84. Section 6.3.4, pp. 6-18 thru 6-30

Describe the design philosophy for excluding concentrated plutonium solution from these units.

Three CCUs–the Solvent Recovery Unit, Acid Recovery Unit, and Silver Recovery Unit–are expected to have low concentrations of plutonium under normal conditions. However, the process description refers to concentration mechanisms (*i.e.*, evaporators) that could result in a higher plutonium concentration. Knowledge of the design philosophy is necessary to ensure that the process remains subcritical under both normal and credible abnormal conditions in accordance with 10 CFR 70.61(d).

Response:

The design philosophy for the Solvent Recovery Unit, Acid Recovery Unit, and Silver Recovery Unit is that the concentration will be demonstrated to be low under all normal and off-normal conditions in accordance with the double contingency principle. In-line monitors and/or sampling measurements will be employed to ensure that concentration limits established in NCS calculations are not exceeded and that the double contingency principle is implemented prior to material transfer into these units.

Action:

None

85. Section 6.3.4, pp. 6-18 thru 6-30

Describe at what point in the aqueous polishing process low concentrated waste will be transferred from favorable to unfavorable geometry, and describe the design philosophy for preventing its occurrence. (Section 11.3.2.13 describes a sampling system, but it is not clear whether this is credited for preventing this type of hazard or how it is used.)

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.2.B recommends that no single credible event or failure should result in a criticality that necessitates consideration of all credible failure mechanisms. At some point in the Aqueous Polishing Process, low concentrated waste will have to be transferred from favorable to unfavorable geometry. One of the most significant criticality hazards is the potential for transfer of concentrated plutonium solution to unfavorable geometry. Knowledge of the design philosophy is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

The MFFF is designed to recycle fissile material as shown in CAR Figure 10-1.

The solvent recovery unit, the acid recovery unit, the offgas treatment unit, the silver recovery unit, and the liquid waste reception unit do not utilize criticality favorable geometry. Therefore, the design philosophy is that the concentration will be demonstrated to be low prior to introducing material into non-favorable geometric units under all normal and off-normal conditions in accordance with the double contingency principle. It is anticipated that the concentrations will be demonstrated to be very low by independent sampling or a measuring device.

Action:

None

86. <u>Section 6.3.4, 6-18 thru 6-30</u>

For the Aqueous Polishing Process, where concentration control is credited for criticality safety, describe the design philosophy for ensuring that concentration measurements are representative.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.2.7.E recommends that particular attention be given to robustness of concentration controls where concentration is the only means of ensuring subcriticality in an unfavorable geometry. Knowledge of the design philosophy is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

In the AP process, where concentration control is credited for criticality safety, the design philosophy for ensuring that concentration measurements are representative is to take sufficient measurements in accordance with an approved sampling program. The measurement technique will be demonstrated to be representative in the NCSEs.

Action:

None

87. <u>Section 6.3.4.3.1.3, pp. 6-20 and 6-21</u>

Provide the background calculations demonstrating the conclusion that, "the impact of a variation of these parameters on the calculated effective neutron multiplication factor (k_{eff}) is within the uncertainty of the criticality calculation," in Section 6.3.4.3.1.3.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.2.7.D recommends that dual independent sampling be used when sampling is used for concentration control, and that common-mode failures that include non-representativeness of the samples be considered. Assurance that validated calculational methods will be used is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

The final paragraph of CAR Section 6.3.4.3.1.3 will be replaced with the following:

> "These parameters are important to the final product. As a result, the impact of a variation of these parameters on the calculated effective neutron multiplication factor (k_{eff}) will be demonstrated to be conservative based upon the criticality calculations and evaluated by the NCSEs."

Preliminary calculations confirm that credible variations in the pellet characteristics have only a small influence on the maximum possible k_{eff} values, and the bounding conditions are selected in the criticality calculations.

The criticality safety of units that involve pellets will be demonstrated in NCSEs including referenced calculations. The demonstration of safety will be made over the full range of allowable pellet characteristics.

Action:

The next update of the CAR will incorporate the indicated text.

88. Section 6.3.5.2, pp. 6-34 and 6-35

Describe what statistical techniques will be used to benchmark the criticality codes for regions where there is little available experimental data.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.1.B recommends that the applicant demonstrate the adequacy of the subcriticality margin and the areas of applicability of the code. Section 6.3.5.2 states that validation tools exist (as referenced in NUREG/CR-6361 and NUREG/ CR-6655) that are useful for regions where there is little available experimental data, but does not describe what techniques will be used. Assurance that validated calculational methods will be used is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

In cases where there exists a scarcity of experimental data that closely matches design application physical or chemical configurations upon inspection, more detailed comparisons of nuclear characteristics, such as Energy of Average Lethargy causing Fission (EALF), may be necessary to establish applicability. Statistical techniques could include performing...analysis on neutron energy spectra (i.e., experiment vs. design application) to demonstrate similarity in important characteristics. Such methods are based on similar concepts as the Sensitivity and Uncertainty (S/U) methodology under development at Oak Ridge National Laboratories (ORNL; NUREG/CR-6655).

Details of the validation methodology for systems involving limited amounts of experimental data will be included in staged parts of the Criticality Validation Report submitted to NRC prior to submission of the LA and ISA.

Action:

Details of the validation methodology for systems involving limited amounts of experimental data will be included in staged parts of the Criticality Validation Report submitted to NRC prior to submission of the LA and ISA.

89. Section 6.3.5.3, pp. 6-35 and 6-36

Describe the specific sets of benchmark experiments that will be used to validate criticality codes in the different neutron energy ranges, and especially, in the intermediate energy range.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.1.B recommends that the applicant demonstrate the adequacy of the subcriticality margin and the areas of applicability of the code. Section 6.3.5.3 states that "A wide range of experimental benchmark data is also available to help validate neutron cross-sections over thermal, intermediate, and fast neutron energy ranges." Assurance that validated calculational methods will be used is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

Part 1 of the Criticality Validation Report has been submitted recently to NRC (DCS, 2001). Part 1 of the Validation Report addresses homogeneous Pu-Nitrate systems and heterogeneous systems of MOX pellets and rods. Benchmark experiments that will be used to validate criticality codes for the different neutron energy ranges involved with those systems are reported in that submitted report. Subsequent staged parts of the Criticality Validation Report will be submitted to NRC prior to submission of the LA and ISA.

It is anticipated that the Areas of Applicability (AOA) for PuO_2 and MOX powder handling design applications will involve intermediate neutron energy range conditions. Benchmark experiments that will be used to validate criticality codes in the intermediate energy range for these design applications have been preliminarily identified. PuO_2/Polystyrene Slab experiments that are likely to be useful in validation work for the PuO_2 powder systems are documented in the OECD International Handbook of Evaluated Criticality Safety Benchmark Experiments as cases PU-COMP-MIXED-001, and PU-COMP-MIXED –002. Similar polystyrene slab experiments incorporating MOX fissile material were also performed and have been published in ORNL/TM-13603/V2, *Neutronics Benchmarks for the Utilization of Mixed-Oxide Fuel: Joint U.S./Russian Progress Report for Fiscal Year 1997*, and are expected to be documented in a future edition of the OECD International Handbook under the identifier MIX-COMP-INTER-001.

References:

Duke Cogema Stone & Webster, 2001. Letter from P. Hastings to NRC. DCS-NRC-000052, 25 June 2001.

Action:

None

90. Section 6.4, pp. 6-37 thru 6-39

Clarify exactly what ANSI standards and provisions of those standards are included in the commitments in the Application.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.2 lists several ANSI standards that have been endorsed by the NRC for criticality safety. The applicant refers to Regulatory Guide 3.71, but does not describe what ANSI standards and what provisions of those standards are being committed to (including "should" vs. "shall" statements). This information constitutes part of the design bases of the facility.

Response:

The bulleted list of Subcommittee ANS-8 (Fissionable Materials Outside Reactors) standards provided in Section 6.4 and the 1st paragraph on page 6-39 of the CAR will be replaced with the following text:

ANSI/ANS-8.1-1983 (R1998), Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors

This standard is referenced as a basis for the design of MFFF processes and fissile material handling and storage areas. The standard provides general guidance addressing administrative and technical practices, as well as single-parameter and multi-parameter control limits for systems containing ^{233}U, ^{235}U, and ^{239}Pu. Of particular significance to the MFFF design, ANSI/ANS-8.1-1983 (R1998) provides requirements for performing NCS analysis methodology validation. Although the administrative and technical practices are well supplemented by other Subcommittee ANS-8 standards, ANSI/ANS-8.1 NCS practices will be referenced to support of MFFF design and operational approach. Also, MFFF processes and storage areas that contain plutonium, uranium, or plutonium-uranium fuel mixtures will typically be explicitly evaluated using validated NCS analysis methodology in accordance with ANSI/ANS-8.1 technical practice requirements. However, criticality safety may be demonstrated by reference to ANSI/ANS-8.1 single-parameter and multi-parameter control limits in lieu of analysis.

MFFF operations will comply with the requirements and implement the recommendations of ANSI/ANS-8.1-1983 (R1998). Clarifications are noted as follows:

- Section 4.2.2: MFFF process, material handling, or storage area designs will incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible. For the purposes of demonstrating compliance with this requirement, "unlikely" is defined as events or event sequences that are not expected to occur during the facility lifetime, but are considered credible. This commitment is considered applicable to process, material handling, or storage area designs where a criticality accident has been determined to be credible.

- Section 4.2.3: MFFF process design will rely on engineered features where practicable rather than administrative controls. Justifications for use of administrative controls will be provided.

- Section 4.3.2: In cases where a large extension in the area(s) of applicability of a NCS analysis methodology is required, the method will be supplemented by other calculation methods to provide a better estimate of bias in the extended area(s). As an alternative, the extension in the area(s) of applicability may be addressed through an increased margin of subcriticality.

Note that Regulatory Guide 3.71 endorses the 1983 version of this standard. The MFFF will reference guidance provided in the most recent Subcommittee ANS-8 working group approved version ANSI/ANS-8.1-1983 (R1998).

ANSI/ANS-8.3-1997, Criticality Accident Alarm System

This standard is referenced as a basis for the design of MFFF process and fissile material handling and storage areas. The standard provides general guidance for the design, testing and maintenance of criticality accident alarm systems at facilities where a criticality accident may lead to excessive exposure to radiation. The scope of guidance provided in ANSI/ANS-8.3-1997 is applicable to both MFFF design and operations.

MFFF operations will comply with the requirements and implement the recommendations of ANSI/ANS-8.3-1997. Clarifications are noted as follows:

- Section 4.1.3: Overall risk to personnel resulting from hazards that may result from false alarms and subsequent sudden interruption of operations and relocation of personnel will be evaluated.

- Section 5.3: The system will be designed to remain operational in the event of seismic shock equivalent to the site-specific design basis earthquake. (This requirement applies to mounting and power supply, but should not be interpreted to require seismic testing of system components.)

ANSI/ANS-8.7-1975, Guide for Nuclear Criticality Safety in the Storage of Fissile Materials

This standard may be referenced as a basis for the design of MFFF fissile material storage areas. Although MFFF storage areas that contain plutonium, uranium, or plutonium-uranium fuel mixtures will typically be explicitly evaluated using validated NCS analysis methodology in accordance with ANSI/ANS-8.1-1983, criticality safety may be demonstrated by reference to ANSI/ANS-8.7-1975 in lieu of analysis.

MFFF operations will comply with the requirements and implement the recommendations of ANSI/ANS-8.7-1975. Clarifications are noted as follows:

- Section 4.2.4: The design of storage structures will preclude unacceptable arrangements or configurations without reliance on administrative controls to extent practicable. Any reliance on administrative controls will be justified.

- Section 4.2.6: The design of MFFF fissile material storage areas will be reviewed and administrative controls limiting the introduction of combustible materials during operation applied to ensure an acceptable combustible loading is maintained. Fire protection provisions (i.e., whether or not fire suppression provided and type) in areas where fissile material is processed, handled or stored will be justified.

Note that Regulatory Guide 3.71 endorses the 1975 version of this standard. The MFFF may also reference guidance provided in the most recent Subcommittee ANS-8 working group approved version (i.e., ANSI/ANS-8.7-1998).

ANSI/ANS-8.9-1987, Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials

This standard has been officially withdrawn by the ANS-8 working group, but continues to be available for reference. This standard will not be referenced as a basis for design for the MFFF. Intersections of process components and piping containing aqueous solutions of fissile materials will be explicitly evaluated using validated NCS analysis methodology in accordance with ANSI/ANS-8.1-1983.

ANSI/ANS-8.10-1983, Criteria for Nuclear Criticality Safety Controls in Operations with Shielding and Confinement

MFFF Nuclear Criticality Safety Evaluations (NCSEs) performed for each process unit or area will demonstrate compliance with the double contingency principle consistent with guidance provided in Section 4.2.2 of ANSI/ANS-8.1-1998. Therefore, the requirements and recommendations provided in ANSI/ANS-8.10-1983 are not generally applicable to the MFFF. However, guidance provided for crediting shielding and confinement may be used when demonstrating compliance with worker safety performance criteria specified in 10 CFR §70.61(b). Therefore, this standard may be referenced as a basis for design for the MFFF.

ANSI/ANS-8.12-1987, Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors

This standard may be reaffirmed or withdrawn in future action by the ANS-8 working group (reference ANS-8 meeting minutes, Albuquerque, NM, March 30, 2000). This standard may be referenced as a basis for MFFF process design. Although MFFF processes that contain plutonium-uranium fuel mixtures will typically be explicitly evaluated using validated NCS analysis methodology in accordance with ANSI/ANS-8.1-1983, criticality safety may be demonstrated by reference to ANSI/ANS-8.12-1987 in lieu of analysis.

ANSI/ANS-8.15-1981, Nuclear Criticality Control of Special Actinide Elements

This standard is applicable to operations with isolated units containing special actinide nuclides other than ^{233}U, ^{235}U, and ^{239}Pu. Criticality safety data is presented for the following special actinide nuclides:

^{237}Np, ^{238}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{242}Am, ^{243}Am,

^{243}Cm, ^{244}Cm, ^{245}Cm, ^{247}Cm, ^{249}Cf, and ^{251}Cf.

Although MFFF processes will contain special actinide nuclides, they will always be present in relatively low concentrations in mixtures with ^{235}U, and ^{239}Pu. Therefore, this standard will not be referenced as a basis for design for the MFFF. Nuclear criticality control of special actinide nuclides will be explicitly evaluated using validated NCS analysis methodology in accordance with ANSI/ANS-8.1-1983, or criticality safety may be demonstrated by reference to the single-parameter limits or multiparameter control specified in Sections 5 and 6 of ANSI/ANS-8.1-1983.

ANSI/ANS-8.17-1984, Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors

This standard is referenced as a basis for the design of MFFF fissile material handling and storage areas. The standard provides guidance addressing general safety criteria and criteria for establishing subcriticality for handling, storage, and transportation of LWR fuel rods outside reactor cores. Of particular significance to the MFFF design, ANSI/ANS-8.17-1984 provides general requirements for combining the various bias, uncertainty, and administrative safety margin terms that must be considered when performing criticality calculations in order to establish a final k_{eff} acceptance criteria. Examples of normal and credible abnormal conditions that must be considered when performing NCSEs are also provided in an appendix to the standard.

MFFF operations will comply with the requirements and implement the recommendations of ANSI/ANS-8.17-1984. Clarifications are noted as follows:

- Section 4.11: Fuel units and rods will be handled, stored, and transported in a manner that provides a sufficient factor of safety to require at least two unlikely, independent, and concurrent changes in conditions before a criticality accident is possible. This commitment is considered applicable to process, material handling, or storage area designs where a criticality accident has been determined to be credible.

- Section 5.1: The criticality experiments used a benchmarks in computing k_c will have physical compositions, configurations, and nuclear characteristics (including reflectors) similar to those of the system being evaluated. In cases where similar experiments are not available or are not similar in criticality safety significant respects to the design application, alternative analyses will be presented. Alternative analyses will further demonstrate similarity or, in cases where a large extension in the area(s) of applicability of a NCS analysis methodology is required, the method will be supplemented by other calculation methods to provide a better estimate of bias in the extended area(s). As an alternative, the extension in the area(s) of applicability may be addressed through an increased margin of subcriticality.

ANSI/ANS-8.19-1996, Administrative Practices for Nuclear Criticality Safety

This standard is referenced as a basis for the design of MFFF processes and fissile material handling and storage areas. This standard provides criteria for the administration of a nuclear criticality safety program for operations outside reactors in which there exists a potential for criticality accidents.

MFFF operations will comply with the requirements and implement the recommendations of ANSI/ANS-8.19-1996. An exception is noted as follows:

- Section 10: Requirements for planned response to nuclear criticality accidents are addressed by ANSI/ANS-8.23-1997. Therefore, no commitments are made to satisfy the requirements or recommendations of this section.

ANSI/ANS-8.20-1991, Nuclear Criticality Safety Training

This standard is referenced as a basis for MFFF operational practices. The standard provides detailed guidance for NCS training for personnel associated with operations outside reactors where a potential exists for criticality accidents.

MFFF operations will comply with the requirements and implement the recommendations of ANSI/ANS-8.20-1991. No exceptions or clarifications are noted.

ANSI/ANS-8.21-1995, Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors

This standard is referenced as a basis for the design of MFFF processes and fissile material handling and storage areas. The standard provides detailed guidance for use of fixed neutron absorbers used for criticality control.

The MFFF will comply with the requirements of this standard to assure fixed neutron absorber material integrity and reliability to perform NCS functions. The guidance includes no recommendations that require further clarification and no exceptions are taken.

ANSI/ANS-8.22-1997, Nuclear Criticality Safety Based on Limiting and Controlling Moderators

This standard is referenced as a basis for the design of MFFF processes and fissile material handling and storage areas. The standard provides detailed guidance for limiting and controlling moderators to achieve criticality control (i.e., process units or areas where "Yes" is indicated in Tables 6.1 or 6.2 under the moderation control column).

MFFF operations will comply with the requirements and implement the recommendations of ANSI/ANS-8.22-1997. Clarifications are noted as follows:

- Section 4.1.7: The design of MFFF fissile material storage areas will be reviewed and administrative controls limiting the introduction of combustible materials during operation applied to ensure an acceptable combustible loading is maintained. Fire protection provisions (i.e., whether or not fire suppression provided and type) provided in areas where fissile material is processed, handled or stored will be justified.

- Section 5.4.1: Where fire suppression is determined to be justified in moderator control areas, the use of non-moderating fire suppressant media will be considered.

ANSI/ANS-8.23-1997, Nuclear Criticality Accident Emergency Planning and Response.

This standard is referenced as a basis for the design of MFFF processes and fissile material handling and storage areas. The standard provides guidance for minimizing risks to personnel during emergency response to a nuclear criticality accident outside reactors.

MFFF operations will comply with the requirements and implement the recommendations of ANSI/ANS-8.23-1997. No exceptions are taken.

Action:

The next update of CAR Chapter 6 will reflect the above discussion.

91. Section 6.4, pp. 6-37 thru 6-39

Define the term "administrative margin" as used in this section, and provide the basis for this margin.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.1.B recommends that the applicant demonstrate the adequacy of the subcriticality margin and the areas of applicability of the code. Section 6.4 describes an administrative k_{eff} margin of 0.05 for MFFF design applications, but does not provide a definition of this margin (such as whether the margin includes the bias or is applied in addition to the bias) or a technical justification. This information constitutes part of the design bases of the facility.

Response:

The term "administrative margin" refers to an additional safety margin applied to nuclear criticality safety limits to ensure that a system or process remains subcritical under normal and credible accident conditions over and above bias and uncertainty, consistent with NUREG 1718. For example, the *Mixed Oxide Fuel Fabrication Facility Criticality Code Validation – Part I* report, submitted to the NRC in June 2001, documents the validation of the SCALE 4.4 code package for two of the facility's five design applications: (1) Pu-nitrate solutions, and (2) MOX pellets, fuel rods, and fuel assemblies. The report calculates an upper safety limit (USL) to be used for criticality analyses. The USL accounts for the computational bias, uncertainties, and a 0.05 administrative margin. Historically, a 0.05 margin has commonly been applied by the nuclear criticality safety community. NUREG-1718, *Standard Review Plan of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility* (NRC 2000), recommends an administrative margin of $\Delta k_m = 0.05$ based on an adequate number of representative benchmark experiments covering the range of applicability of design conditions. The USLs for the first two design applications are calculated using 182 and 36 critical benchmarks, respectively. Both sets of experiments are adequate to cover the range of the design application. In addition, the USL is calculated using two separate statistical methods. The purpose of applying two statistical methods is to use the two methods in tandem to verify that the administrative margin used in the first method is adequate. The validation report shows that the 0.05 administrative margin is justified.

