, ensures that necessary personnel are trained in the use of approved procedures before implementation.

Change control for operating and administrative procedures is the same as for other items in the document management system. Document management procedures ensure that changes to the facility, including procedures, are entered into the EDMS and address control and distribution of changes (including those for emergency conditions, temporary procedure changes, temporary modifications, etc.). The MPQAP provides requirements for QA procedures, which detail the controls for design input, processes, verification, changes, and approval.

To ensure technical accuracy, radiation protection procedures, respiratory protection procedures, operating and maintenance procedures are reviewed every five years to verify their continued applicability and accuracy. Additionally, all respiratory protection procedures are reviewed whenever the MFFF undergoes a modification, change in process or replacement of equipment. Emergency procedures are reviewed annually for the first two years of MFFF operation and at least every two years thereafter. These periodic reviews are performed by qualified individuals assigned by the functional management responsible and accountable for the associated operation. Reissue/approval of a procedure meets the requirements for procedure periodic review. Additionally, if procedural inadequacy is identified as a root cause from an incident investigation, applicable procedures are reviewed and modified, as necessary.

15.6 AUDITS AND ASSESSMENTS

MOX Services maintains the program for audits and assessments described in the MPQAP, Section 18, *Audits*.

15.7 INCIDENT INVESTIGATIONS

MOX Services implements two programs for investigating discrepancies: the Corrective Action Process and Incident Investigations. This section describes these programs.

15.7.1 Corrective Action Process

The MFFF Corrective Action Process is used for identifying, investigating, reporting, tracking, correcting, and preventing recurrence of conditions adverse to quality. It is performed in accordance with MPQAP Section 16, *Corrective Action*. Nonconforming materials, parts, or components are identified and controlled in accordance with MPQAP Section 15, *Nonconforming Materials, Parts, or Components*.

15.7.2 Incident Investigations

Incident investigations are used for investigating abnormal events, other than those that involve conditions adverse to quality identified in Section 15.7.1. Incident investigations are less formal than the Corrective Action Process. Identification of the need for an incident investigation may come from anyone in the MFFF organization. An incident investigation is performed by one or more individuals assigned by the manager of production. The process used for the investigation may be similar to that of the Corrective Action Process. Upon completion, a report on the incident and its investigation is made to the production manager, who initiates appropriate action(s), if determined necessary.

15.8 RECORDS MANAGEMENT

MFFF records are managed in accordance with the records management program described in MPQAP Section 17, *Quality Assurance Records.*