11.0 PLANT SYSTEMS

11.9 FLUID SYSTEMS (BULK MATERIALS, REAGENTS, AND GASES)

11.9.1 CONDUCT OF REVIEW

This chapter of the revised draft Safety Evaluation Report (DSER) contains the staff's review of the fluid systems described by the applicant in Chapter 11.0 of the revised Construction Authorization Request (CAR). The objective of this review is to determine whether the fluid principal structures, systems, and components (PSSCs) and their design bases identified by the applicant provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents. The staff evaluated the information provided by the applicant for fluid systems by reviewing Chapter 11.0 of the revised CAR, other sections of the revised CAR, supplementary information provided by the applicant, and relevant documents available at the applicant's offices but not submitted by the applicant. The review of fluid systems design bases and strategies was closely coordinated with the review of fire protection in Section 7.0 of this revised DSER, the review of chemical safety in Section 8.0 of this revised DSER, and the review of accident sequences described in the Safety Assessment of the Design Bases (see Chapter 5.0 of this revised DSER).

The staff reviewed how the information in the revised CAR addresses the following regulation:

- Section 70.23(b) of 10 CFR requires that the design bases of the PSSCs and the quality assurance program must provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents before construction of the principal structures, systems and components is approved.

The review for this construction approval focused on the design bases of fluid systems, their components, and other related information. For fluid systems, the staff reviewed and evaluated the information provided by the applicant for the safety function, system description, and safety analysis. The review also encompassed proposed design basis considerations such as redundancy, independence, reliability, and quality. The staff used Chapter 11.0 in NUREG-1718 as guidance in performing the review.

In the revised DSER discussions that follow, the system descriptions are provided as well as function, major components, control concepts, and system interfaces. These discussions include, but are not limited to, PSSCs, to provide an understanding of the system. Design bases of PSSCs are provided in Section 11.9.1.2.

The Nuclear Regulatory Commission (NRC) staff reviewed the revised CAR submitted by the applicant for the following areas applicable to the fluid systems at the construction approval stage and consistent with the level of design:

- System description.
- System function.
- Major components.
- Control concepts.
- System interfaces.
- Design bases.

Regarding the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF or the facility) fluid systems, specific design considerations given in the CAR should demonstrate the following:

- Transfer of heat loads to an appropriate heat sink under normal, off-normal, and accident conditions.

- Adequate water supply under normal, off-normal, and accident conditions.

- Adequate component redundance; the capability to isolate components, systems, or piping for maintaining system safety function under varying system configuration; and the capability of integrated system control.

- The applicant's commitment to supporting management measures (including tests and other verification methods) that ensure the structural integrity and system leak tightness (including the prevention of cross-contamination (radioactive and chemical)), the operability and adequate performance of active system components, and the capability of the system to perform required functions during normal and accident situations.

- Capability for withstanding environmental hazards resulting from pipeline breaks and dynamic effects associated with flow instability and attendant loads and measures to prevent such dynamic conditions from occurring.

- Capacity and capability for detecting leaks and cross-contamination (radioactive and chemical), for inservice component inspection and system maintenance, and for operational functional testing of the system and its components.

- System capability to maintain functionality when subject to tornadoes, tornado missiles, earthquakes, floods, and any other appropriate severe natural phenomena.

11.9.1.1 Description (Bulk Material, Reagent, and Gas Systems)

The facility fluid systems are bulk materials, reagents, and gas systems designed to support the production function of the facility. Duke, Cogema, Stone & Webster (DCS) has identified the Seismic Isolation Valves, Emergency Diesel Generator Fuel Oil System, and the Emergency Scavenging Air System as PSSC fluid systems. Non-PSSC systems may contain PSSC components, such as seismic isolation valves. Because these non-PSSC systems contain and could interact with PSSCs, they are summarized but not evaluated in this section. Only PSSC systems are evaluated. The fluid systems are divided into three generalized categories: Mechanical Utility Systems, Reagent Systems, and Bulk Gas Systems.

Mechanical Utility Systems: The mechanical utility systems consist of the heating, ventilation, and air conditioning (HVAC) chilled water system, process chilled water system, demineralized water system, process hot water system, process steam and condensate systems, plant water system, the emergency diesel generator fuel oil system, standby diesel generator fuel oil system, service air system, instrument air system (which includes the emergency scavenging air subsystem), breathing air system, and the radiation monitoring vacuum system. In general, these systems are non-PSSCs, but contain components, such as seismic isolation valves, that are PSSCs.

The HVAC chilled water system consists of an external loop to supply chilled water to the HVAC supply air system fan coils and an internal cooling loop to provide cooling water to individual area fan coils. The primary ventilation cooling coils are located “upstream” of the building intake high efficiency particulate air (HEPA) filters, thereby placing them outside of the building radiological boundary. Placing them in this location allows the condensate formed to be discharged directly. The process chilled water system consists of an external cooling loop that provides cooling water to multiple intermediate heat exchangers. In-leakage to the system will be monitored for contamination by radiation detectors located on a continuous bypass flowpath in the common chilled water return line of each internal cooling loop. The demineralized water system receives, stores, and transfers pressurized and gravity-fed demineralized water to process equipment and utility systems. The process hot water system is a closed-loop circulating system that supplies hot water to process equipment in the solvent recovery and purification cycles and the oxalic precipitation and oxidation units. The process steam system transfers and regulates the primary steam supplied by Savannah River Site (SRS) and the acid recovery unit secondary steam to the aqueous polishing (AP) area. The process condensate system collects and transfers primary condensate and acid recovery unit secondary condensate. Radiation detection is included in the design for the secondary steam/condensate closed loop systems. The plant water system consists of a supply header the supplies industrial-grade water from SRS to utility, MOX Processing (MP), and AP users. The standby diesel generator fuel oil system (SDGFOL) supplies fuel oil to the standby generators that are used to provide an onsite power source for major electrical loads. The service air system supplies pressurized air to the facility service air headers for maintenance and utility use and makeup to the instrument air system. The breathing air system is an independent air supply system that is used for personnel breathing in an emergency. The radiation monitoring vacuum system consists of multiple, parallel vacuum pumps, a common header and associated piping connected to parallel continuous air monitors and samplers designed to evaluate airborne radioactivity in the facility.

