[7590-01-P]

NUCLEAR REGULATORY COMMISSION

[Docket No. 72-09; NRC-2015-0150]

Independent Spent Fuel Storage Installation, Department of Energy;

Fort St. Vrain

AGENCY: Nuclear Regulatory Commission.

ACTION: Exemption; issuance.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is issuing an exemption in response to a March 19, 2015 request, as supplemented April 3, and June 1, 2015, from the Department of Energy (DOE or the licensee). The exemption seeks to delay the performance of an O-ring leakage rate test specified in Technical Specification (TS) 3.3.1 of Appendix A of Special Nuclear Material License No. SNM-2504, and to delay the performance of an aging management surveillance described in the Fort St. Vrain (FSV) Final Safety Analysis Report (FSAR) to check six Fuel Storage Containers (FSCs) for hydrogen buildup, both until June, 2016.

DATES: Notice of issuance of exemption given on **[INSERT DATE OF PUBLICATION IN THE *FEDERAL REGISTER*]**.

ADDRESSES: Please refer to Docket ID **NRC-2015-0150** when contacting the NRC about the availability of information regarding this document. You may obtain publicly-available information related to this document using any of the following methods:

- **Federal Rulemaking Web site:** Go to http://www.regulations.gov and search for Docket ID **NRC-2015-0150**. Address questions about NRC dockets to Carol Gallagher; telephone: 301-415-3463; e-mail: Carol.Gallagher@nrc.gov. For technical questions, contact the individual listed in the FOR FURTHER INFORMATION CONTACT section of this document.

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- **NRC's PDR:** You may examine and purchase copies of public documents at the NRC's PDR, Room O1-F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852.

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I. BACKGROUND.

DOE is the holder of Special Nuclear Material License No. SNM-2504 which authorizes receipt, possession, storage, transfer, and use of irradiated fuel elements from the decommissioned FSV Nuclear Generating Station in Platteville, Colorado, under part 72 of Title 10 of the *Code of Federal Regulations* (10 CFR).

II. REQUEST/ACTION.

According to TS 3.1.1 in Appendix A of License No. SNM-2504, the FSC seal leakage rate shall not exceed 1×10^{-3} reference cubic centimeters per second (ref-cm^3/s). Surveillance Requirement (SR) 3.3.1.1 calls for one FSC from each vault to be leakage rate tested every five years. The last leakage rate test was performed in June, 2010; the next leakage rate test is scheduled to be completed by June, 2015. In addition, as part of the aging management program implemented when the license was renewed in 2011, Chapter 9 of the FSV FSAR provides the licensee will check six FSCs for hydrogen buildup by June, 2015. This provision regards the potential for hydrogen generation. The date of sampling was chosen to be consistent with the FSC seal leakage rate testing schedule. No FSCs have been sampled for hydrogen since being placed into storage. DOE requests an exemption to delay performance of both the FSC O-ring leakage rate test requirement and the FSAR aging management activity described above by one year.

III. DISCUSSION.

Under 10 CFR 72.7, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR part 72 when the exemption is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. In addition to the requirement from which DOE requested exemption, the NRC staff determined that an exemption from 10 CFR 72.44(c)(1) would also be necessary to implement DOE's exemption proposal. Section 72.44(c)(1) requires, in part, compliance with functional and operational limits to protect the integrity of waste containers and to guard against the uncontrolled release of radioactive material.

Authorized by Law

This exemption would delay performance of an FSC O-ring leakage rate test required by TS 3.3.1 of Appendix A of Special Nuclear Material License No. SNM-2504, and an FSAR aging management surveillance to check six FSCs for hydrogen buildup by June, 2015 by one year. Condition 9 of SNM-2504 states, in part, that authorized use of the material at the FSV ISFSI shall be "in accordance with statements, representations, and the conditions of the Technical Specifications and Safety Analysis Report." Condition 11 of SNM-2504 also directs the licensee to operate the facility in accordance with the Technical Specifications in Appendix A.