The last paragraph of Section 6.4, pp 6-39 will be modified to read as follows:

Specific guidance regarding the establishment of method bias, the proper accounting for analytical uncertainties, and the determination of subcritical limits in criticality safety analyses provided in ANSI/ANS-8.17-1984 will be followed. A design application (system) is *considered subcritical when the calculated multiplication factor for the design application (system) is shown to be less than or equal to an established upper safety limit (USL) that properly accounts for computational method bias and uncertainty and administrative margin. An administrative safety margin of 0.05 plus computational bias will be used for MFFF design applications. Justification for use of this value is provided in the Mixed Oxide Fuel Fabrication Facility Criticality Code Validation – Part I report for two of the facility's design applications. Justifications for the remaining design applications will be provided in other reports by the time of the license application.*

Action:

The above identified text revision will be incorporated in the last paragraph of Section 6.4 in the next update of the CAR.

92. Section 6.4, pp. 6-37 thru 6-39

Explain the statement, "To the extent practical, process designs will incorporate sufficient features such that they can be demonstrated to be subcritical under both normal and credible accident conditions."

10 CFR 70.61(d) requires that processes remain subcritical under both normal and credible abnormal conditions and is not optional. This information constitutes part of the design bases of the facility.

Response:

In all cases in the MFFF, process designs will incorporate sufficient features such that they can be demonstrated to be subcritical under both normal and credible accident conditions.

Action:

Delete the phrase, "*To the extent practical*" on CAR page 6-39 in the next update of the CAR.

93. Section 6.4, pp. 6-37 thru 6-39

On page 6-37 of the application, specify how any modifications to the design bases requirements applicable to the design and operation of criticality safety SSCs will be accomplished.

10 CFR 70.61(d) requires that processes remain subcritical under both normal and credible abnormal conditions. The NRC is reviewing the submitted design bases as is. Any change after the fact may affect reviewed design bases. This information is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

Section 15.2.1, Configuration Management Policy, states that "Configuration management is provided for principal SSCs throughout MFFF design, construction, testing, operation, and deactivation. Configuration management provides the means to establish and maintain a technical baseline for the MFFF based on clearly defined requirements. ...Design changes to principal SSCs undergo formal review, including interdisciplinary reviews as appropriate, in accordance with these procedures" (i.e., QA procedures).

The last sentence of the first paragraph of Section 6.4, pp 6-37 will be replaced as follows:

> *These requirements may be modified during the final design phase in accordance with the configuration management system, described in Section 15.2.*

Action:

The above referenced text will be incorporated in the next update of the CAR.

94. <u>Section 6.4, pp. 6-37 thru 6-39</u>

Page 6-38, first paragraph, identify the approved margin of subcriticality that will be used to design nuclear processes.

10 CFR 70.61(d) requires that the applicant demonstrate subcriticality including the use of an approved margin of subcriticality. Since this facility has not been built yet, identifying the margin of subcriticality prior to construction allows for adequate implementation of the hierarchy of controls to rely more heavily on physical rather than administrative controls. This information is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

The last paragraph of Section 6.4, pp 6-39, states that "An administrative safety margin of 0.05 will be used for MFFF design applications." Consistent with NUREG 1718, this is in addition to the computational bias and uncertainty. The justification of a 0.05 administrative safety margin is provided in the *Mixed Oxide Fuel Fabrication Facility Criticality Code Validation – Part I* report, submitted to the NRC in June 2001, and discussed in response to Question 91.

The third sentence of the first paragraph on pp 6-38 will be replaced with the following:

> *Under normal and credible abnormal conditions, nuclear processes will be designed to be subcritical, including use of a safety margin, which will account for computational bias, uncertainties, and a 0.05 administrative safety margin.*

Action:

The above referenced text will be incorporated in the next update of the CAR.

95. Section 6.4, pp. 6-37 thru 6-39

Revise the included list of ANSI/ANS standards, and the several references on page 6-39, to provide the correct references.

For example, the reference to ANSI/ANS-8.1-1983 should be corrected to ANSI/ANS-8.1-1983 (R1988).

Response:

The references in the CAR Chapter 6 will be revised to the latest revision of the ANSI/ANS-8.1 standard (R1998).

Action:

The ANSI/ANS-8.1 date of applicability will be corrected in the next update of the CAR.

96. Section 6.4, pp. 6-37 thru 6-39

Update the references in this section to clarify the fact that ANSI/ANS-8.9-1987, "Nuclear Criticality Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials", has been withdrawn.

The use of the currently endorsed versions of the ANSI standards has been found to be generally acceptable to the staff. However, standards that have been withdrawn should not be used without an appropriate justification and consideration of the circumstances under which it was withdrawn.

Response:

The reference to ANS 8.9 will be removed in the CAR Section 6.4. As noted in the response to Question 90, it will not be used.

Action:

Section 6.4 will be updated to reflect the above response in the next update of the CAR.

97. Table 6-1, pp. 6-43 thru 6-48

Provide information on the principal criticality parameters in Table 6-1 for the Offgas Treatment Unit, the Liquid Waste Reception Unit, and the Sampling System.

10 CFR 70.61(d) requires that processes remain subcritical under both normal and credible abnormal conditions. SRP Section 6.4.3.3.2.E recommends that the applicant describe the controlled parameters for each process. Three process units described in Section 11.3 are not described in Table 6-1: the Offgas Treatment Unit, the Liquid Waste Reception Unit, and the Sampling System. Knowledge of the dominant controlled parameters upon which the facility design will be based is necessary to ensure that the design ~~bases will provide~~ reasonable assurance of protection against a criticality accident.

Response:

CAR Tables 6-1 and 6-2 have been revised, as shown in the response to Question 83, to include criticality safety control parameters for these units.

Action:

None

98. <u>Tables 6-1 and 6-2, pp. 6-43 thru 6-58</u>

Revise Tables 6-1 and 6-2 to identify each parameter that is controlled for a given CCU, regardless of whether the control was implemented in an upstream process.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performanee requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for ~~the safety assessment~~ of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61 performance requirements. SRP Section 6.4.3.3.2.E recommends that the applicant describe the controlled parameters for each process. The current convention does not make it clear where the control relied upon is found. This information is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

CAR Tables 6-1 and 6-2 have been revised, as shown in the response to Question 83.

Action:

None

99. Tables 6-1 and 6-2, pp. 6-43 thru 6-58

Revise Tables 6-1 and 6-2 to correspond to the Process Description or otherwise provide a method for cross-referencing these data.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.2.E recommends that the applicant describe the controlled parameters for each process. The names and numbers of CCUs in Tables 6-1 and 6-2 do not correspond well to the list of process units in Chapter 11, making it difficult to cross-reference and reconcile the process description with the list of dominant controlled parameters. Knowledge of the dominant controlled parameters upon which the facility design will be based is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

The following two tables provide a cross-reference between the CCUs in CAR Tables 6-1 and 6-2 (as revised in the response to Question 83) with the appropriate sections in 11.2 and 11.3.

Action:

None

Cross-reference from Table 6-1 to Chapter 11.

Criticality Control Unit	Section in Chapter 11
Decanning Unit	
PuO_2 dosing hopper	11.3.2.1
Dissolution Unit	
Electrolyzer	11.3.2.2
Reception tank	11.3.2.2
PuO_2 filter	11.3.2.2
Dilution and sampling tank	11.3.2.2
Buffer Tank	11.3.2.2
Purification Unit	
Feeding Tank	11.3.2.3
Purification pulsed columns: Extraction Scrubbing Pu stripping	11.3.2.3
Diluent washing pulsed columns	11.3.2.3
Pu barrier mixer settlers	11.3.2.3
U stripping + diluent washing mixer settlers	11.3.2.3
Oxidation columns	11.3.2.3
Pu Rework Tank	11.3.2.3
Rafinates Reception, and Recycling, Control Tanks	11.3.2.3
Oxalic Precipitation and Oxidation Unit	
Reception tank	11.3.2.5
Preparation tank	11.3.2.5
Precipitators	11.3.2.5
Flat filter	11.3.2.5
Calcination furnace	11.3.2.5
Homogenization Unit	
Homogenizing hoppers	11.3.2.6
Canning Unit	
Canning feeding head	11.3.2.7
Oxalic Mother Liquor Recovery Unit	
Oxalic mother liquors recovery	11.3.2.8
Solvent Recovery Unit	
Solvent recovery mixer settlers	11.3.2.4
Acid Recovery Unit	
Acid recovery	11.3.2.9
Silver Recovery Unit	
Silver recovery	11.3.2.10

Cross-reference from Table 6-2 to Chapter 11

Criticality Control Unit	Section in Chapter 11
Receiving Area	
PuO_2 3013 storage pit	11.2.2.3
PuO_2 container opening and handling	11.2.2.5
PuO_2 buffer storage	11.2.2.4
Primary dosing (including master blend homogenizing)	11.2.2.6
Powder Area	
Primary blend ball milling Scrap milling	11.2.2.7 11.2.2.11
Final dosing	11.2.2.8
Homogenizing and pelletizing	11.2.2.9
Jar storage and handling tunnel	11.2.2.13
Scrap processing	11.2.2.10
Powder auxiliary	11.2.2.12
Pellet Process Area	
Pellet storage including sintered pellets storage	11.2.2.14 11.2.2.16
Sintering furnace	11.2.2.15
Grinding	11.2.2.17
Pellet inspection and sorting, quality control and manual sorting	11.2.2.19 11.2.2.20
Pellet tray-baskets storage including ground and sorted pellets storage	11.2.2.18
Scrap pellet storage	11.2.2.23
Scrap box loading, pellet repackaging, and pellet handling	11.2.2.21 11.2.2.22 11.2.2.24
Fuel Rod Process Area	
Rod cladding and decontamination	11.2.2.25
Rod controls (decontamination, helium leak testing, x-ray inspection, rod scanning, rod inspection, and sorting units, decladding, tray loading, and dry cleaning)	11.2.2.27 11.2.2.28 11.2.2.29 11.2.2.30 11.2.2.31 11.2.2.32 11.2.2.26 11.2.2.35
Rod storage	11.2.2.27

Cross-reference from Table 6-2 to Chapter 11 (continued)

Assembly Area	Section in Chapter 11
Assembly mock-up loading	11.2.2.33
Assembly mounting	11.2.2.34
Assembly handling and inspection	11.2.2.36
Assembly storage	11.2.2.37

100. Table 6-2, pp. 6-49 thru 6-58

Add information regarding the criticality control modes for the following areas:

a. PuO_2 Container Opening and Handling Unit (11.2.2.5)
b. Scrap Processing Unit (11.2.2.10)
c. Powder Auxiliary Unit (11.2.2.12)
d. Sintered Pellet Storage Unit (11.2.2.16)
e. Ground and Sorted Pellet Storage Unit (11.2.2.18)
f. Quality Control and Manual Sorting Unit (11.2.2.20)
g. Scrap Box Loading Unit (11.2.2.21)
h. Pellet Repackaging Unit (11.2.2.22)?
i. Pellet Handling Unit (11.2.2.24)
j. Rod Tray Loading Unit (11.2.2.26)?
k. Assembly Dry Cleaning Unit (11.2.2.35)
l. Assembly Packaging Unit (11.2.2.38)

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.2.E recommends that the applicant describe the controlled parameters for each process. The above process units appear not to be described in Table 6-2, in addition to Units 1 and 2 (non-fissile) and Unit 11 (identical design to another unit). This information is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

The tables were meant to refer to the main or principal units. Some of the referenced units are included in other named criticality control units. The remaining units have been added to the revised table.

a.	PuO_2 Container Opening and Handling Unit	See revised Table 6-2
b.	Scrap Processing Unit	See revised Table 6-2
c.	Powder Auxiliary Unit	See revised Table 6-2
d.	Sintered Pellet Storage Unit	Part of Pellet storage unit, page 6-53
e.	Ground and Sorted Pellet Storage Unit	Part of Pellet tray baskets, page 6-54
f.	Quality Control and Manual Sorting Unit	See revised Table 6-2 (combined with Pellet inspection and sorting.
g.	Scrap Box Loading Unit	See revised Table 6-2

h.	Pellet Repackaging Unit	See revised Table 6-2
i.	Pellet Handling Unit	See revised Table 6-2
j.	Rod Tray Loading Unit	See revised Table 6-2 (combined with Rod controls.
k.	Assembly Dry Cleaning Unit	See revised Table 6-2 (combined with Rod controls.
l.	Assembly Packaging Unit	See revised Table 6-2

Action:

The revised Table 6-2 will be included in the next update to the CAR. (See revised tables as part of the response to Question 83.)

101. Table 6-2, pp. 6-49 thru 6-58

Explain the following footnotes in Table 6-2:

a. Parameter value ranges indicated are selected for use in criticality design calculations to encompass credible optimum conditions without reliance on process variable controls.

b. Reflection and interaction addressed by geometry control.

c. ...Clad characteristics guaranteed by supplied (Describe how this is confirmed.)

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.2.E recommends that the applicant describe the controlled parameters for each process. Knowledge of the design philosophy is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

a. Footnote 1 in CAR Table 6-2: Parameter value ranges indicated are selected for use in criticality design calculations to encompass credible optimum conditions without reliance on process variable controls.

This footnote refers to two types of entries, density and ^{240}Pu content. The density is a conservative value based upon supplier specification, direct measurement, or conservative analysis and will be justified in the NCSE. The ^{240}Pu content is based upon supplier specification and a conservative value which, along with the balance being assumed to be ^{239}Pu, will be justified in the NCSE to encompass the other isotopics (such as ^{241}Pu).

b. Footnote 2 in CAR Table 6-2: Reflection and interaction addressed by geometry control.

This footnote refers to reflection and interaction as criticality control methods. There is no active, controllable reflection or interaction control used in the MFFF. Rather, the physical effects of reflection and interaction are a result of the geometric arrangement of equipment. Therefore, the conservative calculation and evaluation of the geometrical arrangement in the NCSE also evaluates the effects of reflection and interaction.

c. Footnote 11 in CAR Table 6-2: Clad characteristics guaranteed by supplier.

The DCS Quality Assurance program will be imposed upon the supplier to ensure that cladding characteristics will be as required. Supplier tests and inspections will be performed to confirm that the characteristics are as specified.

Action:

None

102. Tables 6-1 and 6-2, pp. 6-43 thru 6-58

In Tables 6-1 and 6-2, describe what criticality control mode corresponds to reliance on the relative proportion of PuO_2 and UO_2 powder.

10 CFR 70.22(f) states, in part: "Each application for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant shall contain...a description and safety assessment of the design bases of the principal structures, systems, and components of the plant..." 10 CFR 70.62(a) states that each licensee or applicant shall establish and maintain a safety program that demonstrates compliance with the performance requirements of 10 CFR 70.61. Nuclear criticality safety is an important area for the safety assessment of the design bases of the principal structures, systems, and components and for the safety program that demonstrates compliance with the 10 CFR 70.61performance requirements. SRP Section 6.4.3.3.2.E recommends that the applicant describe the controlled parameters for each process. Knowledge of the dominant controlled parameters upon which the facility design will be based is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

In accordance with SRP 6.4.3.3.2.4, isotopic abundance (isotopics) is taken to include both the ^{235}U concentration (enrichment) and the concentration of fissile and non-fissile plutonium isotopes (such as ^{239}Pu, ^{240}Pu, ^{241}Pu) "as well as the relative abundance of plutonium to uranium." This is also stated in CAR Section 6.3.3.2.4 and CAR Section 6.3.4.3.2.4.

Therefore, the column labeled "Isotopics (I)" in Tables 6-1 and 6-2 includes the relative proportion of PuO_2 and UO_2 powder. This can be seen in the column labeled "Isotopics (I)" in Table 6-2 that, in addition to the ^{240}Pu content, the "%Pu" is also stated.

Action:

None

103. Table 6-3, p. 6-59; Table 6-4, p. 6-60

Provide the technical basis and/or references for the single-parameter limits in Tables 6-3 and 6-4.

10 CFR 70.61(d) requires that all processes be subcritical under both normal and credible abnormal conditions. The single-parameter limits in Tables 6-3 and 6-4 are provided as possible subcritical values, but no demonstration of their adequacy is provided.

Response:

During a meeting with the NRC in November 1999, it was suggested that typical or order-of-magnitude values of plutonium media found in the MFFF be provided. Therefore, CAR Table 6-3 contains typical, order-of-magnitude values of Pu materials found mainly in the AP process at optimum moderation. CAR Table 6-4 contains typical, order-of-magnitude values of MOX materials found mainly in the MP process at typical low moderation conditions.

The values listed in Tables 6-3 and 6-4 are not single parameter limits. The values listed are presented as "information only" in order to provide "preliminary best estimate" nominal Pu values typical of those expected to be found in the AP and MP processes.

The actual values referenced in the NCSEs will be based upon calculations and not necessarily the values shown in Tables 6-3 and 6-4.

Action:

In the next update to the CAR, footnotes will be added to Tables 6-3 and 6-4 to indicate that these are typical order of magnitude values that will not necessarily be used in the calculations/NCSEs.

104. <u>Table 6-3, p. 6-59; Table 6-4, p. 6-60</u>

Clarify the conditions under which the mass limits in Tables 6-3 and 6-4 were determined (*e.g.*, fully or partially reflected).

10 CFR 70.61(d) requires that all processes be subcritical under both normal and credible abnormal conditions. Knowledge of the conditions upon which the facility design will be based is necessary to ensure that the design bases will provide reasonable assurance of protection against a criticality accident.

Response:

CAR Table 6-3 contains typical, order-of-magnitude values of Pu materials found mainly in the AP process at optimum moderation. The physical forms are, as noted in the tables, sphere, infinite cylinder, and infinite slab. In all cases, the fissile material was fully reflected with water.

CAR Table 6-4 contains typical, order-of-magnitude values of MOX materials found mainly in the MP process at typical low moderation conditions. The physical form used in the typical calculations is a sphere. In all cases, the fissile material was fully reflected with water.

The values listed in Tables 6-3 and 6-4 are not mass limits. The values listed are presented as "information only" in order to provide "preliminary best estimate" nominal Pu values typical of those expected to be found in the AP and MP processes.

The actual values referenced in the NCSEs will be based upon calculations and not necessarily the values shown in Tables 6-3 and 6-4.

Action:

In the next update to the CAR, footnotes will be added to Tables 6-3 and 6-4 to indicate that these are typical order of magnitude values that will be validated in the criticality calculations.

CHAPTER 7, FIRE PROTECTION

105. Chapter 7, General

Clearly identify the types of equipment and/or processes in each fire area.

Under Appendix D4 of the SRP, process equipment and operations information should be provided to comprehensively assess fire safety. This chapter does not provide a detailed list of fire hazards that result from the use of equipment or processes. This information is necessary to comprehensively identify hazards and develop credible protection schemes.