The HVAC chilled water system, process chilled water, demineralized water, process steam and condensate, and plant water system, contain seismic isolation valves, designated as PSSCs, that close on a seismic event to prevent flooding in the facility.

The emergency diesel generator fuel oil system (EDGFOS) is a PSSC that supports the emergency diesel generators. This system receives, samples, stores, and supplies fuel oil to the emergency diesel generators. The EDGFOS consists of a two independent fuel oil sub-systems, each capable of fuel receipt, long term storage, and transferring an adequate supply of fuel oil to its associated emergency diesel generator (EDG) operating at 100% load continuously for seven days. The tanks will be protected in a below-grade concrete vault adjacent to the EDG building. Each supply line has its own storage tank, transfer pump, day tank, purification system, strainers, filters, instrumentation and control elements, and piping. The supply lines will be installed in a protective enclosure located adjacent to the EDG. The EDGFOS will supply No. 2 fuel oil to the day tanks that are sized to store 660 gallons (2,500 liters) each. The EDG exhaust system is a PSSC and is made up of piping and silencers supplied in accordance with the manufacturer’s general design and supplied as part of the vendor-supplied skid-mounted generator set. The function of the EDGFOS is to receive, store, and transfer fuel oil to the emergency diesel generators used to provide emergency power to PSSCs in the facility. The function of the EDG exhaust system is to remove fumes and dampen noise produced by the EDGs. The major components of the EDGFOS are the fuel oil storage tank, the fuel oil day tanks, the fuel oil transfer pumps, isolation valves, and the EDG exhaust system. The EDGFOS employs fuel oil day tank level control and various level instrumentation and alarms. The EDGFOS interfaces with the EDGs and the emergency electrical power supply.

The instrument air system is a non-PSSC and is designed to supply instrument air to the instruments, air-operated pneumatic valves and HVAC dampers, normal bubbling air (normal scavenging air) for plutonium vessel level measurement and equipment atmosphere scavenging, cooling air for gloveboxes and pelletizing press bellows, and nitrogen system backup. Instrument air is a dried and filtered air specifically designed for instrumentation, valves, and emergency scavenging air; the emergency scavenging air subsystem is a PSSC. Instrument air is further dried for use as bubbling air for scavenging AP gloveboxes and miscellaneous equipment. A portion of the instrument air will be further dried to get super-dry process air for various instruments and for air being supplied directly to the AP process stream and in glovebox applications. The instrument air system will be designed to meet or exceed the standards of American National Standards Institute/Instrument Society of America (ANSI/ISA) S7.0.01-1996, "Quality Standard for Instrument Air."

The facility seismic isolation valves, that are PSSCs, automatically isolate during a seismic event. This system interfaces with the instrument air system, very high depressurization exhaust system, instrumentation and control (I&C) system, and seismic detectors. The applicant has considered related industry experience in developing the design basis of non-safety related air systems that support safety related equipment at the facility.

Reagent Systems: The reagent systems consist of the nitric acid system, the silver nitrate system, tributyl phosphate system, hydroxylamine nitrate system, sodium hydroxide system, oxalic acid system, diluent system, sodium carbonate system, hydrogen peroxide system, hydrazine system, manganese nitrate system, decontamination system, and nitric oxide system. In general, these systems are non-PSSCs, but contain components, such as isolation valves, that are PSSCs.

The nitric acid system provides 13.6N nitric acid to the AP process and for the preparation of hydrazine, oxalic acid, manganese nitrate, and silver nitrate reagents. The acid is stored in 55 gallon (208 liter) drums in the reagent processing building. The system includes isolation valves, designated PSSCs, that automatically isolate during a seismic event.

The silver nitrate system provides silver nitrate to the electrolyzers in the dissolution unit. Silver nitrate, demineralized water, and 13.6N nitric acid are mixed in a preparation tank in the AP area and fed to the AP process by a dosing pump.

The tributyl phosphate (TBP) system provides TBP for solvent extraction in the purification cycle of the AP process and solvent washing in the solvent recovery cycle. The system includes isolation valves, designated PSSCs, that automatically isolate during a seismic event.

The hydroxylamine nitrate system supports the stripping of plutonium in the AP or purification process. The system includes isolation valves, designated PSSCs, that automatically isolate during a seismic event. The hydroxylamine nitrate system interfaces with the normal power system, seismic detectors, and the purification cycle.

The sodium hydroxide system makes the sodium hydroxide "soda" for washing in the solvent recovery cycle. The sodium hydroxide system interfaces with the solvent recovery cycle and the normal power supply.

The oxalic acid system provides oxalic acid for converting plutonium nitrate to plutonium oxalate in the oxalic precipitation and oxidation unit. The oxalic acid system design includes isolation valves, designated PSSCs, that automatically isolate during a seismic event. The oxalic acid system interfaces with the normal power system, seismic detectors, nitric acid system, demineralized water system, and oxalic precipitation and oxidation unit.