The provisions in 10 CFR part 72 from which DOE requests an exemption, as well as the provisions considered by the NRC staff, require the licensee to follow the technical specifications and the functional and operational limits for the facility. Section 72.7 allows the NRC to grant exemptions from the requirements of 10 CFR part 72. Issuance of this exemption is consistent with the Atomic Energy Act of 1954, as amended, and not otherwise inconsistent with NRC regulations or other applicable laws. Therefore, the exemption is authorized by law.

<u>Will Not Endanger Life or Property or the Common Defense and Security</u>

As discussed below, the NRC staff has evaluated the proposed exemption request, and found that it would not endanger life or property, or the common defense and security.

<u>Potential Corrosion</u>

The FSV ISFSI Aging Management Program described in Section 9.8 of the FSV ISFSI FSAR provides for sampling one FSC in each vault for hydrogen no later than June, 2015. The intent of the test was to identify any potential corrosion on the interior of the FSCs. The applicant stated its position as to why hydrogen buildup has not occurred, and thus why there are no safety implications with delaying the test for one year, including:

1. the fuel was stored in dry helium prior to placement in the FSCs,
2. general corrosion, as opposed to galvanic corrosion, was determined by the licensee to be the only corrosion mechanism of concern for the canister, and
3. the expected corrosion reactions would not generate significant quantities of hydrogen since the pH of any water inside the FSCs was expected to be neutral (i.e., not acidic).

In addition to reviewing information in the exemption request, the NRC staff also reviewed information associated with the 2011 license renewal applicable to this request. From its review of the license renewal documents, the NRC staff identified the following information pertinent to its review of DOE's exemption request: corrosion originating on the FSC interior surfaces was evaluated in Engineering Design File 9166 (EDF-9166) (ADAMS Accession No. ML15132A638). The EDF 9166 assumed that 775.6 grams of water was present in each FSC.

The analysis assumed uniform corrosion of all interior FSC surfaces resulting in a loss of material of 0.0014 inches. Crevice and galvanic corrosion were also assumed for the FSC bottom plate resulting in a loss of thickness of 0.0576 inches. In both cases, the licensee's analyses determined that the remaining material thicknesses for all interior FSC surfaces were greater than the required minimum thickness for the FSCs to maintain confinement of the radioactive material.

As referenced in the application, a surface coating had been applied to the interior FSC surfaces, but the NRC staff also found that the licensee's statement that general corrosion, and not galvanic corrosion, was the only corrosion mechanism of concern for the FSCs is not consistent with information in the FSV FSAR. For instance, Chapter 4, section 4.2.3.2.3 of the FSV ISFSI FSAR considered the potential for galvanic corrosion with the carbon steel FSC acting as the anode and the graphite fuel acting as the cathode. In addition, the NRC staff determined that EDF-9166 may not have fully considered all possible reactions. For instance, EDF-9166 only considered galvanic corrosion between the fuel blocks and the bottom of the FSC, and it assumed material loss from corrosion was distributed over the entire internal surface area of the FSC. The NRC staff notes that small portions of carbon steel, resulting either from coating defects during the surface coating application or from nicks and scratches during fabrication or loading, could act as localized sites of galvanic corrosion when exposed to water in the FSC. Therefore, the NRC staff finds that the applicant may have incorrectly assumed that corrosion is uniformly distributed to all FSC interior surfaces instead of being localized where protective coating is not present. Nevertheless, the NRC staff finds that through wall corrosion remains unlikely even if localized corrosion occurs at areas of coating defects or damage because the amount of water present is limited, because water is a low conductivity electrolyte, and the voluminous iron hydroxide formed by the corrosion reactions would stifle the corrosion process prior to significant localized loss of thickness of the FSC.