Response:

The Fire Hazards Analysis, which will identify the processes and the IROFS equipment (if any) in each fire area, is being performed in support of the license application. In the interim, CAR Figures 11.1-2 through 11.1-6 and Figures 11.1-16, -17, and -18 contain tables that provide a description of the function of each room in the MFFF by room number. Room numbers are identified on the fire barrier diagrams (CAR Figures 7-1 through 7-8) and on the suppression coverage diagrams (CAR Figures 7-16 through 7-23). CAR Table 7-1 lists all rooms in each fire area with a description of their function and their fire loading. Additionally, descriptive information regarding the processes in the MOX and Aqueous Polishing Areas is provided in Sections 11.2 and 11.3 of the CAR. For convenience, the subsections within Sections 11.2 and 11.3 that can be related to specific rooms have been identified as delineated in the following table:

Subsection	Subsection Title	Related Room Number(s)
11.2.2.1	UO_2 Receiving and Storage Unit	B-392
11.2.2.2	UO_2 Drum Emptying Unit	B-323
11.2.2.4	PuO_2 Buffer Storage Unit	B-152
11.2.2.5	PuO_2 Container Opening and Handling Unit	B-124
11.2.2.6	Primary Dosing Unit	B-124
11.2.2.7	Primary Blend Ball Milling Unit	B-126
11.2.2.8	Final Dosing Unit	B-126
11.2.2.9	Homogenization and Pelletizing Unit	B-119 and B-121
11.2.2.10	Scrap Processing Unit	B-139
11.2.2.11	Scrap Milling Unit	B-126
11.2.2.12	Powder Auxiliary Unit	B-141
11.2.2.13	Jar Storage and Handling Unit	B-123
11.2.2.14	Green Pellet Storage Unit	B-117
11.2.2.15	Sintering Units	B-115
11.2.2.16	Sintered Pellet Storage Unit	B-129
11.2.2.17	Grinding Units	B-132 and B-140
11.2.2.18	Ground and Sorted Pellet Storage Unit	B-239
11.2.2.19	Pellet Inspection and Sorting Units	B-243
11.2.2.20	Quality Control and Manual Sorting Units	B-242

Subsection	Subsection Title	Related Room Number(s)
11.2.2.21	Scrap Box Loading Unit	B-140
11.2.2.22	Pellet Repackaging Unit	B-140
11.2.2.23	Scrap Pellet Storage Unit	B-135
11.2.2.24	Pellet Handling Unit	B-136
11.2.2.25	Rod Cladding and Decontamination Units	B-264
11.2.2.26	Rod Tray Loading Unit	B-172
11.2.2.27	Rod Storage Unit	B-186
11.2.2.28	Helium Leak Test Unit	B-169
11.2.2.29	X-Ray Inspection Units	B-169
11.2.2.30	Rod Scanning Unit	B-169
11.2.2.31	Rod Inspection and Sorting Unit	B-173
11.2.2.32	Rod Decladding Unit	B-278
11.2.2.33	Assembly Mockup Loading Unit	B-174b
11.2.2.34	Assembly Mounting Unit	B-174a
11.2.2.35	Assembly Dry Cleaning Unit	B-174a
11.2.2.36	Assembly Dimensional Inspection Unit and Assembly Final Inspection Unit	B-174a
11.2.2.37	Assembly Handling and Storage Unit	B-174a and B-183
11.2.2.38	Assembly Packaging Unit	B-185
11.3.2.1	Decanning Unit	B-153, B-155, C-430, and C-431
11.3.2.2	Dissolution Unit	C-137, C-210, C-228, C-322, and C-323
11.3.2.3	Purification Cycle	C-110, C-134, C-135, C-137, C-140, C-141, C-233, C-234, C-322, C-323, and C-334
11.3.2.4	Solvent Recovery Cycle	C-136 and C-233
11.3.2.5	Oxalic Precipitation and Oxidation Unit	C-134, C-226, C-318, C-330, and C-334
11.3.2.6	Homogenization Unit	C-204 and C-226
11.3.2.7	Canning Unit	C-132
11.3.2.8	Oxalic Mother Liquor Recovery Unit	C-121, C-134, and C-237
11.3.2.9	Acid Recovery Unit	C-138, C-140, C-205, C-209, and C-314
11.3.2.10	Silver Recovery Unit	C-218 and C-333
11.3.2.11	Offgas Treatment Unit	C-234
11.3.2.12	Liquid Waste Reception Unit	C-123

Action:

None

106. Chapter 7, General

Include discussion of fire prevention features for the Secured Warehouse Building.

SRP Sections 7.4.3.2 (C) and (F) recommend that fire resistivity and combustibility details for radioactive waste or storage facilities be provided. Buildings other than the MOX Fuel Fabrication Building, which contain radioactive materials, should be analyzed for fire events.

Response:

The Secured Warehouse Building (BSW) is a slab-on-grade, pre-engineered, metal building. The exterior walls and roof consist of insulated metal panels. Within the BSW are a general storage area, an electrical equipment room, parts washing area, offices, toilets, depleted uranium oxide (DUO_2) storage area, and the MOX Fresh Fuel Package storage and maintenance area with an overhead crane or monorail. The parts washing area, which is two stories in height, has reinforced masonry block or reinforced concrete walls and a second floor comprised of a concrete slab on metal decking. The DUO_2 storage area has reinforced masonry block or reinforced concrete walls and a ceiling comprised of a concrete slab on metal decking. The BSW complies with the standards of Type II construction as defined in NFPA 220.

The passive fire protection features in the BSW include walls, ceilings, and penetrations surrounding the parts washing area and the DUO_2 storage area rated at a minimum of two hours and doors separating these areas from other areas of the BSW rated at a minimum of 1-1/2 hours. Lightning protection for the BSW building will be provided in accordance with the applicable requirements of NFPA 780.

The BSW will be provided with a fire detection and alarm system and a wet-pipe sprinkler system. The system is hydraulically designed and installed in accordance with the applicable requirements of NFPA 13 for Ordinary Hazard (Group 1) occupancy (in the majority of the building) and NFPA 231C for Special Hazard occupancy involving Class IV commodities stored in this building. Fire protection water will be provided to the BSW from the MFFF firewater loop, which is supplied from the SRS F-Area firewater loop. Portable fire extinguishers are provided in accordance with the applicable requirements of NFPA 10.

Action:

None

107. Section 7.2.2.3.1

Discuss the reliability of the selection of pre-action over wet-pipe sprinkler systems where criticality is not a concern.

Per Appendix D5 of the SRP, the Fire Hazard Analysis (FHA) should evaluate the consequences of automatic fire protection system malfunction. This evaluation would demonstrate whether the selected protection scheme is appropriate for the hazard. Pre-action systems respond slower and are less reliable than wet-pipe systems.

Response:

To clarify the intent of the discussion provided in Section 7.2.3.3.1 of the CAR, the word "not" in the phrase "where criticality is not a concern" will be removed from the first paragraph of Section 7.2.3.3.1 in the next amendment to the CAR. At the MFFF, the most reliable fire suppression systems will be utilized after taking operational considerations into account. For example, in areas of the MFFF where criticality is not a concern and water-based suppression is the preferred suppression system type, wet-pipe sprinkler systems will be utilized because wet-pipe sprinkler systems are more reliable than pre-action sprinkler systems.

Action:

The word "not" in the phrase "where criticality is not a concern" will be removed from the first paragraph of Section 7.2.3.3.1 in the next amendment to the CAR.

108. Section 7.4, pp. 7-16 thru 7-20

Provide the analysis portion of the preliminary Fire Hazard Analysis

Section 7.3.D of the SRP recommends that the FHA evaluate anticipated consequences. Section 7.4 discusses the approach, assumptions, and the conclusions of the preliminary fire hazard analysis. A presentation of the preliminary analyses would help clarify key conclusions of the report. In particular, one of the key conclusions asserts that the use of polycarbonate/Plexiglas glovebox windows does not compromise fire safety. However, the preliminary FHA does not provide quantitative details on the fire model or data assumptions to support this conclusion.

Response:

The analysis portion of the Preliminary Fire Hazard Analysis (PFHA) evaluated the MFFF preliminary design as based on design documentation, drawings, and specifications that were available as of July 2000. At the time, the MFFF was split into 360 different fire areas as follows:

- 169 fire areas in the MOX Processing Area
- 128 fire areas in the Aqueous Polishing Area
- 56 fire areas in the Shipping and Receiving
- 7 fire areas for the remainder of the MFFF.

Based on the fire areas that were analyzed, the conclusions presented in Section 7.4.2 of the CAR are provided. The approach and key assumptions related to the PFHA are as provided in Sections 7.4.1.2 and 7.4.1.3 of the CAR, respectively.

For the purpose of the PFHA, the MELOX facility serves the same function as the MOX Processing Area at the MFFF. Additionally, for particular processes within the MELOX facility, the counterpart rooms in the MOX Processing Area have similar equipment and components. Therefore, by taking into account slightly different room configurations between similar MELOX and MOX Processing Area rooms, the combustible loading in a MOX Processing Area room is equivalent to the fire loading to its MELOX facility counterpart. This equivalency was extended to the Aqueous Polishing Area and the Shipping and Receiving Area where MELOX facility rooms have similar functions, such as electrical rooms and control rooms.

For the PFHA, the fire severity of the MFFF fire areas was estimated by equating a fire load of 80,000 Btu/ft^2 to a fire severity of 60 minutes. This fire severity/fire load relationship is utilized extensively in the nuclear power industry as a basic rule-of-thumb for deriving a representative fire severity. Additionally, the use of this relationship is supported by analysis of fire tests conducted by the National Bureau of Standards (NBS); refer to the NFPA Fire Protection Handbook for additional details.

The FHA will still utilize the fire severity/fire load relationship for fire severity determinations. However, the FHA fire severity determinations will be supplemented as necessary with fire modeling in various circumstances, such as:

- Where the estimated fire severity is high relative to the rating of the fire barriers surrounding the fire area
- Where the fire load is concentrated in the vicinity of a specific fire barrier
- Where Class A combustibles are not the primary combustible within the fire area.

The fire models that are currently being considered for this modeling effort include CFAST, FASTLite, and/or FPEtool.

Separate from the PFHA and the CAR, an analysis detailing the trade-offs related to the use of polycarbonate as the MFFF process glovebox window material was generated and provided to the NRC on December 15, 2000, for review and concurrence. To support the discussions provided in this analysis, a fire model analysis was performed to model the fires that could occur in a pelletizing room. The fires were considered to start in either an electrical panel or one of the various motors within the room.

The fire modeling software, FPEtool Version 3.2, was utilized to determine the heat release rate from a fire (where a radiant heat flux could potentially impact polycarbonate windows) and/or the peak ceiling temperature due to a fire (which is the maximum temperature in the room due to a fire). FPEtool is a collection of computer simulated procedures providing numerical engineering calculations of fire phenomena. One of these collections is in a module entitled "FIREFORM," which was used extensively to support this analysis.

The fire modeling concluded that the potential radiant heat flux from a fire was far below the heat flux necessary to ignite polycarbonate windows, and the maximum temperature in a room resulting from a panel fire. However, due to the limited quantity of the combustibles in a panel (which were assumed to be polyethylene) and the low heat release rate for these combustibles (42 BTU/sec), the peak ceiling temperature was determined to be 353°F, which is far below the ignition temperature of polycarbonate at 1,166°F.

Action:

None

109. Section 7.4, pp. 7-16 thru 7-20

Analyze the potential for fire spread between two fire areas.

Appendix D4 of the SRP identifies "potential for fire spread between two fire areas" as information needed to comprehensively assess fire safety. The fire hazard analysis confines the fire event to the area of fire origin. The analysis does not consider spread through interconnected glove boxes which could occur due to the heating of metal fire doors between glove boxes, an explosion, or room fire doors that are propped open.

Response:

By definition, a fire area is surrounded by fire barriers, the fire barrier penetrations are fire-sealed, the doors entering the fire area are fire-rated, and the transfer gloveboxes (if any) penetrating the fire barriers are provided with doors that are fire-rated. Fire-rated doors, by their design and testing, protect openings in fire barriers against the spread of fire and smoke into and out of the fire areas they are serving. The transfer glovebox fire doors have been tested in accordance with French testing requirements (comparable to the SFPE Handbook of Fire Protection) and have been demonstrated to be capable of withstanding a two-hour fire. The test for these fire doors indicated that on the unexposed side of the fire doors, the maximum temperature at the two hour point was approximately 110°C (230°F). Therefore, due to this relatively low temperature, the heating of these fire doors will not adversely impact any of the materials that are likely to be installed on the unexposed side.

At the MFFF, the possibility of fire spread by way of an explosion is eliminated by the prevention of explosions. Refer to the response to Question 60 for additional details.

In support of the analysis of the potential for fire spread at the MFFF, the combustible load for the each fire area is determined. For the PFHA, these fire loads were estimated; refer to the response to Question 108 for additional details. To ensure the fire ratings assigned to a fire area are adequate, it assumed that a fire that consumes 100% of the combustibles in the fire area where the fire occurs, including an allowance for transient loads. This total fire load is equated to a fire severity (see response to Question 108 for additional details), and the fire severity is compared to the rating of the fire barriers of the fire area to ensure the fire severity is no greater than the minimum fire barrier rating.

The PFHA reached three basis conclusions as discussed in Section 7.4.2 of the CAR, although not all fire areas were fully analyzed (see response to Question 108 for additional details). These conclusions are as follows:

- For the majority of the fire areas at the MFFF, the potential fires will be small and non-propagating.
- For those fires that could involve an entire fire area, the fire barriers surrounding the fire area will contain the effects of the fire to the fire area itself.

- To provide defense-in-depth to the fire barriers protecting areas containing dispersible radioactive materials, the fire detection and fire suppression systems in these areas will be designated principal SSCs.

The reason that most potential fires will be small and non-propagating is because the duration of these fires will be short relative to the rating of the fire barriers of the fire area and the fires themselves will typically have a low heat release rate and/or heat flux. Additionally, the ability for the fire to propagate is minimized by the fire barriers surrounding the fire areas (minimum fire rating of two hours), the routine inspection of fire barrier penetrations, self-closing fire doors, and the fire-rated doors that are part of the transfer gloveboxes. In the unexpected event of a barrier failure (e.g., propped open fire door), any fire in these fire areas is not expected to result in the spread of a fire due to the limited nature of the fire.

The reason that fires that can potentially involve an entire fire area do not propagate outside of the fire areas is due to the fire barriers that surround the fire area, which can contain the effects of the fire; these fire barriers typically have a fire rating of three hours. For those fire areas analyzed in the PFHA where this fire scenario could occur, it should be noted that these areas do not contain dispersible radioactive materials. In the unexpected event of a barrier failure (e.g., propped open fire door), it is conceivable that the fire may propagate to an adjacent fire area. However, because the fire barrier penetrations are routinely inspected and the fire doors are self-closing, the continued propagation of the fire as a result of barrier failures is doubtful.

Action:

None

110. Table 7-1, pp. 7-25 thru 7-36

Provide additional data in terms of the type, form and quantity of hazard.

MFFF Room Combustible Summary (Table 7-1) presents combustibility data in terms of equivalent fire load and estimated fire severity. Because materials burn differently, staff will be better able to assess postulated fire scenarios and protection schemes if the material form and quantity is provided per SRP Appendix D.10.

Response:

The preliminary FHA was based on MELOX information. The MFFF fire loading data, which are being developed in support of the Fire Hazards Analysis, will be completed in support of the license application for possession and use of special nuclear material. The MFFF fire loading data for each MFFF fire area will identify the combustible form (e.g., electrical insulation, furniture, etc.), the combustible type (e.g., polyethylene, polyurethane), the combustible quantity (in gallons, pounds, etc., as appropriate), the heat of combustion associated with each combustible, the fire load contribution of each combustible, and the total fire load for the fire area.

Action:

None

CHAPTER 8, CHEMICAL PROCESS SAFETY

111. Chapter 8, General

Provide additional information on chemical safety (general).

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete."

The application provides a qualitative description of the chemical process, potential hazards, and safety approaches and controls. Limited quantitative information is provided. Additional detailed information and quantification is needed in the following areas for the staff to adequately assess the safety implications and complete its review:

a. inventories

b. design bases and associated values, parameters, and ranges

c. system descriptions

d. general increase in quantification.

Response:

Chemical inventories are provided in the response to Question 113.

Design information including values, parameters and ranges for chemicals used in the MFFF are found in the figures listed below (the figures themselves are Proprietary and are provided in a separate Proprietary submittal). The data contained therein are also a resource for Questions 112 and others.

Each process flow sheet shows flow characteristics, controls, and major equipment components used for each process unit and can be used with the calculation and flow sheet documents for a total picture of the AP process.

The attached *Aqueous Polishing Flowsheet Calculation Basis* document describes the concentration bases used throughout the AP process that form the basis for the chemical flow sheets. The attached *Aqueous Polishing Chemical Flow Sheet* document provides mass balances for each stage of the AP process units.

These documents, when used in conjunction with the text description in CAR Chapter 11, provide a description of each process unit. Each process flow sheet has information about each fluid stream in the process.

Action:

None

Proprietary Figures Attached to Response to Question 111

UNIT	DESCRIPTION	FIGURE NUMBER
KCA	Conversion	KCA-131
KCD	Oxalic Mother Liquors Recovery	KCD-134
KDB	Plutonium Dissolution	KDB-138
KDC	Uranium Dissolution	KDC-6058
KPA	Purification	KPA-125
KPB	Solvent Recovery	KPB-126
KPC	Acid Recovery	KPC-127
KPF	Silver Recovery	KPF-050
KWD	Low Level Waste	KWD-14738
KWG	Off-Gas Treatment	KWG-137
KLE	Lab Line KLE	KLE-4737
KLC	Lab Line KLC	KLC-4736
KLB	Lab Line KLB	KLB-4735
KLA	Lab Line KLA	KLA-4734
KKJ	Lab Line KLD	KKJ-4738
RNA	Nitric Acid	RNA-14730
RHN	Hydroxylamine Nitrate	RHN-14731
ROA	Oxalic Acid	ROA-14732
RHZ	Hydrazine	RHZ-14733
RHP/RSN	Hydrogen Peroxide/Silver Nitrate	RHP/RSN-14734
GNO/RMN	Dinitrogen Tetroxide/Manganese Nitrate	GNO/RMN-14735
RTP/RDO	Tributyl Phosphate/Diluent	RTP/RDO-14736
RSC/RSH	Sodium Carbonate/Sodium Hydroxide	RSC/RSH-14737
KKJ	AP Flow Sheet Calculation Basis	N/A
KKJ	AP Chemical Flow Sheet	N/A

Figure KCA-131 (3 pages)

Figure KCD-134 (3 pages)

Figure KDB-138 (5 pages)

Figure KDC-6058 (1 page)

Figure KPA-125 (6 pages)

Figure KPB-126 (1 page)

Figure KPC-127 (4 pages)

Figure KPF-050 (1 page)

Figure KWD-14738 (1 page)

Figure KWG-137 (4 pages)

Figure KLE-4737 (1 page)

Figure KLC-4736 (1 page)

Figure KLB-4735 (1 page)

Figure KLA-4734 (1 page)

Figure KKJ-4738 (1 page)

Figure KKJ-15 (13 pages)

[redacted]

Figure KKJ-4307 (17 pages)

Figure RNA-14730 (3 pages)

Figure RHN-14731 (1 page)

Figure ROA-14732 (1 page)

Figure RHZ-14733 (1 page)

Figure RHP/RSN-14734 (1 page)

Figure GNO/RMN-14735 (1 page)

Figure RTP/RDO-14736 (1 page)

Figure RSC/RSH-14737 (1 page)

112. Chapter 8, General

Clarify the description of chemical process and chemical safety items.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete."

As currently written, the information on chemical process and safety is disjointed and split between several sections (e.g., Section 5, Section 8, Section 11.2, Section 11.3, Section 11.6, Section 11.8, and Section 11.9). Consequently, it is difficult to assess the information in an integrated manner and verify its completeness. It would be beneficial to have more of the information in one place and/or better cross-referenced.

Response:

Additional information and clarifications have been provided in response to the Request for Additional Information Questions 111 through 139 and those applicable to Sections 11.2 and 11.3.

Action:

None

113. Chapter 8, General

Verify that the chemical listing is complete.

SRP Section 8.4.3.1B recommends that chemical process details, such as chemical reactants and products, be provided in the application. SRP Section 8.4.3.1E recommends that chemical inventory information be provided with complete chemical and radionuclide inventories within the facility for routine and credible off-normal conditions. SRP Section 8.4.3.2 recommends that a list of hazardous chemicals and potential interactions be provided.

Table 8-1 lists many of the chemicals used or present in the MFFF. Sections 8.2 and 8.3 mention other chemicals that are not included in the listing, such as CO and azides (HN3), and imply more than trace quantities may be present. A complete listing is necessary to adequately understand the potential hazards and adequately assess the safety of proposed controls.

Response:

Tables 1 through 5 provide updated chemical inventory information used to evaluate the consequences of the release of hazardous chemicals. Table 1 presents the chemicals that are brought into the MFFF. Table 2 presents the maximum chemical inventories in the largest chemical tanks, vessels, and containers at the MFFF. Tanks, vessels, and containers with smaller chemical quantities (i.e., 10 gallons or less with chemical concentrations less than the concentrations in the larger tanks, vessels, and containers) have inventories that are bounded by the larger tanks; and they are not included in Table 2. Tables 3a, 3b, and 3c are anticipated chemical inventories in the secured warehouse, the laboratories, and the gas storage area. These anticipated inventories are likely to be maximum inventories. Table 3d presents the production rates of process waste chemicals. Table 4 presents chemicals that are reaction products or intermediate chemicals generated during normal operations of the Aqueous Polishing process. Table 5 presents chemicals that could be produced in hazardous quantities in Aqueous Polishing under off-normal conditions.

An updated table of airborne chemical concentration limits (i.e., Temporary Emergency Exposure Limits) is presented in Table 6. These limits are used in assessing the significance of chemical release events. Table 7 presents the qualitative chemical consequence categories, which are established for each chemical by the application of the airborne chemical concentration limits of Table 6.

The methodology for the evaluation of chemical consequences is provided in an attachment to this response. The evaluation of potential chemical interactions and explosions is performed as described in the CAR Chapters 5 and 8 and further clarified in response to Questions 50, 57, and 119 through 128.

Action:

Revise the CAR to incorporate this information.