The diluent system supplies diluent (branched dodecane) for washing in the purification and solvent recovery cycles and diluent for preparation of the 30 percent TBP solvent solution. This system interfaces with the purification cycle, solvent recovery cycle, tributyl phosphate system, and normal power system. The diluent system design includes isolation valves, designated PSSCs, that automatically isolate during a seismic event.

The sodium carbonate system is used in the solvent recovery cycle to wash and adjust the pH in the liquid waste reception unit in the AP process. Isolation valves, designated PSSCs, automatically isolate during a seismic event. The sodium carbonate system interfaces with the normal power system, seismic detectors, liquid waste reception unit, demineralized water system, and solvent recovery cycle.

The hydrogen peroxide system is designed to provide hydrogen peroxide for valence adjustment of the dissolution solution in the dissolution unit. Isolation valves, designated PSSCs, automatically isolate during a seismic event. The hydrogen peroxide system interfaces with the normal power system, seismic detectors, and the silver recovery unit.

The hydrazine system supplies hydrazine hydrate to be used in the preparation of hydrazine nitrate. The hydrazine nitrate is mixed with hydroxylamine nitrate and used in the purification cycle of the AP process. Tanks are vented to a hydrogen peroxide scrubber system before release to the atmosphere. All components of this system are located in the reagent processing building and do not require seismic isolation from the material or aqueous polishing buildings.

The manganese nitrate system supplies manganese nitrate to the oxalic mother liquor recovery unit. The manganese nitrate is used as a catalyst. The manganese nitrate system interfaces with the normal power supply, oxalic mother liquor recovery unit, and the nitric acid system.

The decontamination system supplies decontamination solution to the AP process. The decontamination system interfaces with the nitric acid system, the demineralized water system, the oxalic mother liquor recovery unit, the normal power supply, purification cycle, solvent recovery cycle, homogenization unit, acid recovery unit, silver recovery unit, liquid waste reception unit, dissolution unit, and offgas treatment unit.

The nitric oxide system supplies nitrous fumes (nitrogen dioxide and dinitrogen tetroxide) to the AP process to assist in the oxidation of plutonium nitrate in the purification cycle. NO_x detectors will be installed in rooms where fumes could be present. Isolation valves, designated PSSCs, automatically isolate during a seismic event. The system interfaces with the purification cycle, normal power supply, instrument air system, and seismic detectors.

Bulk Gas Systems: The bulk gas systems consist of the nitrogen system, the argon/hydrogen system, helium system, oxygen system, and methane/argon (P10) system. In general, these systems are non-PSSCs, but contain components, such as seismic isolation valves, that are PSSCs.

Nitrogen gas is a non-PSSC system suppled by an onsite nitrogen production system. Liquid nitrogen is stored in a tank in the MP area to supply germanium operating and reserve detectors. Nitrogen gas is also used for MP area glovebox inerting to eliminate adverse effects of atmospheric oxygen on the process or fuel, and also for scavenging the sintering furnace airlock. The sintering furnace airlock transfers molybdenum boats with sintered pellets from an argon/hydrogen atmosphere, and the nitrogen flow in the airlock is intended to eliminate the argon/hydrogen atmosphere prior to returning to the MP gloveboxes. The graphite rear bearing of the calcination furnace is cooled and the atmosphere inerted with nitrogen to lengthen the life of the bearing. DCS stated that this bearing provides a containment function. Nitrogen gas is also used to scavenge the hydrazine and hydroxylamine tanks and is designed to eliminate the concern for the flammability of hydrazine vapors in these tanks. A liquid nitrogen storage tank and ambient air vaporizer, designed to supply at least two days supply of nitrogen, provide backup for the onsite nitrogen production system. The nitrogen system is designed to operate at ambient temperature, at a pressure of 30-102 psig (3-7.9 bar) and a flow rate of 17,500-19,800 ft^3/h (495-561 m^3/h). The estimated annual usage of nitrogen is 3.67 million ft^3 (103,900 m^3). The nitrogen system must supply gas to the gloveboxes to meet the required oxygen impurity level inside the glovebox of less than 2000 ppm. Two nitrogen buffer tanks are included in the design with 1209 ft^3 (34.2 m^3) and 11 ft^3 (0.31 m^3) capacities. The backup nitrogen storage tank is 9000 gallon (34 m^3) capacity. DCS states in CAR section 11.9.2.1.1 that none of the functions of the nitrogen system are credited in the facility safety analyses, and the system is therefore not designated as a PSSC.