The corrosion processes discussed above would generate hydrogen as a result of reduction reactions on the graphite surfaces. For these reduction reactions to occur, a liquid medium must be present in the FSCs. Information contained in the application indicated that, if the temperature of the graphite fuel blocks exceeded 200°F [93°C] due to off-normal or accident conditions, any water in the graphite fuel blocks could be forced out of the fuel blocks resulting in as much as 77.6 grams of water being inside an FSC. The EDF-9166, which stated that it increased this amount of water by a factor 10, contains a corrosion analysis that identified oxygen reduction as the most likely reduction reaction in the system. This reduction reaction does not generate hydrogen. Although the possible generation of hydrogen as a result of other reactions is described in EDF-9166, the applicant did not evaluate the amount of hydrogen that may be produced.

In addition to reviewing information submitted by DOE in the exemption request, the NRC staff identified several possible reactions to assess the potential for hydrogen generation from corrosion reactions. These include the corrosion of iron, the formation of iron corrosion products, the oxidation of iron corrosion products, and the reduction reactions for oxygen, water and hydrogen ions. These reactions are listed below.

Corrosion of iron (Eq. 1)

$$\mathrm{Fe} \rightarrow \mathrm{Fe}^{2+} + 2\mathrm{e}^-$$

Reduction of oxygen (Eq. 2)

$$\mathrm{O_2} + 2\mathrm{H_2O} + 4\mathrm{e}^- \rightarrow 4\mathrm{OH}^-$$

Formation of Iron corrosion products (Eq. 3)

$$\mathrm{Fe}^{2+} + 2\,\mathrm{OH}^- \rightarrow \mathrm{Fe(OH)_2}$$

Oxidation of iron corrosion products (Eq. 4)

$$4Fe(OH)_2 + O_2 + 2H_2O \rightarrow 4Fe(OH)_3$$

Reduction of water to form hydrogen gas (Eq. 5)

$$2H_2O + 2e^- \rightarrow 2OH^- + H_2(g)$$

Reduction of hydrogen ions to form hydrogen gas (Eq. 6)

$$2H^+ + 2e^- \rightarrow H_2(g)$$

The reduction of hydrogen ions (Eq. 6) occurs primarily in acidic solutions. The reduction of oxygen (Eq. 2) is the likely reduction reaction in a system with air. Since the environment inside the FSCs is air, the reduction of oxygen (Eq. 2) is applicable. If the oxygen in the air is completely consumed, then the corrosion reaction can proceed until water is consumed via the water reduction reaction (Eq. 5).

Using the equations above, the NRC staff performed the following analysis assuming the complete consumption of oxygen and water in corrosion product formation and reduction reactions. It is uncertain if the complete consumption of the reactants is a reasonable assumption due to the use of the surface coating. Therefore, it is unknown how much of the carbon steel is available for corrosion product formation and the reduction reactions. Thus, assuming complete consumption of oxygen and water provides a conservative estimate of the amount of hydrogen that may be formed.

The free volume inside an FSC is estimated to be 230 liters. At 200°F [93°C], the temperature at which water, if present, could be released from the graphite, a mole of air, the gas inside an FSC, occupies 30 liters. Since air contains 21 percent oxygen by volume, the free volume of the FSC may be expected to contain 1.61 moles of O_2 and 6.05 moles of N_2. There are 4.3 moles of water in 77.6 grams of water. The reduction of oxygen (Eq. 2) requires 2 moles of water for each mole of oxygen. Reduction of 1.61 moles of O_2 requires 3.22 moles of H_2O leaving 1.08 moles of water unreacted. If the remaining 1.08 moles of water is reduced (Eq. 5), then 0.54 moles of hydrogen would be produced. The volume occupied by 0.54 moles of H_2 at 200°F [93°C] is 16.2 liters. This results in a volume fraction of 16.2/230 = 0.07 or 7 percent H_2.