Table 1. Chemicals Used at the MFFF

CHEMICAL			STATE
Name	**Formula**	**CAS Number**	
Aluminum Nitrate (Lab)	$Al(NO_3)_3$	13473-90-0	Liquid
Argon (Gas Storage Area)	Ar	7440-37-1	Liquid/ Gas
Argon-Hydrogen (Gas Storage Area)	Ar(95%) H(5%)	N/A	Gas
Argon-Methane (P10) (Gas Storage Area and Lab)	CH_4 (93%) + Ar (7%)	N/A	Gas
Azodicarbonamide (BMP)	$H_2NCONNCONH_2$	123-77-3	Solid
Chromic (III) Acid (Lab)	CrO_3	7738-94-5	Liquid
Branched Dodecane (BRP and BAP)	$C_{12}H_{26}$	N/A	Liquid
Ferrous sulfate (Lab)	$FeSO_4$	7720-78-7	Liquid
Fluorine (Lab)	F	7782-41-4	Liquid
Helium (Gas Storage Area)	He	7440-59-7	Gas
Hydrazine Hydrate (BRP)	$N_2H_4.xH_2O$	10217-52-4	Liquid
Hydrazine Nitrate (BRP and BAP)	N_2H_4-HNO_3	13464-97-6	Liquid
Hydrofluoric Acid (Lab)	HF	7664-39-3	Liquid
Hydrochloric Acid (Lab)	HCl	7647-01-0	Liquid
Hydrogen (Gas Storage Area)	H_2	N/A	Gas
Hydrogen Peroxide (BRP and BAP)	H_2O_2	7722-84-1	Liquid
Hydroxylamine Nitrate (BRP and BAP)	NH_2OH-HNO_3	13465-08-2	Liquid
Iron (Lab)	Fe	7439-89-6	Liquid
Isopropanol (BMP)	C_3H_7OH	67-63-0	Liquid
Manganese Nitrate (BAP)	$Mn(NO_3)_2$	10377-66-9	Solid/ Liquid
Manganous Sulfate (Lab)	$MnSO_4$	7785-87-7	Liquid
Nitric Acid (BRP and BAP)	HNO_3	7697-37-2	Liquid
Nitrogen (Gas Storage Area)	N_2	7727-37-9	Gas
Nitrogen Tetroxide and Nitrogen Dioxide (BRP)	N_2O_4 and NO_2	10102-44-0	Liquid/ Gas
Oxalic Acid (BRP and BAP)	$H_2C_2O_4$	144-62-7	Solid/ Liquid
Oxygen (Gas Storage Area)	O_2	N/A	Gas
Potassium Permanganate (Lab)	$KMnO_4$	7722-64-7	Liquid
Silver Nitrate (BAP)	$AgNO_3$	7761-88-8	Solid/

Table 1. Chemicals Used at the MFFF

CHEMICAL			STATE
Name	**Formula**	**CAS Number**	
			Liquid
Silver Oxide (Lab)	AgO	20667-12-3	Liquid
Sodium (Lab)	Na	7440-23-5	Liquid
Sodium Carbonate (BRP and BAP)	Na_2CO_3	497-19-8	Solid/ Liquid
Sodium Hydroxide (BAP)	$NaOH$	1310-73-2	Liquid
Sodium Nitrite (Lab)	$NaNO_2$	7632-00-0	Liquid
Sulfuric Acid (Lab)	H_2SO_4	7664-93-9	Liquid
Sulfamic Acid (Lab)	HSO_3NH_2	5329-14-6	Liquid
Thenoyl TrifluoroAcetone (Lab)	$C_8H_5F_3O_2S$	326-91-0	Liquid
Tributyl Phosphate (BRP and BAP)	$(C_4H_9)_3PO_4$	126-73-8	Liquid
Uranyl Nitrate (BAP)	$UO_2(NO_3)_2$	36478-76-9	Liquid
Xylene (Lab)	$C_6H_4(CH_3)_2$	1330-20-7	Liquid
Zinc Stearate (BMP)	$Zn(C_{18}H_{35}O_2)_2$	557-05-1	Solid

Table 2. Maximum Chemical Inventories in the Largest Chemical Tanks, Vessels, and Containers at the MFFF

Chemical	Form	Symbol, Usage	Concentration		BRP		BAP		BMP
			Quantity	Units	Tank	Capacity (gal)	Tank	Capacity (gal)	Capacity
Azodicarbonamide	S	poreformer	100	%	N/A	N/A	N/A	N/A	1.2-kg (bag)
	S	poreformer	100	%	N/A	N/A	N/A	N/A	4-L (hopper)
Dodecane (Note 1)	L	diluent	100	%	Tote Tank	126	N/A	N/A	N/A
	L	TBP + diluent	70	%	N/A	N/A	RTP TK1020	30	N/A
	L	TBP + diluent	Variable	%	RDO TK1006	150 Note 2	RDO TK1008	60 Note 2	N/A
	L	diluent	100	%	RDO-TK1000	80	RDO-TK1005	50	N/A
Hydrazine Hydrate and Hydrazine Nitrate	L	N_2H_4-(H_2O)	35	%	Tote Tank	126	N/A	N/A	N/A
	L	N_2H_4-H_2O	35	%	RHZ-TK1150	80	N/A	N/A	N/A
	L	N_2H_4-HNO_3	4	M	RHZ-REV-1160	15	N/A	N/A	N/A
	L	N_2H_4-HNO_3	4	M	RHZ-REV-1170	15	N/A	N/A	N/A
	L	N_2H_4-HNO_3	4	M	RHZ-REV-1180	30	N/A	N/A	N/A
Hydrogen Peroxide	L	H_2O_2	35	%	Drums	3 X 15	N/A	N/A	N/A
	L	H_2O_2	10	%	RHP-TK1200	40	RHP-TK1205	40	N/A
	L	H_2O_2		%	RHP-TK1206	40 Note 2	N/A	N/A	N/A

Table 2. Maximum Chemical Inventories in the Largest Chemical Tanks, Vessels, and Containers at the MFFF

Chemical	Form	Symbol, Usage	Concentration		BRP		BAP		BMP
			Quantity	Units	Tank	Capacity (gal)	Tank	Capacity (gal)	Capacity
Hydroxylamine Nitrate	L	HAN	1.9	M	Tote Tank	180	N/A	N/A	N/A
	L	HAN	1.9	M	RHN-TK1060	200	RHN-TK1090	55	N/A
Hydroxylamine and Hydrazine Nitrate	L	HAN-N_2H_2-HNO_3	0.15	M	RHN-TK1070	320	RHN-TK1080	320	N/A
	L	HAN-N_2H_4-HNO_3	0.15	M	RHN TK1110	150 Note 2	RHN-TK1082	60 Note 2	N/A
Isopropanol	L	$(CH_3)_2CHOH$	100	%	N/A	N/A	N/A	N/A	0.5-L (bottle)
Manganese Nitrate	L	Mn^{+2}	1	%	N/A	N/A	Bottles	20 X 0.5 liters	N/A
	L	HNO_3-Mn^{+2}	0.01	M	N/A	N/A	RMN-TK1050	15	N/A
Nitric Acid (Note 1)	L	HNO_3	13.6	N	Tote Tank	126	N/A	N/A	N/A
	L	HNO_3	13.6	N	RNA-TK1260	142	RNA-TK1265	161	N/A
	L	HNO_3	6	N	N/A	N/A	RNA-TK1330	13	N/A
	L	HNO_3	1.5	N	N/A	N/A	RNA-TK1030	350	N/A
	L	HNO_3	1.5	N	N/A	N/A	RNA-TK1040	400	N/A
	L	HNO_3	Variable	N	RNA-TK1421	150 Note 2	N/A	N/A	N/A
Nitrogen Tetroxide	L	N_2O_4	100	%	Cylinders	1 Ton (240 gal)	N/A	N/A	N/A
	L	N_2O_4	100	%	GNO-TK1300	1 Ton (240 gal)	N/A	N/A	N/A
	L	N_2O_4	100	%	GNO-TK1310	1 Ton (240 gal)	N/A	N/A	N/A

Table 2. Maximum Chemical Inventories in the Largest Chemical Tanks, Vessels, and Containers at the MFFF

Chemical	Form	Symbol, Usage	Concentration		BRP		BAP		BMP
			Quantity	Units	Tank	Capacity (gal)	Tank	Capacity (gal)	Capacity
Oxalic Acid	S	$H_2C_2O_4$	100	%	Bags	16 X 25-kg	N/A	N/A	N/A
	L	$H_2C_2O_4$	0.7	M	ROA-TK1120	416	ROA-TK1130	459	N/A
	L	$H_2C_2O_4$-HNO_3	0.05	M	N/A	N/A	ROA-TK1140	162	N/A
Silver Nitrate (Note 1)	S	Ag NO_3	2	N	N/A	N/A	Bottles	8 X 0.5 liter	N/A
	L	Ag^+-HNO_3	1	N	N/A	N/A	RSN-TK1210	30	N/A
Sodium Carbonate	S	Na_2CO_3	100	%	Bags	8 X 5 lbm	N/A	N/A	N/A
	L	Na_2CO_3	0.3	M	RSC-TK1240	46	RSC-TK1250	46	N/A
Sodium Hydroxide	L	NaOH,Soda	10	N	N/A	N/A	Bottles	4 X 0.5 liters	N/A
	L	NaOH,Soda	0.1	N	N/A	N/A	RSH-TK1280	40	N/A
	L	NaOH,Soda	0.1	N	N/A	N/A	RSH-TK1290	40	N/A
Tri Butyl Phosphate	L	solvent, TBP	100	%	Tote Tank	126	N/A	N/A	N/A
	L	solvent, TBP	100	%	RTP-TK1010	80	RTP-TK1015	40	N/A
	L	TBP+diluent	30	%	N/A	N/A	RTP-TK1020	30	N/A
Uranyl Nitrate	L	$UO_2(NO_3)_2$	0.64	g(U)/liter	N/A	N/A	KDB- TK 5000	400 liters	N/A
	L	$UO_2(NO_3)_2$	0.64	g(U)/liter	N/A	N/A	KDB- TK 6000	400 liters	N/A
	L	$UO_2(NO_3)_2$	0.64	g(U)/liter	N/A	N/A	KDB- TK 7000	700 liters	N/A

Table 2. Maximum Chemical Inventories in the Largest Chemical Tanks, Vessels, and Containers at the MFFF

Chemical	Form	Symbol, Usage	Concentration		BRP		BAP		BMP
			Quantity	Units	Tank	Capacity (gal)	Tank	Capacity (gal)	Capacity
	L	$UO_2(NO_3)_2$	200	g(U)/liter	N/A	N/A	KDC- TK 2000	300 liters	N/A
	L	$UO_2(NO_3)_2$	200	g(U)/liter	N/A	N/A	KDC- TK 4000	750 liters	N/A
Zinc Stearate	S	Dry lubricant	100	%	N/A	N/A	N/A	N/A	60-kg (bag)
	S	Dry lubricant	100	%	N/A	N/A	N/A	N/A	16-L (hopper)

NOTES: 1. Diluent, nitric acid, and silver nitrate are recovered in the Aqueous Polishing process. The preparation of these reagents will be drastically reduced, once the AP process is in operation, as recovered reagents will become available.

2. Drain tanks are normally empty.

Table 3a. Anticipated Chemical Inventory in Secured Warehouse

Chemical	Total Quantity Anticipated in Secured Warehouse
Uranium Dioxide (Powder)	37.5 MT (200 drums @ 187.5 kg/drum)

Table 3b. Anticipated Chemical Inventory in the Laboratories

Chemical	Total Quantity Anticipated in Laboratories
Aluminum Nitrate	Less than 10 kilograms
Argon-Hydrogen (95:5)	No more than one cylinder (300 cu ft) per lab
Chromic (III) Acid	Less than 10 kilograms
Ferrous sulfate	Less than 10 kilograms
Fluorine	Less than 10 kilograms
Hydrofluoric Acid	Less than 10 kilograms
Hydrochloric Acid	Less than 10 kilograms
Iron	Less than 10 kilograms
Manganous Sulfate	Less than 10 kilograms
Potassium Permanganate	Less than 10 kilograms
Silver Oxide	Less than 10 kilograms
Sodium	Less than 10 kilograms
Sodium Nitrite	Less than 1 kilogram
Sulfuric Acid	Less than 10 kilograms
Sulfamic Acid	Less than 10 kilograms
Thenoyl TrifluoroAcetone	Less than 10 kilograms
Xylene (Lab)	Less than 10 kilograms

Table 3c. Anticipated Gas Storage Area Inventory

Chemical	Anticipated Gas Storage Area Inventory
Argon	Two (2) 3,000 gallon liquified gas storage tanks – 2-week supply
Argon-Hydrogen	One tube trailer - 53,000 scf – 24-hour supply (emergency backup)
Argon-Methane (P10)	One tube trailer - 45,000 scf – 6-week supply
Helium	One large tube trailer – 140,494 scf – 17-week supply
Hydrogen	One (1) tube trailer – 43,000 scf – 4-week supply
Nitrogen	Two (2) buffer tanks – 1209 and 11 cu ft Liquid nitrogen storage tank – 9000 gallons
Oxygen	Two (2) cylinders – 6250 scf each – 4-month supply

Table 3d. Anticipated Process Waste Chemicals

Chemical	Anticipated Production Rate of Process Waste Chemicals
Alkaline Waste (including Dibutyl Phosphate and Monobutyl Phosphate)	1.8 kg/hr (Note 1)
Nitrogen Oxides	17.55 kg/hr (Note 2)

Note 1: Alkaline Waste (including Dibutyl Phosphate and Monobutyl Phosphate) is temporarily stored in Liquid Waste Reception tanks until transferred to SRS.

Note 2: Nitrogen oxides are recombined in the Aqueous Polishing Offgas Treatment Unit and released through the MFFF stack.

Table 4. Chemicals which are Reaction Products or Intermediate Chemicals of the Aqueous Polishing Process (normal operations)

Chemical	Formula	Comment
Nitrogen	N_2	Reaction product of HAN reaction on nitrous acid
Nitrous Oxide	N_2O	Reaction product of HAN reaction on nitrous acid
Water	H_2O	Reaction product of HAN reaction on nitrous acid
Nitrous Acid	HNO_2	Always present in nitric acid solutions
Carbon Dioxide	CO_2	Reaction product when plutonium oxalate is transformed into PuO_2
Carbon Monoxide	CO	Reaction product when plutonium oxalate is transformed into PuO_2 (trace quantities only)
Hydrogen	H_2	Radiolysis produces hydrogen.

Note: Inventories of Reaction Products or Intermediate Chemicals are not maintained or quantified.

Table 5. Chemicals which could be produced in Hazardous Quantities in Aqueous Polishing under Off-Normal Conditions

Chemical	Formula	Comment
Hydrazoic Acid	HN_3	Interaction of hydrazine nitrate and nitrous acid could initiate, under certain conditions, the formation of hydrazoic acid. However, any accumulation of HN_3, which occurs in the AP process, is ten times lower than the explosive limits. In the gaseous phase, HN_3 may decompose to N_2 and H_2.
Hydrazoic Salts (i.e., azides)	NaN_3, AgN_3	Interaction of hydrazine nitrate and nitrous acid could initiate, under certain conditions, the formation of hydrazoic salts (i.e., azides). However, since the solubility limits of these azides are not exceeded, precipitation and the potential for an explosion are prevented.
Red Oil		Red oil is an organic mixture, consisting of tri-butyl phosphate and its complexes with plutonium nitrate and nitric acid, degradation products of TBP (e.g., di-butyl phosphate), and possibly various nitrated hydrocarbons. These are compounds that could react exothermically at temperatures higher than 135°C. Process unit design prevents the process fluid temperature from exceeding 135°C by providing adequate margin between the maximum operating temperature and 135°C.

Table 6. Updated TEEL Values Used as Chemical Limits for Chemicals at the MFFF

	Temporary Emergency Exposure Limits, Rev. 17m			
Name	**TEEL-1**	**TEEL-2**	**TEEL-3**	**Units**
Aluminum Nitrate (Lab)	6	10	500	mg/m^3
Argon (liquid)	N/A	N/A	N/A	mg/m^3
Argon-Hydrogen (gas)	N/A	N/A	N/A	mg/m^3
Argon-Methane (P10 gas)	N/A	N/A	N/A	mg/m^3
Azodicarbonamide	9	15	250	mg/m^3
Chromic (III) Acid (Lab)	0.75	2.5	25	mg/m^3
Dodecane	3.5	20	7500	mg/m^3
Ferrous sulfate (Lab)	3	5	350	mg/m^3
Fluorine (Lab)	0.75	7.5	30	mg/m^3
Helium	N/A	N/A	N/A	mg/m^3
Hydrazine Hydrate	0.0025	0.02	0.02	ppm
Hydrazine Nitrate	3	5	5	mg/m^3
Hydrofluoric Acid	1.5	15	40	mg/m^3
Hydrochloric Acid	4	30	200	mg/m^3
Hydrogen	N/A	N/A	N/A	mg/m^3
Hydrogen Peroxide	12.5	60	125	mg/m^3
Hydroxylamine Nitrate	10	26	125	mg/m^3
Iron (Lab)	30	50	500	mg/m^3
Isopropanol	1000	1000	5000	mg/m^3
Manganese	3	5	500	mg/m^3
Manganese Nitrate	3	5	500	mg/m^3
Manganous Sulfate (Lab)	3	5	500	mg/m^3
Nitric Acid	2.5	12.5	50	mg/m^3
Nitric Oxide	30	30	125	mg/m^3
Nitrogen	N/A	N/A	N/A	mg/m^3
Nitrogen Dioxide	3.5	25	50	mg/m^3
Nitrogen Tetroxide	5	5	20	ppm
Oxalic Acid	2	5	500	mg/m^3
Oxygen	N/A	N/A	N/A	mg/m^3
Potassium Permanganate (Lab)	3	5	125	mg/m^3
Silver Nitrate	0.03	0.05	10	mg/m^3
Silver Oxide (Lab)	30	50	75	mg/m^3
Sodium (Lab)	2	2	10	mg/m^3
Sodium Carbonate	30	50	500	mg/m^3
Sodium Hydroxide	0.5	5	50	mg/m^3
Sodium Nitrite (Lab)	0.125	1	60	mg/m^3
Sulfuric Acid (Lab)	2	10	30	mg/m^3

Table 6. Updated TEEL Values Used as Chemical Limits for Chemicals at the MFFF

	Temporary Emergency Exposure Limits, Rev. 17m			
Name	**TEEL-1**	**TEEL-2**	**TEEL-3**	**Units**
Sulfamic Acid (Lab)	40	250	500	mg/m^3
Thenoyl TrifluoroAcetone (Lab)	3.5	25	125	mg/m^3
Tributyl Phosphate	6	10	300	mg/m^3
Uranyl Nitrate	0.6	0.6	10	mg/m^3
Xylene (Lab)	600	750	4000	mg/m^3
Zinc Stearate	30	50	400	mg/m^3

Table 7. Application of Chemical Limits to Qualitative Chemical Consequence Categories

Consequence Category	Worker	Public
High	Concentration ≥ TEEL-3	Concentration ≥ TEEL-2
Intermediate	TEEL-3 > Concentration ≥ TEEL-2	TEEL-2 > Concentration ≥ TEEL-1
Low	TEEL-2 > Concentration	TEEL-1 > Concentration

Attachment to Response to Question 113

CHEMICAL CONSEQUENCE ANALYSIS METHODOLOGY APPLICATIONS

This section discusses the methods that are used to calculate chemical consequences for the public, site workers, and control room workers.

Chemical consequence analyses are performed in support of the Integrated Safety Assessment (ISA) in order to ensure that the performance requirements of 10 CFR 70.61 are satisfied. Specifically, 10 CFR 70.61 requires that the risk of each credible high-consequence event must be limited, unless the event is highly unlikely through the application of engineered controls or administrative controls. These high consequence events include acute chemical exposure to an individual from licensed material or hazardous chemicals produced from licensed material that could endanger the life of a worker or that could lead to irreversible or other serious, long-lasting health effects to any individual located outside the controlled area.

The methods used to calculate chemical consequences are described in the following sections.

1.1 CHEMICAL CONSEQUENCE ANALYSIS MODELING FOR PUBLIC CONSEQUENCES

For evaporative releases, the chemical consequence analysis modeling for public consequences will use the ALOHA code (ALOHA, 2000) to calculate the maximum airborne chemical concentration at the Savannah River Site boundary, which is the controlled area boundary (5.4 miles from the MFFF). The calculated concentration at the site boundary will be compared with the appropriate TEEL value for the released chemical. An evaporation model extracted from the ALOHA code will be used to calculate a release from a spilled or leaked chemical, which is assumed to form a puddle one-cm deep. A spill or leak from the largest tank or container holding the chemical will be modeled. No credit initially will be taken for an enclosure (such as a building) or a dike or containment/impoundment basin. The following parameters will be used in modeling evaporation and atmospheric dispersion of the release. These parameters, for offsite consequence analysis, are comparable to those parameters suggested in 40 CFR 68.22 and other sources.