The argon/hydrogen system is a non-PSSC system that provides argon/hydrogen mixture to an operating electric sintering furnace, to furnace airlocks, and to the laboratory. The argon/hydrogen system may have IROFS that will be identified in the integrated safety analysis (ISA) summary to be submitted by the applicant as part of its application for a 10 CFR Part 70 operating license. The system will be designed to National Fire Protection Association (NFPA) 50A, “Standard for Gaseous Hydrogen Systems at Consumer Sites.” The argon/hydrogen system is designed to mix the gasses to make a 95:5 mixture (a proprietary range is given) used in scavenging the operating electric sintering furnace and airlocks in the MP area. It is also used in the laboratory. An emergency system, made of argon/hydrogen in compressed cylinders at 4.3 to 8 percent hydrogen, serves as backup to the normal supply system. This emergency supply of pre-mixed argon and hydrogen is stored in a tube trailer with a capacity of 53,000 ft^3 (1500 m^3) for a 24-hour backup supply. Pure argon provides secondary backup and pure nitrogen provides tertiary backup to the argon/hydrogen system. The argon is supplied from two argon vaporizing packages sourced from two 3,000 gallon (11 m^3) bulk liquid argon storage tanks, for a two week supply. Hydrogen gas is supplied from a tube trailer holding 43,000 ft^3 (1200 m^3) located in the facility gas storage area. The gas is supplied at 2,900 psig (200 bar) and pressure-reduced in two stations to normal operating pressure before being mixed with argon. The mixture of the two gasses is controlled by PSSC proportioning control valves and a PSSC static mixer. The hydrogen concentration in the buffer tank is continuously monitored by redundant detectors, identified as PSSCs, to ensure that the lower explosion limit in not exceeded. The argon/hydrogen mixture is supplied to the operating furnace at 29 psig (2 bar). The argon/hydrogen system is designed to operate at ambient temperature, at a pressure of 2,900 psig (200 bar) and a flow rate of 2,400 ft^3/h (68 m^3/h). The estimated annual usage of argon in the sintering furnaces and laboratory is 16.3 million ft^3 (462,000 m^3) and the estimated annual usage of hydrogen in the sintering furnace is 403,000 ft^3 (11,400 m^3). The major components of the argon/hydrogen system are the liquid argon bulk storage system, the hydrogen tube trailer, the backup argon/hydrogen cylinders, in-line mixing stations, and the buffer tanks, pressure transmitters, pressure control valves, alarms, piping, and isolation valves. The argon/hydrogen system is controlled by argon and hydrogen levels after mixing, automatic switching from normal supply to backup supply on low pressure, gas flow is maintained by flow control valves, pressure control valves regulate gas pressure to the sintering furnaces and laboratory, redundant hydrogen monitors, and the facility seismic isolation valves, designated as PSSCs, that actuate in the event of a seismic event. The argon/hydrogen system interfaces with the sintering furnaces, normal power supply, standby power supply, laboratory, and facility seismic detectors.

The helium system is supplied from tube trailers located in the gas storage area.   The safety functions of this system are to isolate during a seismic event and prevent backflow into the system. The major components of the helium system are the tube trailer, pressure regulator, pressure switches, alarms, relief valves, isolation valves, piping and switchover circuit. Penetrations into the facility have seismic isolation valves, designated as PSSCs, that automatically isolate the system during a seismic event. The helium system interfaces with the rod cladding and decontamination unit, rod welding scavenging, laboratory, and seismic detectors.

The oxygen system provides oxygen from cylinders, stored in the North end of the loading dock at the Reagent Processing building, to the calcination furnace in the homogenization unit in the AP area and to the laboratory in the MP area. The major components of this system are the cylinders, pressure regulators, pressure switches, alarms, three-way valve, relief valves, isolation valves, piping, and the instrumentation. The safety functions of this system are to isolate during a seismic event and prevent backflow into the system. The oxygen system interfaces with the calcination furnace, the MP area laboratory, and seismic detectors that actuate the seismic isolation valves, designated as PSSCs, during seismic events.

The methane/argon (P10) system is composed of 10 percent methane and 90 percent argon. DCS states that the system is supplied by one tube trailer holding a 6-week supply (45,000 ft^3 [1300 m^3] of argon-methane gas). The gas is will be found in the gas storage area and the laboratory.

11.9.1.2 Design Bases of the PSSCs

This section lists the referenced design basis codes and standards for proposed facility fluid systems identified as PSSCs.

Design Bases for PSSCs: Vessels/components are segregated/separated from incompatible chemicals. The chemical makeup of the reagent introduced into cells or AP reagent rooms is controlled to prevent explosions caused by chemical reactions. All piping, chemicals, and equipment will be clearly marked to prevent errors. Pressure vessels will be located away from PSSCs or otherwise protected so that a failure of any vessel would have no impact on the ability of the PSSC to perform its safety function.

Design Basis for Seismic Isolation Valves: Piping penetrations in the facility process building walls that could pose a fire, explosion, confinement, or flooding risk, or that could leak radioactive materials into the environment will be isolated by redundant, automatic, seismically qualified isolation valves. The redundant isolation valves are designed to receive isolation signals from redundant seismic monitors. An isolation will occur when a signal is sent to the pneumatic operator of the isolation valve to vent. Valve position indicators will be included in the design of the process and utility control room and the emergency control room. The seismic monitoring system is designed to satisfy the criteria provided in Regulatory Guide 3.17-1974, "Earthquake Instrumentation for Fuel Reprocessing Plants." The design basis of the seismic monitoring system is that it provides sufficient data to evaluate the response of the confinement structure and other PSSCs to a seismic event and initiate a shutdown of process systems in the event of a high seismic event. The seismic system will meet the requirements of Institute of Electrical and Electronics Engineers (IEEE) Standard 603, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations," 1998. Seismic qualification of these valves will be done in accordance with IEEE Standard 344, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," 1987 (See discussion of the acceptability of this standard in Section 11.5, Electrical, and NRC Regulatory Guide 1.100, Rev. 2, "Seismic Qualification of Electric Equipment for Nuclear Power Plants," dated 1988.) These valves have been identified as PSSCs and will be handled according to the facility Quality Assurance Program (QAP) quality level appropriate to each application of an isolation valve.

The seismic isolation valves can be of the following types: butterfly, gate, plug or ball. The design is determined based on the chemical characteristics of the fluid, the construction material for associated piping, and operating conditions. The valve design will use good engineering practices and will be in accordance with applicable code practices. The valves will be supported in such a way as to remain operable during design basis events.
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Instrument air quality is very important to maintain the reliability of pneumatic isolation valves. DCS has committed to design, operate, and maintain the instrument air system to the standard given in ANSI/ISA S7.0.01-1996, "Quality Standard for Instrument Air," or better.

Evaluation of Seismic Isolation Valves: During this evaluation, the staff reviewed applicable federal regulations, national codes and standards, the MOX Standard Review Plant (SRP), other industry and NRC staff guidance, and available operational history. The staff's consideration and use of these documents are discussed in the following evaluation.

As discussed previously, all piping penetrations in the facility process building walls that could pose a fire, explosion, confinement, or flooding risk, or that could leak radioactive materials into the environment will be isolated by redundant, automatic, seismically qualified isolation valves. These valves have been designated PSSCs. They will receive signals to isolate from redundant seismic monitors. These valves have been identified as PSSCs and will be ordered, built, delivered, installed, and used in accordance with the facility QAP quality level appropriate to each application. The staff evaluation of the design basis for the seismic isolation valves follows:

The staff has reviewed DCS proposed design basis for the seismic isolation valves against national codes and standards and industry practices. The staff also applied the guidance of the MOX SRP to the review.

The isolation of fluid systems from the MFFF building is achieved by redundant seismic isolation valves that are designed to fail to a closed position. An isolation will occur when a signal is sent to the pneumatic operator of the isolation valve to vent. The venting of the air from the operator removes the power from the system resulting in the operator moving to the "closed" position. Valve position indicators will be included in the design of the process and utility control room and the emergency control room. Seismic qualification of these valves will be done in accordance with IEEE Standard 344, “IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,” 1987 (See discussion of the acceptability of this standard in Section 11.5, Electrical, and NRC Regulatory Guide 1.100, Rev. 2, “Seismic Qualification of Electric Equipment for Nuclear Power Plants,” dated 1988.) DCS has committed, in its mechanical equipment seismic qualification program, to considering attached piping loads, thermal loads, and live loads such as tank sloshing in its design. The applicant has committed to using standards for the seismic qualification of isolation valves which are commensurate with standards applicable to commercial nuclear power stations. The staff finds these commitments acceptable.

The isolation valves will be designed to passively return to a closed, or isolated, position in the event of a failure of the valve actuator or the air supply. Based on the varying sizes, designs, materials of construction, methods of operation, and fail-safe design, the staff finds that the seismic isolation valves have the redundancy and diversity of components required for isolation and to prevent release of radioactive material to the environment.

DCS has committed to design fluid systems, including the seismic isolation valves and other components with consideration to the process fluids contained therein and will specify materials with the appropriate corrosion resistance. Consideration will also be made by the applicant to proper surface finishes and decontamination characteristics for their particular application in a system. Based on these considerations and their alignment with the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section VIII, for materials and design methodology, the staff finds this design basis to be acceptable.

The seismic isolation valves will be designed and qualified to maintain functionality when subjected to severe natural phenomena such as tornadoes, tornado missiles, earthquakes, floods, and any other appropriate phenomena as established in the ISA. The seismic isolation valves will actuate on a seismic event that is one-third of the design basis earthquake ground motion, that is one-third of the safe-shutdown earthquake ground motion. This design basis meets the requirements for nuclear power generation facilities given in 10 CFR Part 50, Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” Section IV(a)(2)(i)(A). The staff finds this design basis to be acceptable, since the facility design for actuation of the seismic isolation valves is based on the ground motion found to be acceptable at nuclear power generation facilities.

The seismic monitoring system is designed to satisfy the criteria provided in Regulatory Guide 3.17-1974, “Earthquake Instrumentation for Fuel Reprocessing Plants.” The design basis of the seismic monitoring system is that it provides sufficient data to evaluate the response of the confinement structure and other PSSCs to a seismic event and initiate a shutdown of process systems in the event of a high seismic event. The seismic system will meet the requirements of IEEE Standard 603, “IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations,” 1998. On the basis of the seismic monitoring system meeting the requirements of the IEEE standard, the staff finds this design basis to be acceptable.

Instrument air quality is very important to maintain the reliability of pneumatic isolation valves. DCS has committed to design, operate, and maintain the instrument air system to the standard given in ANSI/ISA S7.0.01-1996, “Quality Standard for Instrument Air,” or better. In general, the staff agrees with the use of the instrument air system as the motive force for the seismic isolation valves. On the basis of the applicant’s commitment to ANSI/ISA S7.0.01-1996, and the applicant's consideration of relevant industry experience with non-safety related air systems (discussed in section 11.9.1.1 of this revised DSER), the staff finds this design basis to be acceptable.