- A wind speed of 1.2 meters per second and F stability class, indicative of 95% "worst-case" meteorological conditions at SRS;

  Note: The 95% wind speed of 1.2 meters per second was calculated from the 95% χ/Q value from the ground-level release application of the ARCON96 code (NRC, 1997) applied at a distance of 100 meters (i.e., 4.13E-04 sec/m^3). The ARCON96 code was driven by five years of hourly SRS meteorological data. The calculation assumes an F-stability class to quantify σ_y and σ_z. The 100-meter distance is selected because it represents the site worker location. This technique yields a site-specific 5% meteorological condition (F stability class @ 1.2 m/second wind speed) that is more credible than just adopting the 40 CFR 68.22 meteorology, which is generalized for the entire United States.

- A wind direction that transports the puff kernel and/or plume centerline directly over the receptor of concern (conservative), thereby eliminating any crosswind dispersion;

- An ambient temperature of 25°C (77°F) and 50 percent humidity; representative of late-spring to early-autumn conditions;

- A ground level release (conservative);

- No mechanical or buoyancy plume rise (conservative);

- A rural (i.e., flat terrain) topography (conservative);

  Note: The forest canopy morphology at SRS is more accurately characterized as urban terrain relative to atmospheric turbulence intensity.

- Neutrally buoyant gas model (conservative).

  Note: Dense gas models result in lower downwind concentrations, which are less conservative. This is due to density differences (e.g., Colenbrader model within ALOHA) that entrain clean air within the sides of the pancake-like dense gas plume.

ALOHA has been restricted by its developers at the National Oceanic and Atmospheric Administration (NOAA) to an execution time of one hour because atmospheric conditions are likely to change after more than an hour making the ALOHA calculations, arguably, unreliable after one hour for its intended purposes. ALOHA was developed for the On-Scene Commander at a spill site for primarily emergency response applications. This one-hour time execution limit is hardwired in ALOHA and cannot be removed by the end-user. As a result of this one-hour time execution limit, for light wind speed conditions, ALOHA is unable to provide analytical results for the SRS site boundary/MEOI assessment. For example, for a worst case analysis wind speed of 1.2 meters per second, a dispersing cloud of a chemical can only travel 4.32 km (2.68 miles) at the end of an hour. Thus, the cloud would not reach the site boundary at SRS within an hour under worst case meteorological conditions. To overcome this limitation, the maximum concentration of the released chemical at the site boundary is estimated by extrapolation of the maximum ALOHA concentrations for runs at distances of 2.68 miles and less using curve-fitting techniques. The maximum concentration can then be compared with the appropriate TEELs.

<u>Evaporation Models</u>

The evaporation model in the ALOHA code requires chemical physical properties (e.g., critical temperature, critical pressure, and specific heat) that are not available for all chemicals used at the MFFF. In order to overcome this code limitation, an evaporation model is used (which does not require all these input parameters) to determine a release rate; and then a direct release of the chemical is modeled with ALOHA. Alternate evaporation models can be found in a Los Alamos National Laboratory report (Armstrong, 1999) and in a "Nuclear Fuel Cycle Facility Accident Analysis Handbook" (NRC, 1998a). The equation for evaporation rate, which is taken from the

Los Alamos National Laboratory report (Armstrong, 1999) and which is identified as the evaporation model used in the ALOHA code, is as follows:

E=A*KM*(MWm * P_v/(R*T))

where

- E = evaporation rate (kg/sec)
- A = area of the evaporating puddle (m^2)
- KM = mass transfer coefficient (m/sec)
- MWm = molecular weight of the material of interest (kg/kmol)
- P_v = vapor pressure (Pa)
- R = the gas constant (8314 J/kmol °K)
- T = ambient temperature (°K)

and

- KM = 0.0048 *U7/9 * Z-1/9 * Sc-2/3
- U = wind speed (m/sec)
- Z = the pool diameter in the along-wind direction (m)
- Sc = the laminar Schmidt number

and

- Sc = v/Dm
- v = the kinematic viscosity of air (m^2/sec) = 1.50E-05 m^2/sec
- Dm = the molecular diffusivity of the material of interest in air (m^2/sec)

and

- Dm = DH_2O * (MWH_2O / MWm)
- DH_2O= the molecular diffusivity of water in air (m2/sec) = 2.40E-05 m^2/sec
- MWH_2O= molecular weight of water (kg/kmole) = 18 kg/kmole

In order to account for the dilution of some chemicals in a solution, the vapor pressure of the chemical (i.e., the solute) is multiplied by the mole fraction of the solute:

P_v = vapor pressure (Pa) * mole fraction of solute

Mole fraction of solute = moles of solute / (moles of solute + moles of water)

The equation for evaporation rate, which is taken from the "Nuclear Fuel Cycle Facility Accident Analysis Handbook" (NUREG/CR-6410) (NRC, 1998a), is as follows:

Qo = kg*Ap*pv*M/(R*Tp)

where

- Qo = rate of evaporation (kg/sec)
- kg = mass transfer coefficient (m/sec)
- Ap = area of the pool (m^2)
- pv = vapor pressure (Pa)
- M = molecular weight of the material of interest (kg/kmol)
- R = the gas constant (8314 J/kmol °K)
- Tp = temperature of the pool (°K)

and

- kg = Dm*Nsh/d
- Dm = molecular diffusivity of the vapor in air (m^2/sec)
- d = effective diameter of the pool (m)
- Nsh = Sherwood number

And

- Nsh = 0.037(km/Dm)1/3 * [(ud/km)0.8-15200]
- km = kinematic viscosity of air (m^2/sec)
- u = windspeed at a height of 10 m (m/sec)

These evaporation models are then used in a spreadsheet to calculate evaporation rates, which then can be input into the ALOHA code to subsequently model dispersion.

The approaches described in the previous paragraphs for calculating unmitigated chemical consequences are very conservative. Some of the conservatism could be reasonably removed. For example, credit could reasonably be taken for mitigation features such as dikes or containment basins underneath tanks, which are designed to catch a leak or spill and reduce the surface area of evaporation. However, the initial approach is to calculate conservative, unmitigated exposures to determine if mitigation factors must be credited in order to maintain chemical consequences within acceptable limits.

<u>Source Terms Determined by Release Fractions</u>

For particle solids or powders (which are assumed to be spilled but do not evaporate) airborne release fractions (ARFs) and Respirable Fractions (RFs) are taken into account. A five-factor formula (NRC, 1998a) is used, which is described in the following paragraph.

Airborne releases for aqueous solutions (with solute concentrations less than approximately 50% and with very low solute vapor pressures, for example, uranyl nitrate, manganese nitrate, and oxalic acid) are also modeled with a five-factor formula. The source term is the product of the following five factors:

- material at risk (MAR)

- damage ratio (DR)
- airborne release fraction (ARF),
- respirable fraction (RF), and
- leak path factor (LPF) (i.e., filter penetration fraction).

The source term calculated with the five-factor formula is then used to calculate a release rate. A one-hour release is assumed.

The χ/Q value at 5 miles calculated by MACCS2 (NRC, 1998b) is then multiplied by the release rate to obtain an airborne chemical concentration at 5 miles. This concentration can be compared with the appropriate TEELs.

VAPOR Code Modeling

Chemical releases are also modeled with the VAPOR code developed by Stone and Webster. VAPOR has been successfully applied for more than 25 years at more than 40 civilian nuclear power generating facilities for control room habitability applications as well as for calculating offsite concentrations due to accidental chemical releases. This code, which is based on the model described in the Appendix to Regulatory Guide 1.78, is not limited to a one-hour dispersion calculation and produces results comparable to ALOHA. VAPOR has three components:

- A three-dimensional Gaussian-puff code that transports and disperses in three-dimensions the expanding puff of material directly to the receptor. The puff material results from the flashing of the superheated liquid from a liquid release stored at a different temperature and or pressure than ambient;

- A two-dimensional Gaussian plume code that transports the ensuing plume resulting from the evaporation (or sublimation in the case of carbon dioxide) of the remaining puddle of unflashed liquid. The plume is transported by the wind, diluted by the wind speed and dispersed in the horizontal and vertical planes by atmospheric turbulence;

- An air exchange coefficient (λ) that brings the outdoor concentrated material into the control room. Values of λ are a function of Heating Ventilation and Air Conditioning (HVAC) parameters. These can be varied to determine what level of air tightness will result in the smallest impact to the control room operator.

VAPOR produces a time-history of the outdoor concentrations as well as the indoor concentrations within the same application. It should be noted that ALOHA has the same exchange coefficient capability except that values of λ are more rigid (e.g., defined by building type). Results from VAPOR calculations are compared with the results using the ALOHA evaporation model. VAPOR can also be used to evaluate chemical consequences for other receptors.

1.2 CHEMICAL CONSEQUENCE ANALYSIS MODELING FOR THE SITE WORKER

Evaporation Models

The chemical consequence analysis modeling for the site worker uses the ALOHA and NUREG/CR-6410 evaporation models described in Section 1.1 and a Chi/Q value from calculations with the ARCON96 code (NRC, 1997) to calculate the maximum airborne chemical concentration at 100 meters from the release point. The calculated concentration at 100 meters is compared with the appropriate TEEL values for the released chemical.

A spill or leak from the largest tank or container holding the chemical is modeled. A one-centimeter depth is assumed for the puddle. No credit is taken initially for a mitigation feature such as an enclosure (i.e., a building) or a dike or containment basin. The following parameters are used in modeling evaporation and atmospheric dispersion of the release. These parameters, for offsite consequence analysis, are comparable to those parameters suggested in 40 CFR 68.22 and other sources.

A wind speed of 1.2 meters per second and F stability class, indicative of 95% "worst-case" meteorological conditions at SRS;

- A wind direction that transports the puff kernel and/or plume centerline directly over the receptor of concern (conservative), thereby eliminating any crosswind dispersion;
- An ambient temperature of 25°C (77°F) and 50 percent humidity; representative of late-spring to early-autumn conditions;
- A ground level release (conservative);
- No mechanical or buoyancy plume rise (conservative);
- A rural (i.e., flat terrain) topography (conservative);
- Neutrally buoyant gas model (conservative).

While ALOHA will calculate airborne concentrations of dispersed chemicals at 100 meters using a Gaussian plume model, the dispersion model in the ARCON96 code (NRC, 1997) has been recommended as being more accurate for distances close to the release point. The ARCON96 code, using several wind tunnel (i.e., physical modeling) and gas tracer (e.g., sulfur hexafluoride) studies performed in the 1970s, 1980s and 1990s, empirically takes into account building wake effects occurring under all meteorological conditions and plume meander, which occurs during light-wind stable conditions. It is the only model that is available which accounts for both the vertical and horizontal components of building wake effects and the effects of plume meander. Plume meander occurs under very stable light wind speed conditions (e.g., F stability class with wind speed of 1.2 meters/second). The magnitude of plume meander decreases with distance from the release, higher wind speeds, and more unstable conditions. All of the meander factor decays within 1 km. The building wake effect also decays as the distance from the release location increases, but it increases with wind speed and more unstable conditions. The faster the wind speed, the larger the aerodynamic effect on the wind field of the building structure. The χ/Q value at 100 meters calculated by ARCON96 is multiplied by the evaporation release rate to obtain a more accurate airborne chemical concentration at 100 meters. This concentration is compared with the appropriate TEELs.

The approach described in the previous paragraphs is conservative for calculating worker concentrations at 100 meters. This approach may result in calculated concentrations at 100 meters for some chemicals, which are well in excess of the appropriate TEELs. Some of the conservatism could be reasonably removed. For example, credit could reasonably be taken for dikes or containment basins underneath tanks, which would catch a leak or spill and reduce the surface area of evaporation.

Source Terms Determined by Release Fractions

For particle solids or powders (which are assumed to be spilled but do not evaporate) airborne release fractions and respirable fractions are taken into account. A five-factor formula (NRC, 1998a) is used, which is described in the following paragraph.

Airborne releases for aqueous solutions (with solute concentrations less than approximately 50% and with very low solute vapor pressures, for example, uranyl nitrate, manganese nitrate, and oxalic acid) are also modeled with a five-factor formula. The source term is the product of the following five factors:

- Material at risk (MAR)
- Damage ratio (DR)
- Airborne release fraction (ARF)
- Respirable fraction (RF)
- Leak path factor (LPF) (i.e., filter penetration fraction).

The source term calculated with the five-factor formula is then used to calculate a release rate. A one-hour release is assumed.

The χ/Q value at 100 meters calculated by ARCON96 is then multiplied by the release rate to obtain an airborne chemical concentration at 100 meters. This concentration can be compared with the appropriate TEELs.

VAPOR Code Modeling

The VAPOR code, as described in Section 1.1, also is used to calculate outdoor concentrations for the receptor at 100 meters.

Maximum Threshold Quantities for Laboratory Chemicals

There is one other useful calculation that has been performed using the ARCON96 χ/Q value at 100 meters. Because there are many additional chemicals used in small quantities in the laboratories of the MFFF and because the quantities of those chemicals have not yet been specified, an evaporation calculation or a direct release calculation of a specific amount of those chemicals cannot be performed. However, a maximum allowable amount of those chemicals, which would not result in exceeding the TEEL-2 concentration if the chemical was released, is calculated using the ARCON96 χ/Q value at 100 meters and the TEEL-2 concentration.

1.3 CHEMICAL CONSEQUENCE ANALYSIS MODELING FOR THE CONTROL ROOM WORKER

The chemical consequence analysis modeling for chemical releases, which can affect the control room worker, uses the VAPOR code. The analytical methods used by VAPOR to evaluate the MFFF control room habitability are taken from guidance provided in NRC Regulatory Guide 1.78 (US AEC, 1974).

Releases of hazardous chemicals, which infiltrate the control room, can result in the control room becoming uninhabitable. Regulatory Guide 1.78 (US AEC, 1974) describes assumptions acceptable to the NRC staff for use in assessing the habitability of the control room during and after a postulated external release of hazardous chemicals from mobile or stationary sources, offsite or onsite.

The regulatory guidance states that two types of chemical accidents should be considered for each source of hazardous chemicals: maximum concentration accidents and maximum concentration-duration accidents. A maximum concentration accident is one that results in a short-term puff or instantaneous release of a large quantity of hazardous chemicals.

A maximum concentration-duration accident is one that results in a long-term, low-leakage-rate release. For a maximum concentration-duration accident, the continuous release of hazardous chemicals from the largest safety relief valve on a stationary, mobile, or onsite source should be considered.

According to the regulatory guide, the atmospheric transport of a released hazardous chemical should be calculated using a dispersion or diffusion model that permits temporal as well as spatial variations in release terms and concentrations. Atmospheric dispersion models (e.g., VAPOR) can be used for dispersion calculations as long as these models are capable of calculating spatial and temporal variations in release terms and concentrations, simulating building wake effects, and simulating near-field effects.

The analysis with the VAPOR code conservatively assumes that the release takes place outdoors. In the unmitigated analysis, no credit is taken for building containment. The analysis calculates concentrations for two different control rooms (i.e., D-318 and D-319) in the Storage & Receiving (S & R) unit and for two separate fresh air intakes (i.e., west intake and north intake). The meteorological conditions used in the analysis are based on a 95-percentile wind speed of

1.2 meters per second coupled with a stability class that produces the highest impact for each case analyzed. For ground level releases with a receptor at ground level, the appropriate 95-percentile stability class is stability class F. However, for this source-receptor geometry, ground-level plumes will remain well below the level of the air intake for stability classes of E through G. Accordingly, stability classes A, B, C, and D are used in the model runs for the ground-level releases from the Reagents Building. Under those conditions, the puff and subsequent plume have a better chance of reaching the intakes, which are almost 50 feet above ground level.

It should be noted that this approach is very conservative for dense gases. Virtually all of the chemicals in the Reagents Building are dense gases since their molecular weights are greater than 28.966 g/mole, the density of air at standard temperature and pressure. Dense gases, when released to the ambient environment, exhibit severely restricted vertical dispersion and also entrain clean air into the plume prior to reaching equilibrium at the critical Richardson Number.

REFERENCES

ALOHA, 2000. "ALOHA - Areal Locations of Hazardous Atmospheres User's Manual," Computer-Aided Management of Emergency Operations, August 1999.

Armstrong, D.R., 1999. *Determining Limits for Liquid Hazardous Materials*. LA-UR-99-2600.

NRC, 1997. NUREG/CR-6331 Revision 1, Ramsdell, J. V. Jr. and C. A. Simonen, Atmospheric Relative Concentrations in Building Wakes, PNL-10521, May 1997.

NRC, 1998a. NUREG/CR-6410, Nuclear Fuel Cycle Facility Accident Analysis Handbook, March 1998.

NRC, 1998b. NUREG/CR-6613, SAND97-0594, Vol. 1, Code Manual for MACCS2: Volume 1, User's Guide, May 1998.

US AEC, 1974. "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," US AEC Regulatory Guide 1.78, June 1974

114. Chapter 8, General

Include mass and energy balances, and an estimate of daily usage of the chemicals and reagents, at least down to the individual unit level.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." Section 8.4.3.1 A and B include the recommendation for mass, energy, and radioactivity balances. Section 8.4.3.1.E recommends inventory information.

The application includes some inventory information and limited information on flow rates. Essentially no information is provided on enthalpies and energy sources, such as air lifts and pumps, that are capable of dispersing materials during an event. Source term information, including individual chemicals and radionuclides in process equipment and tanks, is limited. Some streams and components, such as americium and uranium, disappear in the limited information provided. Mass, energy, and radionuclide balance information, at a unit level, is needed for an adequate understanding of the processes and associated hazards, and appropriate measures to address potential safety concerns.

Response:

The flow sheets provided in response to Question 111 provide the information requested.

Action:

None

115. Chapter 8, General

Describe chemical storage and handling design bases and associated values, and principal SSCs/IROFSs.

SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

Table 8-1 and the associated text list the chemicals, their state, and their concentrations. Section 11.9 provides some additional information. Section 11.9.5 is entitled "Design Basis for Principal SSCs" but consists of two short paragraphs and essentially provides no design basis information. Section 5.4.2.5 is also entitled "Design Bases of Principal SSCs" consists of one short paragraph which includes "... These design bases identify the safety functions and the specific values and ranges of values chosen for controlling parameters ..." However, design basis information and values are not clear for storage and handling of the chemicals. In particular, few bases and values are mentioned for the gases. This design basis information is needed to appropriately assess the potential hazards and any needed controls. For example, for gases, the handling of numerous high pressure cylinders presents different hazards as compared to a supply from a pressurized swing absorption (PSA) system. Hydrogen can be supplied by cylinders of various sizes, pipeline, cryogenic deliveries, ammonia dissociation, and natural gas reformation. This design basis information is needed to adequately assess the potential hazards, safety, and principal SSCs/IROFSs of the proposed facility.

Response:

The design basis for chemical storage and handling is found in the response to Question 54.

The flow sheets provided in response to Question 111 give much of the information requested in this question. Additional information on chemical storage and handling has been provided in response to the following Questions: 118, 119, 120, 123, 124, 125, 126, 128, 129, 195, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, and 215.

Action:

None

116. Section 8.1.1.2.1.2, p. 8-3

Revise the last sentence of Section 8.1.1.2.1.2.

As written, the sentence refers to the use of silver as a catalyst for reduction. It appears the silver is used as a reagent for oxidation and dissolution of the plutonium as Pu(VI), and hydrogen peroxide is subsequently applied in a separate step to reduce the Pu(VI) to the more solvent extractable Pu(IV).

Response:

The last sentence of Section 8.1.1.2.1.2 will be corrected. As described in CAR Section 11.3, plutonium oxide is oxidized while Ag^{2+} is reduced to Ag^{+} during the dissolution process leading to the formation of Pu(VI). In the next step, and prior to the purification step, Pu(VI) is reduced to Pu(IV) by the addition of H_2O_2.

Action:

In the next update to the CAR, the text will be modified as indicated above.

117. Section 8.1.1.2.1.3, p. 8-3

Describe the nitrous fume oxidation process in Section 8.1.1.2.1.3.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

Sections 8.1.1.2.1.3 and 11.3.2.3.2 refer to a final plutonium valence adjustment from (III) to (IV) after purification by the use of "nitrous fumes." The process chemistry and sample reactions are not presented. "Nitrous fumes" are presumably nitrogen oxides and usually present hazards that may require safety controls. An adequate description and explanation of the use of "nitrous fumes" is needed before a safety determination can be made.

Response:

Action:

The CAR will be revised to reflect this information.

118. <u>Section 8.7, pp. 8.22 and 8.23</u>

Explain the chemical safety controls and provide a target reliability(ies).