Design Basis of the Emergency Diesel Generator Fuel Oil System: Both the main emergency fuel oil supply vault and the EDG building are designed to survive natural phenomena hazards such as earthquakes, floods and tornadoes. EDG piping and equipment are seismically qualified to prevent failures from causing a loss of emergency electrical power supply. Seismic qualification will be performed in accordance with IEEE Standard 344-1987, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," (See discussion of the acceptability of this standard in Section 11.5, Electrical) and NRC Regulatory Guide 1.100, Rev. 2, "Seismic Qualification of Electric Equipment for Nuclear Power Plants," dated 1988. The each EDG fuel oil system has a bulk tank that is sized for seven days use (plus extra operational margin for testing). The storage capacity was sized for an EDG running at 100% power for seven days plus some reserve capacity. The EDG design, with redundant transfer pumps, fuel oil lines, associated piping, exhaust equipment are designed to prevent a single failure from causing a loss of the emergency electrical power supply. This equipment has been identified as PSSCs and will be handled according to the facility QAP quality level appropriate to the importance of each piece of equipment. The equipment will comply with the requirements of IEEE Std 308-1991, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations," American Nuclear Society (ANS) 59-51-1997, "American Nuclear Society Fuel Oil Systems for Safety Related Emergency Diesel Generators," and American Society for Testing and Materials (ASTM) D75-94, "Standard Specification for Diesel Fuel Oils." The EDG exhaust system function is to collect and remove exhaust efficiently and silently. The engine silencer will be capable of attenuating noise from a running EDG to acceptable Occupational Safety and Health Administration (OSHA) levels for worker hearing protection in an industrial environment. The EDG exhaust system will be included in the generator set from the vendor as a packaged unit and will comply with NFPA-37, "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines" (1998) and NFPA-110, "Standard for Emergency and Standby Power Systems" (1999).

Fuel filtration or conditioning is proposed at five places in the EDGFOS: 1) on receipt of new fuel from the remote filling station, 2) at the transfer pump suction, 3) in a by-pass flow purification system, 4) between the day tank and the engine, and 5) at the engine itself. The filter on the remote filling station for the main tank will be a multi-element, differential pressure instrumented, inlet filter rated at 2μm [0.08 mils]. The basis for this filter is to prevent coagulated fuel and particulates from entering the storage tank assuming a low-pressure input flow of 80-100 gpm (5.0-6.3 L/sec.). The transfer system will use a rotary screw positive displacement pump to filter and circulate fuel oil from a main storage tank to the associated day tank. The transfer system filters will be differential pressure instrumented, dual basket switchable stainless steel suction strainer with automatic transfer and mesh filters rated to remove 100 percent of 1.8 mils (45μm) particles and 98 percent of particles at 0.7 mils (17μm). The flow rate for the transfer pump is approximately 25 gpm (1.6 L/sec.). The by-pass flow purification system will redirect approximately 15-20 gpm (0.9-1.3 L/sec.) of fuel through the purification filters and de-water devices. The by-pass flow purification system is a vendor package containing filters and water-removal equipment that is connected between the transfer system supply and return lines. The transfer pump will provide the flow through the system. The transfer pump will be operated on a periodic basis to maintain fuel oil condition. The purification package will condition the full by-pass flow of fuel oil while the transfer pump is operating.

The immediate use day tank includes an engine supply line with a differential pressure instrumented, switchable stainless steel mesh dual-element strainer with automatic transfer valve. The mesh filters will be rated to remove 100 percent of particles at 0.7 mils (18μm) and 98 percent of particles at 0.2 mils (5μm). These filters are sized to prevent the clogging of the engine-mounted fuel filters, that are also sized at 0.2 mils (5μm). The engine fuel pump provides motive force for this fuel flow. The typical flow in the fuel oil system, between the engine and the day tank is approximately 330 gph (21 L/min), with the EDG using 72 gph (4.5 L/min.) at 100 percent load and 258 gph (16.3 L/min.) returning to the day tank.

The entire system of filters and screens are designed to turnover, filter, and purify the entire volume of the main storage and day tanks every twelve hours. The filtration system is designed to remove abrasive particulates and water that could damage the system pumps and EDG.

Evaluation of Emergency Diesel Generator Fuel Oil System: In order to complete this evaluation, the staff reviewed national codes and standards, such as IEEE Standard 308, “IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,” NFPA-37, “Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines” (1998) and NFPA-110, “Standard for Emergency and Standby Power Systems” (1999). The staff reviewed the seismic design of the EDGs. The staff also reviewed the design basis and provisions for maintaining a clean, reliable source of fuel oil for the emergency diesel generators by comparing the proposed design to standard industry practices and historical diesel generator failure information published by NRC.

As discussed in the system description, the EDGFOS should be designed to supply adequate capacity exists to handle expected volume of material during normal, off-normal, and accident conditions. Each EDG fuel oil system bulk tank capacity is based on an EDG running at 100 percent load for seven days (plus extra operational margin for testing). This design meets the requirements of IEEE Standard 308. The flow rate for the transfer pump is approximately 25 gpm (1.6 L/sec.). The by-pass flow purification system will redirect approximately 15-20 gpm (0.9-1.3 L/sec.) of fuel through the purification filters and de-water devices. The immediate use day tank includes an engine supply line with a differential pressure instrumented, switchable stainless steel mesh dual-element strainer with automatic transfer valve. The typical flow in the fuel oil system, between the engine and the day tank is approximately 330 gph (21 L/min.), with the EDG using 72 gph (4.5 L/min.) at 100 percent load and 258 gph (16.3 L/min.) returning to the day tank. The engine silencer will be capable of attenuating noise from a running EDG to acceptable OSHA levels for worker hearing protection in an industrial environment. The EDG exhaust system will be included in the generator set from the vendor as a packaged unit. Based on this review, the staff believes that the designs of the EDGFOS and the EDG exhaust system are acceptable.

The EDGFOS and EDG exhaust system do not interface with systems that carry radioactive material, therefore the consideration of the redundancy and diversity of components required to prevent release of radioactive material to environment is not required. The evaluation of the adequacy of the EDG system for its intended safety purpose may be found in Section 11.5 of this revised DSER.