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there is a brief paragraph on chemical safety controls. This indicates administrative controls for chemical makeup of reagents and to ensure segregation and separation of vessels and components from incompatible chemicals. No further information is provided. A description and design basis information are needed in order to make a safety determination. For example, the NRC would expect specific chemicals and systems associated with design basis events would be described and discussed, and reliabilities for prevention/mitigation presented. We would anticipate a description of the approach for administrative control(s) and target reliabilities.

Response:

Chemical safety controls ensure that chemical makeup of the reagents is correct and that incompatible chemicals are segregated. This program includes engineering features and administrative controls. The reagent system *chemical safety controls* in the reagents building include the following:

- Use of certified chemicals
- Chemicals are tested prior to use
- Preparation of the reagents by utilizing measured quantities of chemicals and solvents
- Redundant testing procedures to ensure chemical composition as required by the process
- Transfer to AP Building (BAP) by the Control Room Operator only if the test results meet reagent chemical composition requirements.

Low usage chemicals such as silver nitrate, manganese nitrate, and hydrogen peroxide are prepared in the BAP from aqueous-based reagent grade chemicals with known compositions that are mixed with measured quantities of chemical additives and the aqueous solvent. Before use, however, these prepared reagents undergo redundant testing procedures to ensure chemical composition. Transfer to head tanks or supply tanks by the Control Room Operator occur only if the test results meet chemical composition requirements.

In storage in the reagents building, the chemicals are physically separated by type to ensure, for example, that oxidizers are not mixed with reducing compounds. Similarly, the nitric oxide (NO_x), solvent (dodecane with tributylphosphate), and hydroxylamine nitrate (HAN) are prepared in separate rooms to ensure segregation from incompatible chemicals.

IROFS will be identified in the ISA. For information regarding reliabilities, please see the response to Question 39.

Other safety controls are described in response to other questions concerning Chapter 8 of the CAR. Commitments for chemical safety controls are identified in CAR Chapter 5 and will be demonstrated in the ISA.

Action:

The above information will be reflected in the next revision of the CAR.

119. <u>Section 8.7, pp. 8.22 and 8.23</u>

Describe and explain the administrative controls on hydrogen peroxide.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application , or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there is a brief sentence on chemical concentration controls. This indicates administrative controls will be used for ensuring the hydrogen peroxide concentration does not exceed 75 percent. No further information is provided. A description and design basis information are needed before a safety determination can be made. The NRC would expect a description of the approach for administrative controls and the systems/SSCs involved, including target reliabilities for prevention and mitigation aspects of these administrative controls.

Response:

Hydrogen peroxide is received in the warehouse in small 15-gallon polyethylene containers at a certified concentration of 35 Wt. %, well below the threshold value of 52 Wt. % considered to be toxic and reactive per 29 CFR 1910.119 Appendix A.

Using procedures, the incoming concentration of the hydrogen peroxide will be confirmed by independent testing prior to delivery to the reagents building for storage and use. One month's supply or three 15-gallon containers of 35% hydrogen peroxide will be maintained in the reagents building.

From storage in the reagents building, using volumetric totalizers, the 35% hydrogen peroxide will be diluted with demineralized water to form a 10% solution. Again, as part of the procedure, the prepared solution will be confirmed before transfer to the AP Building (BAP) for use in the AP process (dissolution and silver recovery steps).

These administrative controls will ensure that the hydrogen peroxide concentration does not exceed 35 Wt. % either in the reagents building or the BAP.

Action:

CAR Section 11.9.3.9.4 will be updated to include this response in the next revision of the CAR.

120. Section 8.7, pp. 8.22 and 8.23

Describe and explain the administrative controls for hydrazine and the safety limits.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application , or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there is a brief sentence on chemical concentration controls. This indicates administrative controls will be used for ensuring the hydrazine concentration stays within safety limits. No further information is provided. A description and design basis information are needed before a safety determination can be made. The NRC would expect a description of the approach for administrative controls and the systems/SSCs involved, including target reliabilities for prevention and mitigation aspects of these administrative controls. The NRC would also expect the "safety limits" to be defined.

Response:

Hydrazine hydrate ($N_2H_4 \cdot H_20$) will be received in the reagent processing building (BRP) in DOT-approved shipping containers at a certified concentration of 35 Wt. % (22% as N_2H_4). Using ASTM testing procedures, aqueous solutions of hydrazine below 40 % (60 Wt % $N_2H_4 \cdot H_20$) have no flash or fire point *(i.e., are not flammable)*. Thus, by using a concentration of 35 Wt. % hydrazine hydrates, the MFFF is using concentrations well below the flammability safety limits.

The incoming concentration of hydrazine hydrate will be confirmed by independent testing prior to delivery to the reagents building for storage and use, ensuring that the hydrazine concentration is within safe limits. See the response to Question 125 for a discussion of hydrazine control in the process.

Action:

None

121. Section 8.7, pp. 8.22 and 8.23

Explain the design approach and design bases to avoid overpressurization of tanks, vessels, and piping.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application , or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there is a brief statement that principal SSCs include design vessels, tanks, and piping to prevent process deviations from creating overpressurization events. No additional information is provided. The reader is referred to Section 11.8 for details. Section 11.8 provides the general approach and codes and standards. Design basis functions and values are not included. Such information is needed before a safety determination can be made. For example, the NRC would expect a description of the design approach and design bases to address overpressurization concerns, including the identification of specific SSCs, design basis events, and values. Actual pressures, pressure ramps, and quantities could be included.

Response:

All process vessels and tanks in the AP are vented through dedicated vent lines to the process off-gas treatment unit (described in CAR Section 11.3.2.11). All vessels are operated at a slight vacuum (approximately -50 mm W.G.). Additional design information is provided in response to Question 111.

These vents are sized to account for both normal and abnormal conditions.

Action:

The CAR will be revised to reflect this information.

122. Section 8.7, pp. 8.22 and 8.23

Describe and explain the design basis functions and values for avoiding explosions using scavenging air flow.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application , or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there is a brief statement that principal SSCs include the Instrument Air Scavenging System that provides sufficient scavenging airflow to dilute the hydrogen produced by radiolysis such that an explosive condition does not occur. No further information is provided. The reader is referred to Section 11.9 for details. Section 11.9.1.9 discusses the service air system, Section 11.9.1.10 discusses the instrument air system, and Section 11.9.1.11 discusses the breathing air system. The instrument air system appears to be the source of the scavenging air - if this is correct, it should be clearly stated in Section 8.7. Normal dewpoints and pressures are mentioned in Section 11.9.1.10. However, additional design basis information is needed before a safety determination can be made. For example, the NRC would expect there to be a requirement for avoiding explosion limits of vapors, such as providing sufficient airflow to maintain all maximum credible explosive vapor and gas concentrations below 25 percent of their lower flammability limit (LFL) and a verification/monitoring/sampling requirement. Any potential safety controls and IROFS should be identified, along with their design basis and reliability information. For example, it might be anticipated that the step-down regulators or pressure controls for the glove box scavenging would have safety significance - too great a flow might overpressurize the gloveboxes and release plutonium/MOX powder, while too small a flow would not sweep the potentially explosive vapors and gases. Any safety categorizations for the compressed gas cylinder banks, service air system (which supplies the instrument air system), and other monitors (e.g., on the emergency banks) and equipment should also be noted. In addition, the NRC would anticipate more description and design basis information on the emergency conditions; what monitors/alarms/approaches notify the operator of the need to manually activate the emergency system, what response times and reliabilities are needed, what system reliabilities and performance are needed, etc.

Response:

Normal scavenging air is supplied by the Instrument Air System through bubbling level instrumentation. The radiolysis risk mitigation based on the renewal of the atmosphere of the free volume in vessels containing plutonium.

During normal operations, the minimum scavenging flow rate provided from the instrument air system is that calculated to prevent the hydrogen concentration from rising above 1%.

Those vessels that could reach a hydrogen concentration of 4% within seven days after the loss of the bubbling air system are also supplied from an independent, redundant, Emergency Scavenging Air System classified as a principal SSC.

The Emergency Scavenging Air System provides a scavenging air supply for seven days duration from two banks of compressed air cylinders. Each bank has 100% capacity for a seven-day supply. Seven days provides adequate time to resume normal air supply or obtain additional air cylinders. For vessels that cannot reach a 4% hydrogen concentration within seven days, no backup scavenging means is implemented.

The operation of the system is initiated by low pressure alarms located on the bubbling air buffer tank in the header line. The minimum time for the hydrogen concentration to reach 4% is over 21 hours.

The systems that interface with the Emergency Scavenging Air System are the Oxalic Precipitation Oxidation (KDB), Dissolution (KCA), and Purification (KPA) Systems.

Refer to the attached sketch.

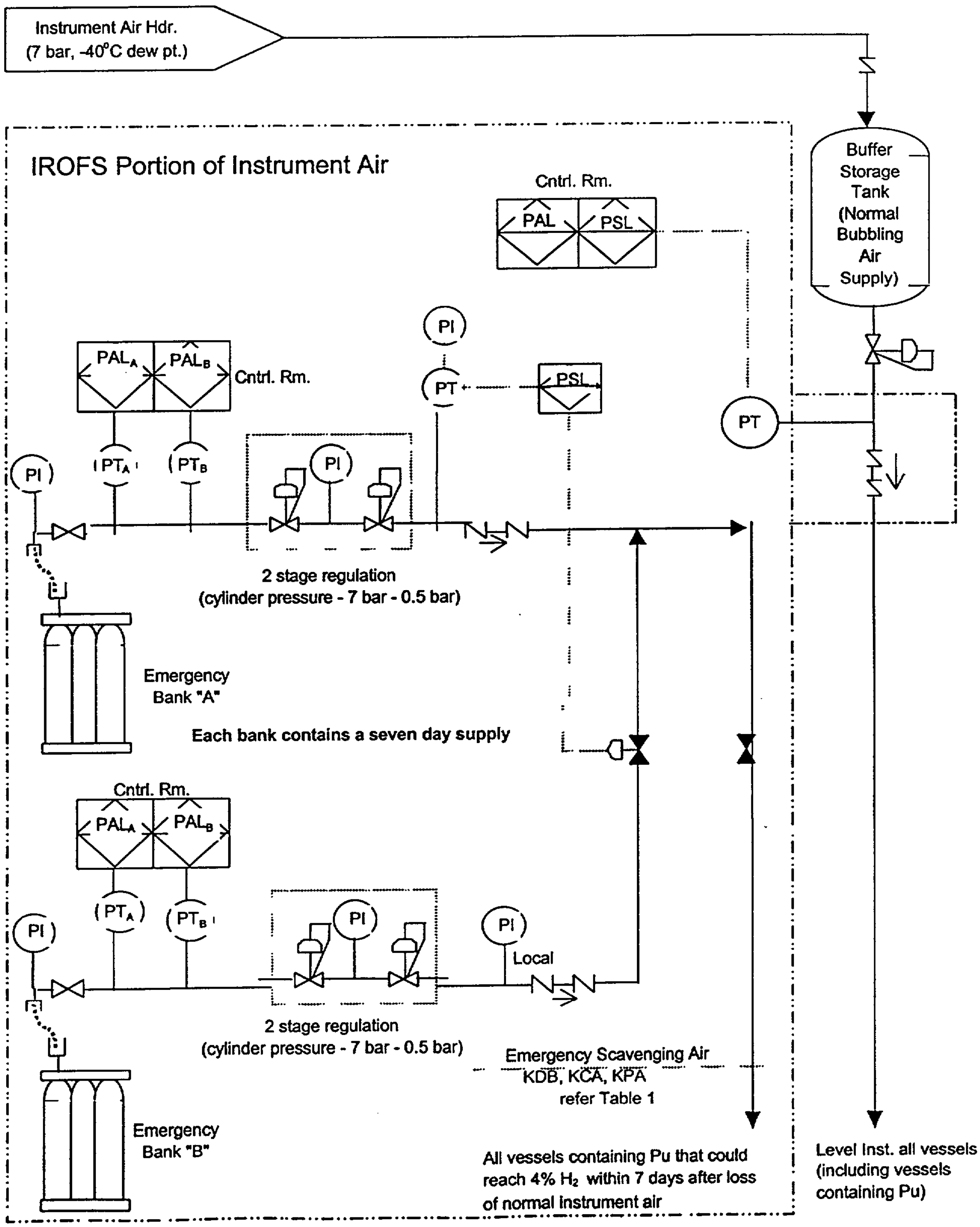
Please see the response to Questions 200 and 201 for more information related to the Instrument Air System and the Emergency Scavenging Air System.

Action:

Section 8.7 will be updated to reflect the information above in the next revision of the CAR.

Emergency Scavenging Air

(Emergency Dilution of Radiolysis Generated Hydrogen in Vessels Containing Pu That Could Reach 4% H_2 Within 7 Days)



123. Section 8.7, pp. 8.22 and 8.23

Describe and explain the process safety controls for evaporators containing tributyl phosphate (TBP).

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application , or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there is a brief statement that principal SSCs include the Process Safety Instrumentation and Control System to ensure that evaporator process temperature conditions do not exceed 275 F (135 C) in the presence of TBP. The reader is referred to Section 11.6 for details. Section 11.6 provides the general approach and codes and standards. Design basis functions and values are not included. Such information is needed before a safety determination can be made. For example, the NRC would anticipate that, in addition to temperature, there would be a design basis for determining the presence of TBP, design basis event(s), and a reliability requirement for the system (including the controllers and the sensors).

Response:

Action:

None

124. Section 8.7, pp. 8.22 and 8.23

Describe and explain the process safety controls for hydrogen and hydrogen/argon gas mixtures.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there are two brief statements that principal SSCs include the Process Safety Instrumentation and Control System to:

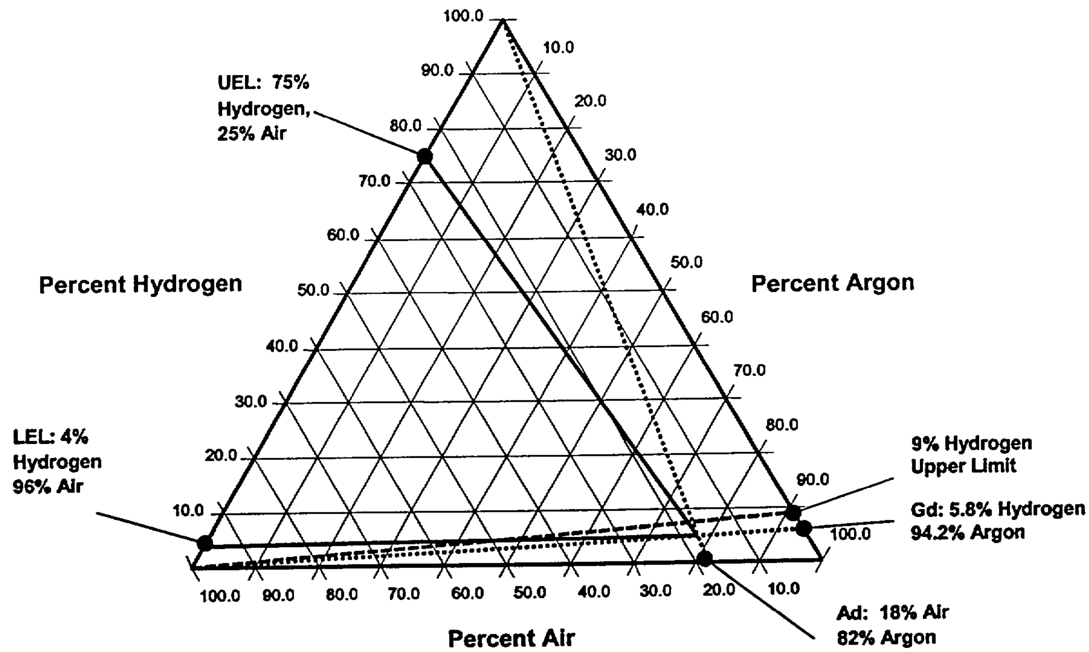
> "Ensure that a non-explosive mixture of hydrogen/argon is introduced into the MOX Fuel Fabrication Building."
>
> "Ensure that the flow of hydrogen is terminated prior to the attainment of explosive conditions."

The reader is referred to Section 11.6 for details. Section 11.6 provides the general approach and codes and standards for control systems. Design basis functions and values are not included. Such information is needed before a safety determination can be made. For example, the NRC would anticipate that there would be a design basis for determining the presence of hydrogen, the hydrogen ratio, presence/absence/quantity of flow, values and ranges, and reliability requirements (for sensors, controllers, and the system).

Response:

Action:

In the next update of the CAR, revisions to Section 11.9.2.2 to include this response will be provided.



LIMITING SAFE MIXTURES
OF
HYDROGEN, ARGON & AIR

Ref: Louis Medard, *Accidental Explosions*, 1989

LEL: Lower Explosive Limit
UEL: Upper Explosive Limit
Ad: Limiting safe mixture - % of argon in air
Gd: Limiting safe mixture - % of argon in hydrogen

125. Section 8.7, pp. 8.22 and 8.23

Describe and explain the process safety controls for hydroxylamine nitrate (HAN)/hydrazine temperature and flow limits.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there is a brief statement that principal SSCs include the Process Safety Instrumentation and Control System to shut down the process prior to exceeding HAN/hydrazine temperature or flow limits. The reader is referred to Section 11.6 for details. Section 11.6 provides the codes and standards for control systems in general terms. Design basis functions and values are not included. Such information is needed before a safety determination can be made. For example, the NRC would anticipate that there would be a description and design basis for measuring HAN and hydrazine, temperatures, flows, ranges and limits, and reliabilities, supported by the hazard analysis and safety assessment. Design bases would include requirements (response time, reliabilities etc.) for the control system, including the sensors, the hardware, and the software.

Response:

Action:

The CAR will be revised to reflect this information.

Attachment to Response for Question 125

DESCRIPTION OF THE INSTABILITY INDEX

The Instability Index is an empirical derivation that should only be used as a guide and should not be used to predict instability for conditions outside the experimental data region, especially for temperatures greater than about 75°C and for other metal catalysts (DOE-EH-0555, Feb. 1998).

Manual data analysis and empirical data fitting of the information generated at SRS and Hanford was used to develop an empirical expression of the instability index. The margin of safety can be predicted by the application of the instability index for the use and storage of HAN/nitric acid solutions with and without the presence of iron. The Instability Index expression, which accounts for the behavior of the system, is comprised of two additive arithmetic functions of the nitric acid to HAN ratio and the iron concentration of a specific solution. The Instability Index (I) is:

$$I = [1 + HNO_3]^{(1 + \log [HNO_3/HAN])} + [1 + HNO_3]^{(1 + \log [1 + 100 \bullet Fe])}$$

Where:

$[HNO_3]$	=	**nitric acid in molarity (M)**
$[HNO_3/HAN]$	=	**molar ratio of nitric acid to HAN**
[Fe]	=	**M_{FE}**
M	=	**ppm/(10^{-3}*Molecular Wt.)**

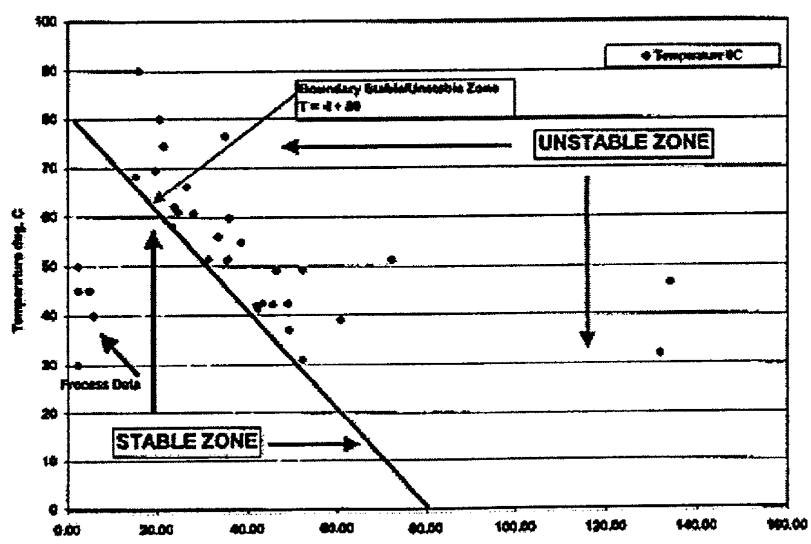


Figure 3. Temperature vs. Instability Index.