The seismic design of the EDGFOS and the EDG exhaust system assure that these systems will be able to safely shutdown during normal operations and accident conditions. Based on the description of the system and the structures that will contain the system, the EDGFOS is adequately designed to maintain functionality when subjected to severe natural phenomena such as tornadoes, tornado missiles, earthquakes, floods, and any other appropriate phenomena as established in the ISA. The EDG engine fuel oil pump is an PSSC that will support the EDGs starting from rest and accepting a load within 10 seconds at a temperature of -7°C [20°F]. See the earlier evaluation of the seismic design bases for the EDGFOS and the EDG exhaust system. The staff finds the provision for emergency power for the continued operation of the EDGs to be acceptable.

The staff has reviewed the design and configuration of the EDGFOS tanks and piping. Due to the nature and location of the system, the staff finds that it cannot be designed to take advantage of gravity flow in order to perform its primary function. However, the redundancy and diversity of the system and the seismic design, applied to the design as standard industry practices, will assure a positive flow of fuel oil into, and waste gas removal from, the EDGs. The EDGFOS and EDG exhaust systems are designed to minimize the likelihood that nuclear material can enter these systems. Neither of these systems interface with systems that contain nuclear material and are, in fact, completely external to the facility buildings. This provides reasonable assurance that contamination or criticality will not occur in these systems. DCS has committed to design these systems and components with consideration to the process fluids contained and will specify materials with the appropriate corrosion resistance where necessary. The staff finds the design of the system tanks, piping, and pumping systems to be acceptable.

The staff has evaluated the EDG exhaust system to determine the provisions for personnel protection. The engine silencer will be capable of attenuating noise from a running EDG to acceptable OSHA levels for worker hearing protection in an industrial environment. The EDG exhaust system will be included in the generator set from the vendor as a packaged unit and will comply with NFPA-37, “Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines” (1998) and NFPA-110, “Standard for Emergency and Standby Power Systems” (1999). On the basis of this system design and industry codes and standards and standard industry practices, the staff finds the EDG exhaust system to be acceptable.

The electrical capacity of the EDGs has been reviewed by the staff and can be found in Section 11.5 of this revised DSER.

Design Basis for Emergency Scavenging Air Subsystem: The emergency scavenging air subsystem of the instrument air system is designed to provide scavenging air for dilution of hydrogen that may be produced by radiolysis. The equipment most likely to produce hydrogen by radiolysis are primarily those tanks containing a high plutonium concentration solution. The emergency pressurized air supply tanks and piping are seismically qualified in accordance with IEEE Standard 344-1987, “IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,” (See discussion of the acceptability of this standard in Section 11.5, Electrical) and NRC Regulatory Guide 1.100, Rev. 2, “Seismic Qualification of Electric Equipment for Nuclear Power Plants,” dated 1988, and will be manually operated following a design basis event. The emergency scavenging air subsystem, a PSSC, is physically separated from the instrument air system and is automatically activated following the loss of the normal instrument air supply by opening one of the two parallel, fail open, air operated valves. The system is intended to be fitted to vessels and equipment in the AP areas that will produce hydrogen by radiolysis and that could reach the LEL of hydrogen in air (4 percent) in seven days. The emergency scavenging air system is designed to provide a seven day supply of emergency scavenging air, based on consideration for a reasonable time to repair or restore the normal bubbling air supply following failure of the instrument air system. The one hour supply for the receiver/buffer tanks is sized based on the estimated time to facilitate a normal process shutdown following loss of instrument air.

Evaluation of Emergency Scavenging Air Subsystem: In order to complete this evaluation, the staff reviewed national codes and standards, such as IEEE Standard 308, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations," NFPA-801, "Standard for Fire Protection for Facilities Handling Radioactive Materials," Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants," Regulatory Guide 1.100, Rev. 2, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," 1988, and IEEE Standard 344, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

The emergency scavenging air subsystem is a PSSC designed to provide emergency scavenging air for dilution of hydrogen that may be produced by radiolysis. The equipment susceptible to this condition are primarily those containing a high plutonium concentration solution. Ordinarily, extra-dry instrument air is used by the Bubbling Air System to scavenge the hydrogen produced in equipment. The Bubbling Air System is designed to prevent the system from exceeding twenty-five percent of the lower flammability limit (LFL) (or 1 percent total) for hydrogen in the tanks. In the event of a failure of any of these systems, the emergency scavenging air subsystem is designed to compensate for the loss of the Bubbling Air System. The emergency scavenging air subsystem is automatically activated following a loss of instrument air. The emergency scavenging air system is designed to supply emergency scavenging air to all process vessels that could reach a hydrogen concentration of 4 percent within seven days. Each bank of the emergency scavenging air system pressurized air supply main and backup banks of compressed air cylinders and piping are designed for 100 percent capacity for seven days. The two banks are connected by an air pressure controller and transfer valves that switch from the primary bank to the secondary bank on low system pressure. The emergency scavenging air subsystem is not physically connected to the normal scavenging air supply.

The NRC staff reviewed the requirements for other safety-related backup systems, including national codes and standards such as IEEE Standard 308, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations." In that standard, the required storage of fuel for the standby power supplies (such as EDGs) is either seven days or the time required to replenish the fuel and test it. DCS has committed to a seven day fuel supply for the EDGs. Therefore, based on the IEEE standard and DCS's commitment to providing a seven day fuel supply for the EDGs, the staff finds that a seven day supply of emergency scavenging air is acceptable. The design basis for the maximum hydrogen level allowed by the emergency scavenging air subsystem is calculated to prevent the hydrogen concentration from exceeding 1 percent by volume. This level is equivalent to 25 percent of the LFL for hydrogen in air and, as discussed in Section 7.0, Fire Protection, is generally an accepted limit. NFPA 801, to which the applicant has committed, specifies that hydrogen concentrations be kept at or below 25 percent of the LFL in air. Therefore, the staff finds that the emergency scavenging air subsystem design basis for the maximum allowed hydrogen concentration in vessels susceptible to hydrogen generation to be acceptable based on DCS's commitment to NFPA 801.