126. Section 8.7, pp. 8-22 and 8-23

Describe and explain the process safety controls for solvent temperature limits.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there is a brief statement that principal SSCs include the Process Safety Instrumentation and Control System to shut down the process prior to exceeding solvent temperature limits. The reader is referred to Section 11.6 for details. Section 11.6 provides the codes and standards for control systems in general terms. Design basis functions and values are not included. Such information is needed before a safety determination can be made. For example, the NRC would anticipate that there would be a description and design basis for measuring solvent temperature(s), the approach/means/control elements to "shut down the process," ranges/limits, and reliabilities, supported by the hazard analysis and safety assessment. Design bases would include requirements (response time, reliabilities etc.) for the control system, including the sensors, the hardware, and the software.

Response:

Action:

The CAR will be revised to reflect this information.

127. Section 8.7, pp. 8-22 and 8-23

Provide the chemical process safety design basis for the offgas treatment unit.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 8.7, "Chemical Process Safety Design Basis," there are the following brief statements on the functions of the Offgas Treatment Unit:

> "Ensure venting of vessels/tanks to prevent over-pressurization conditions."
>
> "Provide exhaust to ensure that an explosive buildup of explosive vapors does not occur."
>
> "Provide exhaust to ensure that an explosive buildup of hydrogen does not occur."

The reader is referred to Section 11.4 for details. Section 11.4 discusses the heating, ventilating, and air conditioning (HVAC) system. Section 11.4.2.1 is one sentence and is entitled "Offgas Treatment Unit" - it refers the reader to Section 11.3.2.11, "Offgas Treatment Unit." This section provides total and nitric acid flow rates. Design basis functions and values are not included for over-pressurization, explosive vapors, and hydrogen. Such information is needed before a safety determination can be made. For example, the NRC would anticipate that there would be a description and design basis for detecting and measuring over pressure, explosive vapors, and hydrogen. There might be an action limit (say, 25 percent of the LFL). This would include the approach/means/control elements to prevent the situation from occurring and/or ameliorate the situation if it does occur. The design basis would include ranges/limits, minimum flow requirements for "important" vessels and situations, and reliabilities, supported by the hazard analysis and safety assessment. Design bases would include requirements (response time, response, reliabilities etc.) for the control system, including the sensors, the hardware, and the software.

Response:

There are no additional design bases for the offgas treatment unit other than what are provided in CAR Section 8.7. Additional functions of the offgas treatment unit are as follows:

- Continuity of the first confinement barrier
- Recombination of nitrous fumes in a specific NOx scrubbing column

- Remove, by water scrubbing, acidic gases collected from AP process units
- Filter the offgases flow by HEPA filtration, before release to the stack (see Section 11.4.9 for filter description, test method and environmental qualification.)
- Treat offgases from the pulsed purification columns by HEPA filtration before release to the stack
- Treat offgases from the calcining furnace by HEPA filtration before release to the stack.

The responses to Questions 111, 121, 122, 142, 200, and 201 provide related information.

Action:

None

128. **Section 8.7, pp. 8-22 and 8-23**

Explain the design bases and controls for asphyxiating gases, such as nitrogen and argon.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

The MFFF intends to use numerous gases, such as nitrogen, argon, hydrogen etc. that are not capable of supporting life. While quantities are not defined, they are implied to be significant. Undetected potential leaks and accumulation of such gases could result in the incapacitation or evacuation of operators and affect the safe handling of radioactive materials. Control of these asphyxiants may be necessary. More information, including design bases and values, is necessary before a determination of safety can be performed.

Response:

As described in Section 5.5.2.10 of the CAR, during emergency conditions MFFF operators perform a monitoring role. They perform this function from the emergency control room. Although no immediate actions for operators have been identified, the Emergency Control Room Air Conditioning System has been identified as a principal SSC. Its function is to ensure habitable conditions for operators. During final design and HAZOP evaluations, specific requirements will be identified and incorporated as necessary. Thus, a release of a gas will not impact the safe handling of radioactive materials.

To support confinement following the design earthquake, each line is equipped with seismic isolation valves at the building penetration.

Additional design information related to MFFF gases is provided below. The table below lists the process parameters and flow rates for potentially asphyxiating gases.

Gas	Operating Temperature (°F)	Operating Pressure (psig)	Maximum Hourly Usage (scfh)	Annual Usage (ft^3/yr)	Line Size	Used In
Argon	Ambient	29.0	1,084	7.65E06	1.5"	Operating sintering furnace
Argon	Ambient	43.5	1,141	8.05E06	1.5"	Standby sintering furnace
Argon	Ambient	43.5	114	575,200	0.75"	Laboratory
Helium, High Pressure	Ambient	362.5	25	148,322	1"	Rod pressurization glovebox
Helium, Low Pressure	Ambient	43.5	127	192,780	1"	Welding scavenging glovebox
Hydrogen[1]	Ambient	29.0	57	402,600	1.5"	Sintering furnace
Nitrogen	Ambient	101.5	19,776	3.67E06	3"	BMP gloveboxes
Nitrogen Oxide[2]	55	25.0	21	147,825	1"	KPA, RNA

Notes: 1: Hydrogen is supplied to the sintering furnaces mixed with argon. There is no pure hydrogen supply.
2. Nitrogen oxide is mixed with an equal amount of compressed air prior to use.

All gases with the exception of argon/hydrogen and nitrogen oxide are primarily used inside continuously ventilated gloveboxes maintained at negative pressure. For example, the normal nitrogen usage outside the gloveboxes is approximately 350 scfh to miscellaneous BMP users, 55 scfh for N_2H_4 tank scavenging, and 175 scfh for sintering furnace airlock scavenging. This represents approximately 4% of normal nitrogen consumption. The remaining 96% of nitrogen is consumed in continuously ventilated BMP gloveboxes. The negative operating pressure of the gloveboxes ensures that the gases will not leak out and create an asphyxiation risk. The small quantities of nitrogen in use outside the gloveboxes coupled with the room ventilation system do not present an asphyxiation risk.

While nitrogen oxide is used in equipment under slight positive pressure, the equipment is located in a process cell and the cell itself is under negative pressure from the ventilation system. Any minimal releases of nitrogen oxide are captured by the ventilation system. In addition, personnel are not present in a process cell during normal operations. While the sintering furnace operates under positive pressure, the room ventilation (two air changes per hour) mitigates any buildup of argon / hydrogen from the sintering furnaces. A leak or rupture of all gas lines outside the gloveboxes creates the potential for gases to leak into areas normally occupied by personnel. However, the building ventilation system provides an average of two (2) air changes per hour. While a gas line could leak undetected, the high ventilation rates preclude the creation of an asphyxiating atmosphere.

The recommendations of Compressed Gas Association (CGA) publication P-14 Accident Prevention in Oxygen-Rich and Oxygen-Deficient Atmospheres will be incorporated in the operating procedures.

During detailed design, individual rooms and areas will be addressed on a case by case basis as necessary to establish if air monitors with alarms are required in some rooms / areas.

Action:

None

129. Table 8-2, p. 8-28

Provide complete chemical inventory information and verify that these are reasonably conservative values.

SRP Section 8.4.3.1B recommends that chemical process details, such as chemical reactants and products be included in the application. SRP Section 8.4.3.1E recommends that chemical inventory information be provided to include the complete chemical and radionuclide inventories within the facility for routine and credible off-normal conditions. SRP Section 8.4.3.2 recommends a list of hazardous chemicals and potential interactions.

Table 8-2 lists anticipated onsite inventories. From the associated discussion in Chapter 8, it is not clear if these are reasonably conservative values. In addition, several inventories are shown as "TBD" - to be determined; values are not given for argon, argon-methane mixture, azodicarbamide, helium, hydrogen, nitrogen, nitrogen tetraoxide, nitrous oxide, oxygen, and zinc stearate. Chemical and radiochemical inventories constitute fundamental contributors to the source terms in hazard analyses and their design basis functions and values are needed in order to make a determination regarding adequate assessment of safety.

Response:

The chemical listings of Chapter 8 of the CAR have been updated and revised as described in response to Question 113. Additionally, the TBDs have been updated.

The values in these tables are based on the largest vessels (tanks, drums, etc.) at the MFFF and assume the vessels are filled to capacity. Thus, the values in these tables provide conservative input values for the evaluation of the chemical consequences associated with a release of each chemical. These values are considered design data.

Potential chemical interactions and potential explosions are evaluated separately as discussed in the CAR. Additional information related to chemical interactions and potential explosions are provided in the responses to Questions 50, 54, 57, and 119 through 128.

Action:

The CAR will be revised to reflect this information.

CHAPTER 9, RADIATION SAFETY

130. Section 9.1.2.4.2, pp. 9-9 thru 9-10

Compare the quantitative values of the internal component of predicted occupational doses to values already provided for the external (direct) radiation component.

Section 9.1.4.2.3.C of the SRP recommends that the applicant's self-assessment of the submitted facility design, shielding, layout, traffic patterns, expected maintenance, and sources shows that both collective and individual doses from significant activities are within the limits of 10 CFR Part 20, As Low As Reasonably Achievable (ALARA), and meet facility design goals for routine and non-routine operations, including anticipated events. Preliminary quantitative estimates of direct radiation occupational doses are provided in section 9.1.2.4.1, "Dose Assessment Estimate." However, quantitative estimates of internal dose estimates are not provided in the following Section 9.1.2.4.2, "Internal Exposure," even though dates and International Nuclear Event Scale (INES) ratings are provided for actual MELOX events which may form such a basis.

Response:

Inhalation dose contributes less than 4.5 person-rem per year (assuming the full 50-year dose commitment in the year of exposure). The direct dose estimate is estimated to be approximately 12 person-rem per year. The total is estimated to be below 20 person-rem per year.

Action:

The first and third paragraphs of CAR Section 9.1.2.4.1 will be revised.

131. Section 9.1.3.1, p. 9-16 thru 9-17; Table 9-3, p. 9-38

In Table 9-3, add the concentration of plutonium-241 in the column for 0 year "Radiological Isotopic Composition."

10 CFR 70.22(a)(4) requires that the applicant provide the name, amount and specification of the special nuclear material the applicant proposes to use.

Response:

The composition of Pu-241 and Am-241 are set equal to the highest concentration over time, which is 0.01 Pu-241 and 0.00792 Am-241.

Action:

CAR Table 9-3 will be modified (see below) in the next CAR revision.

Table 9-3. Non-Polished Plutonium Sources (continued)

Non-Polished Plutonium Sources			
Isotope	**Concentration (gm/gm Pu+Am)**		
	0 yr RIC	**40 yr TIC**	**70 yr FIC**
Th-231		4.24E-15	7.74E-14
Th-232		1.50E-10	4.58E-10
Th-234		1.02E-18	1.83E-14
Pa-231		2.02E-11	5.62E-10
Pa-233			1.84E-11
Pa-234m		3.45E-23	6.16E-19
Pa-234		1.54E-23	2.75E-19
U-232		6.96E-10	5.22E-10
U-233			2.33E-09
U-234		1.83E-04	2.86E-04
U-235		1.83E-02	1.90E-02
U-236		2.57E-04	4.49E-04
U-237			7.31E-11
U-238		1.26E-03	1.26E-03
Np-237			5.42E-04
Pu-236	1.00E-09	5.98E-14	4.06E-17
Pu-238	6.86E-04	5.00E-04	3.95E-04
Pu-239	9.21E-01	9.20E-01	9.19E-01
Pu-240	6.18E-02	6.15E-02	6.13E-02
Pu-241	1.00E-02	1.00E-02	1.00E-02
Pu-242	1.00E-03	1.00E-03	1.00E-03
Am-241	7.00E-03	7.00E-03	7.92E-03

RIC – Radiological Isotopic Composition
TIC – Today's Isotopic Composition
FIC – Final Isotopic Composition

132. Section 9.1.3.1, p. 9-16 thru 9-17; Table 9-3, p. 9-38

Explain why the concentration of plutonium-242 shown in Table 9-3 increases from 0.001 grams Pu/Pu+Am at 0 years to 0.01 grams Pu/Pu+Am at 40 years, then decreases to 0.001 grams Pu/Pu+Am at 70 years.

10 CFR 70.22(a)(4) requires that the applicant provide the name, amount and specification of the special nuclear material the applicant proposes to use.

Response:

There is no increase. The Pu-242 concentration at 40 years has been revised to 0.001. See the revision to Table 9-3 in the response to Question 131.

Action:

CAR Table 9-3 will be modified in the next CAR revision.

133. Section 9.1.5, pp. 9-20 thru 9-23

Clarify the description of design goals provided in section 9.1.5, "Shielding Evaluations" (second full paragraph on p. 9-21)

Section 9.1.4.5.3.C of SRP recommends that the applicant derive permanent or temporary shielding requirements and specifications based on identified design objectives. The phrase "these are developed in the design," which appears to refer to design goals, is understood to mean that the 500 mrem design ALARA goal for workers, which is the goal defined in the ABAQUES method, is likely to change as design progresses. The last sentence, "The design goals are set based on this dose estimate" also suggests that design goals will be regularly reduced from an initial design goal of 500 mrem.

The design goal for internal and direct dose is based on a fraction of 10 CFR Part 20 limits. This design goal is achieved by making use of the design features and experience of the MELOX and La Hague facilities. The use of actual exposure data and the difference in the source terms between MELOX and MFFF material facilitate achievement of these design goals. The permanent and temporary shielding requirements developed as part of the design process ensure compliance with this design goal.

Response:

Requirements for shielding are determined during the design process. The design goal for the maximum individual dose was established early in the design process and will not change.

Action:

CAR Section 9.1.5 will be revised to add this clarification.

134. Table 9-2, p. 9-36

Update the MELOX Event INES Ratings described in Table 9-2 to include the most recent INES Level 1 event in March 2001.

Section 9.1.4.2.3.C of SRP recommends that the applicant's self-assessment of the submitted facility design, shielding, layout, traffic patterns, expected maintenance, and sources shows that both collective and individual doses from significant activities are within the limits of 10 CFR Part 20, ALARA, and meet facility design goals for routine and nonroutine operations, including anticipated events. Though quantitative estimates of internal dose estimates are not provided in the Section 9.1.2.4.2, "Internal Exposure," the dates and INES ratings are provided for actual MELOX events which may form such a basis. These events should be updated in the application to ensure that consideration is given to events which may affect the design of the MFFF.

Response:

An update of CAR Table 9-2 is provided below. An estimate of the inhalation dose potential is added to the direct exposure estimate to ensure compliance with 10 CFR 20 and ALARA. See response to Question 130.

Table 9-2 contains loss of confinement events with INES ratings only. The event in March 2001 (03/25/01), INES Level 1, was associated with the buildup of Pu on a HEPA filter and there was no loss of confinement and no internal occupational exposure. Therefore, this event is not included in Table 9-2.

Table 9-2. MELOX Event INES Ratings

Event Date	Unit	INES Rating
03/16/95	PuO_2 Decanning	Level 0
06/25/96	PuO_2 Decanning	Level 0
08/17/96	Grinding	Level 0
08/07/97	All Ventilation	Level 1
01/09/98	Grinding	Level 0
09/26/98	Grinding	Level 0
02/08/99	UO_2 Decanning	Level 0
06/29/99	Laboratory	Level 0
11/03/99	UO_2 Decanning	Level 0
11/14/00	Grinding	Level 1

INES – International Nuclear Event Scale
Data are current as of July 2001

From 1996 to July 2001, there have been 41 persons who have received an internal radiation exposure: 30 have received < 10% ALI, 10 ranging from 10% to 33.3% ALI, and 1 ranging from 33.3% to 100% ALI.

Action:

CAR Table 9-2 will be updated in the next revision of the CAR.

CHAPTER 10, ENVIRONMENTAL PROTECTION

135. Figure 10-1, p. 10-21

Explain and describe the high alpha waste buffer storage.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application , or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

Figure 10-1 depicts the liquid waste streams from aqueous polishing and has a box labeled "High Alpha Waste Buffer Storage." A description of this process area, its design bases, and design basis values could not be found in the associated text in Sections 8.1.1.2.3, 10.1.4, and 11.3.2.12. Such a description is necessary to understand the potential hazards associated with this system, safety issues, and any proposed principal SSCs and IROFSs.

Response:

The table below identifies the high alpha waste sources, the quantities of the waste streams, and the concentrations (or quantities) of the radioactive materials in the streams. The attached figure provides a simplified sketch of the high alpha waste system.

Waste Stream Designation	Maximum[1] Flow Rate (gallons/yr)	Normal Flow Rate (gallons/yr)	Concentration[2] or Annual Quantity
Excess Acid	1,321	1,321	Americium < 14 mg/yr
Stripped Uranium	42,530	35,400	Uranium = 16 g/L Or 2150 kg/yr U-235 concentration < 1% Plutonium < 0.1 mg/L
Liquid Americium	10,000	8,350	Americium = 24.5 kg/yr Gallium = 42 kg/yr Plutonium < 150 g/yr
Alkaline Wash	2,980	2,483	Uranium < 13 g/yr Plutonium < 13 g/yr

Note 1: Maximum flow includes unplanned recycling.

Note 2: Concentrations are based on normal flow rate. Total radioactive material quantities are the same for maximum or normal flow rate. Concentrations based on maximum flow rates would be less.

The stripped uranium stream produced by the KPA unit has 30% U-235. Therefore, the uranium nitrate from the mixer settler is collected in one of two isotopic dilution tanks where it undergoes isotopic dilution by the stream from the KDC to less than 1% U-235 (i.e., less than the critically safe limit of 2%). Two dilution tanks are provided. While one of the tanks is being pumped out, the other collects the stripped uranium stream. Once the stream has been diluted to less than 2% U-235, it may be transferred to the high alpha waste tanks.

The alkaline waste stream will be acidified in a separate neutralization tank prior to being mixed with the diluted uranium nitrate in the high alpha waste tanks. Neutralization and acidification is performed to eliminate the potential for an explosion from azide formation that may form under alkaline conditions. In acidic media the azides have a solubility limit greater than their concentration. Since the solubility limits of azides in alkaline media are lower, the alkaline media is neutralized to increase the solubility limits. This ensures that the azides do not precipitate and create an explosion potential.

The diluted uranium stream, the acidified alkaline stream, and the rest of the high alpha waste is collected in one of two high alpha waste tanks. While one tank is pumped out, the other collects the high alpha waste. The waste is pumped to SRS for storage and treatment using shielded lines. Level inside the tanks is remotely monitored using level instrumentation. The tank contents are sampled prior to start of transfer to SRS to ensure that they comply with the SRS Waste Acceptance Criteria (WAC). It is anticipated that a communications link between the MOX facility and SRS will be used to receive acceptance from SRS to initiate transfers and to signal end of operation at the end of transfer. These communication link issues will be developed during detail engineering.

The high alpha waste tanks are sized to accommodate a one-week quantity of waste based on 42 operating weeks per year. This corresponds to approximately 1,200 gallons per week. In addition, the tanks are sized to accommodate an equal volume (1,200 gallons) of backwash. Based on a suitable operating margin of 600 gallons, the high alpha buffer tanks are each sized for 3,000 gallons. The isotopic dilution tanks, high alpha waste tanks, and the neutralization tank are all located inside closed cells. The cells will be remotely monitored for radiation levels. Details of radiation monitoring issues will be addressed during detail design.

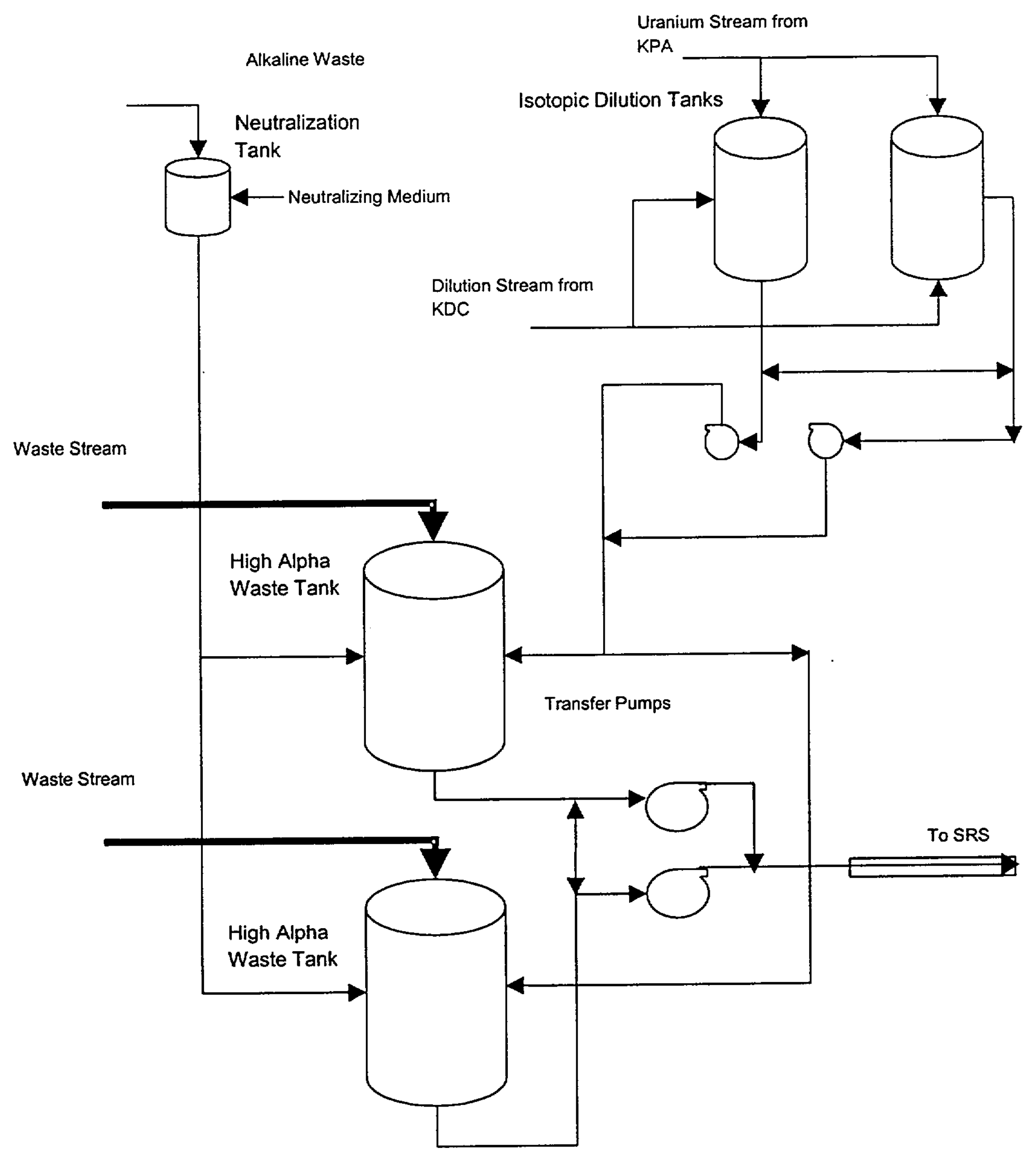
The high alpha buffer tanks are equipped with one operating and one spare pump. The pumps are each 40 gpm. This allows the transfer of the normal tank contents of 1,200 gallons from one high alpha buffer tank to SRS in 30 minutes. If the tank contents are greater than 1,200 gallons, transfer times will be longer.

Final design of the high alpha waste system will be clarified during the ISA/LA.

The high alpha waste system is designated IROFS.

Action:

Revise the CAR to reflect the above information.



High Alpha Waste System Diagram (Preliminary)

CHAPTER 11, PLANT SYSTEMS

136. Section 11.1.2, pp. 11.1-1 and 11.1-2

Indicate the significance (in terms of fire) of the "membrane top" or "engineered fill material" atop the roof slab in the MFFF.

Appendix D7 of the SRP recommends that fire resistance ratings for barriers should be a minimum of two hours, subject to an evaluation of the hazards. Therefore, ratings of all barriers are necessary to evaluate their adequacy. The upper membrane is not discussed in terms of fire or seismic hazards. Section 7.2.3.1 does not indicate the combustibility or fire resistance of the outer security structures.

Response:

The structural roof slab of the MOX Fuel Fabrication Building is reinforced concrete with engineered fill material atop the roof slab, which is covered by an additional reinforced concrete slab. The engineered fill is enclosed between reinforced concrete slabs. Granular, stone materials are used for the engineered fill.

Atop the uppermost concrete slab is a roof system constructed of rigid foam board insulation, tapered to provide a downward slope from the center to edges of the roof, and a fully adhered synthetic rubber, ethylene propylene diene monomer (EPDM), roof membrane. The fire hazard classification of the roof membrane is Class A in accordance with UL 790.

The engineered fill, additional concrete slab, and roofing system are considered in the seismic design of the Building.

Action:

In the next update to the CAR, the information above will be included.

137. Section 11.3, General

Provide the design basis information, including reliabilities, for SSCs in the aqueous polishing area.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

In Section 11.3, the aqueous polishing process and equipment are discussed. Some of the SSCs will be in cells that are not normally accessible and may have to go for extended periods (potentially the life of the plant) without planned inspection and maintenance. Design basis information and/or management measures are needed to demonstrate this can be accomplished in a safe manner. In addition, pumps and fluid moving devices will be in this area. Design basis information is needed to address leakage, seal replacement, and other pump inspection and maintenance activities. In the absence of this information, it is not possible to make a safety determination.

Response:

All process equipment containing nuclear material is located in cells or in gloveboxes in process rooms.

Process equipment located in process cells includes all welded vessels and piping with no routine maintenance required. These process cells will require minimum surveillance/corrective maintenance during the operating life of the facility. For these circumstances, the hazard will be removed prior to access.

Sensors are put in place or removed through guide tubes (pipe) from the adjacent corridors or rooms.

It is possible to enter the cells to perform programmed visual inspection or maintenance. Each cell is provided with a drip tray, which is monitored to detect process equipment leaks.

All other process equipment in which nuclear materials are handled such as pumps, valves, filters, and flanges are located in gloveboxes. These gloveboxes allow for easy access to structures, systems and components for routine inspection and maintenance while maintaining confinement.

The response to Question 39 contains additional information concerning reliabilities.

Action:

None

138. <u>Section 11.3, General</u>

Check and revise as necessary the use of the word "analyte"

The word "analyte" is used in several places where electrolysis is discussed (e.g., first sentence page 11.3-5). "Analyte" is usually used to refer to samples for analysis. "Anolyte" is the term usually used in reference to the solution around the anode of an electrolytic cell. The use of anolyte would seem to be a better choice to avoid confusion.

Response:

The correct term should have been "anolyte."

Action:

The term will be corrected in the next update of the CAR.

139. Section 11.3.2, General

Provide more information on principal SSCs/IROFSs for chemical safety and the corresponding operating ranges and limits.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application , or incorporated by reference, provided that these references are clear, specific, and essentially complete."

Sections 11.3.2.2.7 on page 11.3-6, 11.3.2.3.7 on page 11.3-9, 11.3.2.4.7 on page 11.3-10, 11.3.2.5.7 on page 11.3-13, 11.3.2.6.7 on page 11.3-14, 11.3.2.7.7 on page 11.3-15, 11.3.2.8.7 on page 11.3-18, 11.3.2.9.7 on page 11.3-20, 11.3.2.10.7 on page 11.3-23, and 11.3.2.11.7 on page 11.3-25 contain the phrase:

> "Normal operating parameters are described in Section 11.3.2.x.6. Principal SSCs are described in Chapter 5. Specific operating limits and the associated IROFSs will be provided in the ISA."

Additional information on chemical ranges and limits, and on IROFSs is needed before a determination of adequate safety can be made.

Response:

The response to Question 111 provides additional information on chemical ranges and limits for all of the unit operations. HAZOP studies currently being performed will establish and validate specific operating limits and verify that the planned IROFS are sufficient to ensure that the process conditions remain within safe limits. Additionally, responses to questions on Chapter 8 (Questions 111 – 129), Section 11.3 (Questions 137 – 143), Section 11.8 (Questions 190 – 195), and Section 11.9 (Questions 196 – 215) provide additional information on the operation of specific process units including information on chemical ranges and limits.

Action:

None

140. <u>Section 11.3, General</u>

Explain the flow path and disposition of the impurities (primarily americium, gallium, and uranium) in the plutonium.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application , or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

The aqueous polishing removes impurities (primarily americium, gallium, and uranium) from the plutonium. Tables 11.3-27 and 11.3-28 list some of the impurities, including values for maximum content and maximum exceptional content. It would be beneficial to have an explanation of the two terms "maximum content" and "maximum exceptional content." The flow path and intermediate accumulation locations of these impurities are not clear in Section 11.3, along with their disposition. A description of the flow path and disposition of these impurities, and their associated design bases and values, is needed before a safety determination can be made.

Response:

Action:

None

141. Section 11.3.2, pp. 11.3-1 thru 11.3-25

Explain the corrosion allowance and control in the electrolyzer and the dissolution unit.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

Section 11.3.2 indicates that the process uses silver(II) as an oxidant to assist with the dissolution of the plutonium oxides, and the reagent is generated electrically. This reagent and stray currents from electrolysis can be very corrosive to normally corrosion resistant materials of construction, such as stainless steels. Portions of the dissolver circuit may have to be made out of different alloys and/or controls may be necessary to limit the silver(II) concentration going to lower alloy portions of the system. Design basis information on corrosion allowances (e.g., limit for mil/yr), cracking, allowable crack depth/through-wall percentages, online monitoring techniques, and inspection approaches (e.g., monthly, annually) are needed to adequately assess hazards associated with potential failures induced by corrosion and the need for any safety controls.

Response:

Action:

None

142. Section 11.3.2.11., pp. 11.3-23 thru 11.3-25

Provide a description of the aqueous processing system offgas filtration system referred to as the "filtering line." Describe the relationship of the process vessel offgas system with the ventilation systems in Section 11.4. Describe how the offgas ventilation system is designed to withstand both routine and severe environmental conditions such as fires and explosions. Describe how HEPA filters in this system are tested to ensure performance.

The application describes how offgases from the aqueous polishing system are processed. The application does not provide a description of the filtration system, other than refer to it as a "filtering line" and say HEPA filtration will be used. It is unclear if the "filtering line" is the same as the filtration units described in Section 11.4.9. The application does not clearly describe the relationship to this ventilation system with the ventilation systems described in Section 11.4. The application does not describe how the offgas ventilation system is designed to withstand both routine and severe environmental conditions.

Response:

The "filtering line" consists of two stages of HEPA filters in a single housing. The HEPA filters are fabricated of glass media with metallic frames and silicone gaskets. The filters are at least 99.95% efficient and can operate in continuous service at 450°F (232°C). The filters can withstand a differential pressure of 10 inches WG (2488 Pa) without failure. Independent "filtering lines" are provided for several flow streams as identified in CAR Figure 11.3-21 and the process flow sheets provided in response to Question 111.

The Offgas Treatment Unit exhausters discharge into the building ventilation stack downstream of the ventilation fans and upstream of the effluent monitors.

The Offgas Treatment Unit has the following design features to withstand routine and severe environmental operating conditions.

- Bubbling Air scavenges tank ullage to maintain hydrogen concentrations at 1% or less.
- The system operates below the flash point of solvent vapors. See response to Question 123 for information on flash points of solvent.
- Supplemental air is added to the system to further dilute any potential combustible concentrations of gasses and to maintain minimum volumetric throughput for the scrubbing and washing columns.
- The material of construction is stainless steel to resist the corrosive atmosphere.
- The HEPA filters are constructed of acid resistant materials.

The HEPA filters will be tested in accordance with ASME N510.

Action:

None

143. Section 11.3.2.12, p. 11.3-25

Explain and describe the liquid and LLW process units.

Section 8.3 of the SRP states, "Information contained in the application should be of sufficient quality and detail to allow for an independent review, assessment, and verification by the reviewers. Some information may be referenced to other sections of the application, or incorporated by reference, provided that these references are clear, specific, and essentially complete." SRP Section 8.4.3.1 states that an application would be acceptable if it addresses the baseline design criteria for chemical safety and includes information on the chemicals, process, equipment, inventories, ranges, and limits. At the construction permit stage, this would be expected to include design bases and values for these items, with sufficient system description to allow verification of the design bases and values. Sections 8.4.3.5 B, C, D, and F recommend that design bases, process safety features, and IROFS be included in the application.

Section 11.3.2.12 mentions a "liquid waste reception unit." There is one sentence that reads, "The Liquid Waste Reception Unit will receive liquid waste from the AP process for temporary storage before sending it to SRS for treatment and processing." Figure 10-1 shows at least two liquid LLW buffer storage areas/units. A description of these areas, their design bases, and design basis values could not be found in the associated text in Sections 8.1.1.2.3, 10.1.4, and 11.3.2.12. Such a description is necessary to understand the potential hazards associated with this system, safety issues, and any proposed principal SSCs and IROFSs.

Response:

There are no principal SSCs associated with the LLW processing units because of the low radionuclide concentrations. Additional design information is provided below:

The low-level liquid waste streams include those that are aqueous based and one that is solvent based. The aqueous waste liquids are collected in tanks in the liquid waste collection (KWD) unit, whereas the solvent waste is placed into carboys for transport to SRS following analysis.

The low-level aqueous wastes will be analyzed and released to the SRS process sewer for treatment at the Effluent Treatment Facility (ETF). The stream will be sampled and verified to be in compliance with the existing criteria prior to release to the SRS.

Low Level Aqueous Waste Streams

- Room HVAC condensate, rinsing water from laboratories, and wash water from sanitary washing
- Distillate stream from the acid recovery unit that is contaminated and slightly acidic

Low Level Aqueous Waste Stream	Max. Flow Rate[1] (gallons/yr)	Normal Flow Rate, (gallons/yr.)	Concentration[2] or Annual Quantity of Radioactive Material
Rinsing Water	158,000	132,000	10^{-7} μCi/ml
Distillate	101,500	84,540	0.84 mg/year Am-241

Note 1: Maximum flows include unplanned recycling.

Note 2: Concentrations are based on normal flow rate. Total radioactive material quantities are the same for maximum or normal flow rate. Concentrations based on maximum flow rates would be less.

Additionally, corridor drains from firewater release are first routed to a sump and then transferred to the waste tanks in the KWD; no flow is expected during normal operation.

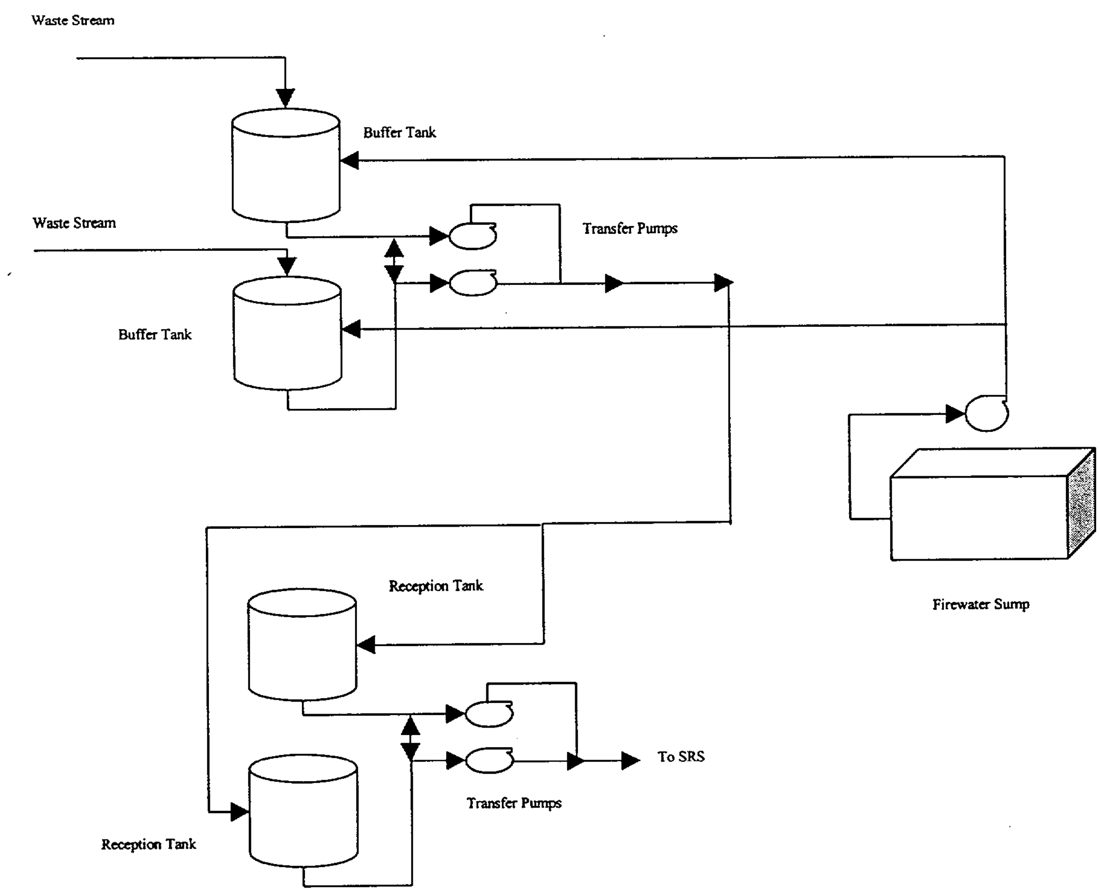
The aqueous LLW streams are collected in one of two 1,200-gallon capacity tanks in the KWD. The tanks are equipped with an operating and a spare pump that allow transfer downstream but are also connected to permit recirculation of the tank contents. The LLW is fed forward to two 5,000-gallon capacity waste reception tanks. These tanks are also equipped with an operating and a spare pump with similar transfer and recirculation capabilities. After sampling, the LLW from the waste reception tanks is transferred to the SRS process sewer for disposal in the ETF.

This system of buffer and reception tanks allows testing and recirculation, if necessary, to protect against an accidental release of waste that exceeds the SRS process sewer criteria. A simplified sketch for the LLW system is shown below.

Tanks in the LLW system will have level monitoring and sampling capabilities. Details of the system monitoring and controls will be developed during detailed design.

DUKE COGEMA
STONE & WEBSTER

Aqueous LLW Reception Unit Simplified Diagram

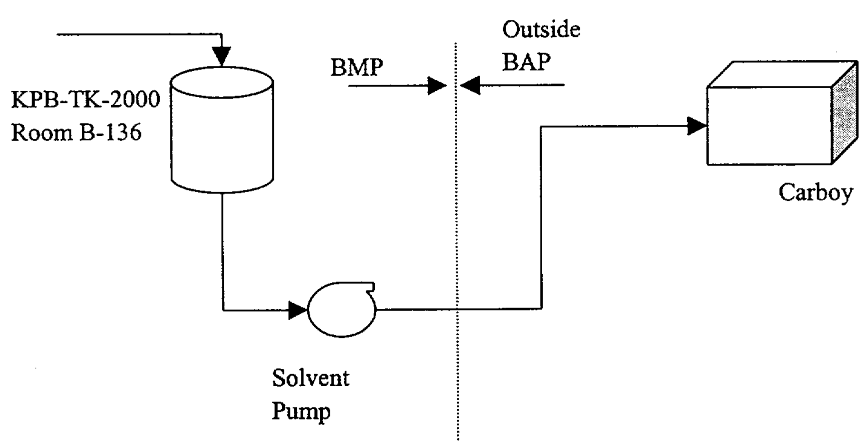


Solvent LLW Stream

Low level waste also includes excess solvent waste from the purification and solvent recovery units. This stream is very slightly radioactive with a maximum plutonium concentration of 2.0E-06 g/L. The normal annual flow rate of the excess solvent stream is 2,330 gallons with a maximum annual flow rate of 2,800 gallons.

Excess LLW solvent will be pumped to a 300-gallon capacity carboy outside the BAP and transported to SRS for disposal as part of the SRS low-level solvent waste processing system. A simplified sketch for the solvent system is shown below.

Solvent Waste Reception and Transfer (Proposed)



Action:

None

144. Section 11.4.1.2, pp. 11.4-1 thru 11.4-4

Provide a discussion of how the confinement system concepts in this section are applied to the sintering furnace. Provide justification for not enclosing the furnaces in gloveboxes to prevent releases to areas normally occupied by personnel.

Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants," states that ventilation systems should confine radioactive materials and prevent uncontrolled releases into room and areas normally occupied by personnel. The sintering furnaces are presented as static barriers without being enclosed by gloveboxes. Since the sintering furnaces operate at a positive pressure to maintain the reducing environment needed for reliable operation, any release from the sintering furnace would be discharged directly to an area normally occupied by personnel.

Response:

Action:

None

145. Section 11.4.2.6.3, p. 11.4-14

In the list of components for the Supply Air System, clarify the type of filters used in the "filter bank."

SRP Section 11.4.5.2.D.iv indicates that information is needed to determine if ventilation systems are capable of controlling airborne particulate material (dust) accumulation. The application describes the components in the Supply Air System. One of the components listed is a "filter bank" without further discussion on the type of filters used.

Response:

The filter bank, referred to in Section 11.4.2.6.3, Major Components, is composed of approximately 135 (24-inch x 24-inch x 11.5-inch) high efficiency particulate air (HEPA) filters rated at least 99.95% efficiency on particles of 0.3 microns and larger. This filter bank is down stream of the supply system's cooling coils and functions to prevent the remote possibility of radioactive contamination being carried by reverse airflow into the cooling coil section where it could contaminate the cooling coil condensate. This allows the cooling coil condensate to be handled as non-contaminated waste. These filters are protected from atmospheric dust loading by the upstream prefilter bank.

Action:

None