The emergency scavenging air subsystem is designed to provide two trains each capable of supplying 100 percent of the scavenging air requirements for seven days. Based on the provision of two 100% capacity trains of emergency scavenging air, and the design of the system air pressure control to switch supply banks on low system pressure, the staff finds that the subsystem has adequate redundancy and diversity of components required to prevent release of radioactive material to the environment and that its design is adequate for safe operation of the system.

The emergency scavenging air subsystem is independent of the instrument air system and is automatically actuated following loss of the scavenging air function in certain tanks susceptible to the buildup of flammable levels of hydrogen due to radiolysis. The subsystem does not rely on emergency power and is designed to operate during accident conditions. The staff concludes that, due to the passive nature of the subsystem, it can be safely shutdown during any normal or accident conditions.

The emergency scavenging air subsystem is isolated from process fluids by the air-spaces at the top of the tanks it is designed to serve. In accident situations, the system is pressurized above the pressure in the process equipment, so the flow of material is expected to be into the tank. The staff concludes that, based on the positive pressure of the subsystem, and the location of the supply nozzles relative to process fluids, that the subsystem is adequately designed to minimize the likelihood of contamination and holdup of hazardous nuclear materials.

The design of the emergency scavenging air subsystem falls into the fluid transport system (FTS) Category 2, discussed in revised DSER Section 11.8. Category 2 is for PSSC components that may contain trace quantities of plutonium or americium or non-radiological fluids that play a significant role in plant production reliability. This means that the system is designed to ASME B&PV and B31.3 codes standards. This includes consideration of piping material for corrosion protection and piping layout. Enhanced positive material identification, inspection, and test requirements are used in the procurement specifications for FTS Category 2 components. The staff concludes that these design criteria adequately address equipment design to resist corrosion, piping design and layout.

The design basis of the emergency scavenging air subsystem includes layout and design of the system to minimize the potential for entrapment and buildup of radioactive materials. Therefore, the staff concludes that the equipment is made of materials with the proper surface finishes and decontamination characteristics for their particular application.

The SRP guidance suggest that equipment be adequately designed to maintain functionality when subjected to severe natural phenomena such as tornadoes, tornado missiles, earthquakes, floods, and any other appropriate phenomena as established in the ISA. The emergency scavenging air system is seismically designed and qualified in accordance with the guidance of NRC Regulatory Guide 1.100, Rev. 2, “Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants,” 1988, and IEEE Standard 344, “IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,” 1987. On the basis of the design to that guidance and industry standard, the staff concludes that the applicant adequately addressed the features that apply to this PSSC.

11.9.2 EVALUATION FINDINGS

In revised CAR Section 11.9, DCS provided design basis information for the fluid systems that it identified as PSSCs for the proposed facility. Based on the staff's review of the revised CAR and supporting information provided by the applicant relevant to the fluid systems, the staff concludes, pursuant to 10 CFR 70.23(b), that the design bases of the PSSCs evaluated in this revised DSER section will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

11.9.3 REFERENCES

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11.9.3.2 _____. ASME B16.10, “Face-to-Face and End-to-End Dimensions of Valves.” ASME: 2000.

11.9.3.3 _____. ASME B31.3, “Process Piping.” ASME: 2001.

11.9.3.4 American Society of Testing and Materials (ASTM). ASTM D75, “Standard Specification for Diesel Fuel Oils.” ASTM: 1974.

11.9.3.5 Institute of Electrical and Electronics Engineers (IEEE). IEEE Standard 308, “IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,” 1991.

11.9.3.6 _____. IEEE Standard 344, “IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.” IEEE: 1987.

11.9.3.7 _____. IEEE Standard 603, “IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.,” IEEE: 1998.

11.9.3.8 Ihde, R, Duke Cogema Stone & Webster, letter to Document Control Desk, U.S. Nuclear Regulatory Commission, RE. Mixed Oxide Fuel Fabrication Facility—Revised Construction Authorization Request, October 31, 2002.

11.9.3.9 National Fire Protection Association (NFPA). NFPA-37, “Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.” NFPA: 1998.

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11.9.3.11 _____. NFPA-801, “Standard for Fire Protection for Facilities Handling Radioactive Materials.” NFPA: 1998.

11.9.3.12 Nuclear Regulatory Commission (U.S.)(NRC). NUREG-1718, "Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility." NRC: Washington, D.C. August 2000.

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11.9.3.15 ______. Regulatory Guide 3.14, "Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants." NRC: Washington, D.C. 1973.

11.9.3.16 ____. Regulatory Guide 3.17, "Earthquake Instrumentation for Fuel Reprocessing Plants" NRC: Washington, D.C. 1974.

11.9.3.17 Hastings, P., Duke Cogema Stone and Webster, letter to Document Control Desk, US Nuclear Regulatory Commission, RE. Mixed Oxide Fuel Fabrication Facility – Evaluation of the Draft Safety Evaluation Report (DSER) on Construction of a Mixed Oxide Fuel Fabrication Facility, 09 July 2002

11.9.3.18 Persinko, A., US Nuclear Regulatory Commission, letter to P. Hastings, Duke Cogema Stone and Webster, RE. Response to DCS Letter Dated July 9, 2002 (DCS-NRC-0010000), October 30, 2002.