Although the analysis above does not consider either the formation of water as a result of decomposition of the surface coating on the interior surfaces of the FSC or hydrogen formation from the small amount of grease used on the metallic O-rings, it shows that, if all of the water present is released from the graphite and subsequently consumed in corrosion reactions, there is a possibility of generating a significant amount of hydrogen. It also shows that, if the amount of water assumed by DOE in EDF-9166 were present in the FSCs, the amount of hydrogen would be even greater.

However, the NRC staff notes the following facts relative to the possibility of either an explosive or combustible mixture of gases inside an FSC at the FSV ISFSI. Based upon the above reactions, oxygen, which is a necessary ingredient in explosive and combustible gas mixtures, would not be present within the FSC interior free volume because the reduction reactions would have completely consumed it. There are no credible sources of ignition during normal fuel storage operations for the following reasons. First, sparks caused by metal to metal interaction are not produced because the FSCs are stationary. Second, Chapter 3 of the FSV FSAR identified the maximum FSC gas temperature as approximately165°F (74°C). The NRC staff notes that this gas temperature is far below the estimated minimum auto-ignition temperature of hydrogen gas in air of 752°F (400°C). Since the maximum temperature in Chapter 3 of the FSV FSAR was used in support of the license renewal, the NRC staff further notes that the maximum temperature inside the FSC is now even lower considering the fuel has been in storage for 24 years. Finally, Chapter 4 of the FSV FSAR states the licensee will, prior to either handling of a loaded FSC or removal of the lid bolts, implement the following procedural controls:

1. analyze the gas environment in the FSCs,
2. determine if flammable levels of hydrogen are present, and
3. as necessary, either evacuate or purge the FSC with air to assure hydrogen concentrations are below flammable levels.

Therefore, NRC staff concludes that a fire or explosion due to the presence of hydrogen is very unlikely, and does not present a significant safety issue if the exemption request is granted. Consequently, delaying the analysis of the gases inside the FSC from 24 to 25 years would not result in an increase in the probability of either a hydrogen ignition event during storage or failure of the FSC integrity due to corrosion. The NRC staff also finds that, as long as operational controls that eliminate ignition sources and requirements for gas sampling prior to handling or removal of lid bolts are maintained and followed, hydrogen ignition events associated with handling FSCs will not occur.

Leakage Rate

Limiting Condition of Operation 3.3.1 in Appendix A of License No. SNM-2504 states that the FSCs seal leakage rate shall not exceed 1×10^{-3} ref-cm^3/s. SR 3.3.1.1 calls for one FSC from each vault to be leakage rate tested every 5 years. The basis for SR 3.3.1.1 is that performance of a leakage rate test of at least six FSC closures every 5 years provides reasonable assurance of continued integrity. The leakage rate test was originally performed in 1991 after loading and subsequent leakage rate tests were performed in 1996, 2001, 2005, and 2010. None of the prior leakage rate tests exceeded the requirement of 1×10^{-3} ref-cm^3/s.

DOE evaluated the potential impact of this exemption request in accordance with the confinement requirements described in the FSV FSAR. DOE classified the failure of the FSC redundant metal O-ring seals as a low probability event, and stated Chapter 8, section 8.2.15 of the FSV FSAR identified no credible failure mechanisms for the FSC O-rings. DOE also estimated average and maximum O-ring seal leakage rates would be 3.75×10^{-4} and 6.76×10^{-4} ref-cm^3/s, respectively and documented these calculations in EDF-10727 (ML15104A064). Both seal leakage rate values are below the allowed leakage rate of 1×10^{-3} ref-cm^3/s required by TS 3.3.1. DOE identified O-ring failure as a potential failure mode that would allow leakage in excess 1×10^{-3} ref-c cm^3/s; however, DOE provided no specific details of potential O-ring failure mechanisms.

The NRC staff notes typical failure modes for O-ring seals include:

1. corrosion of the O-ring,
2. corrosion of the O-ring flange sealing surface (area in contact with the O-ring), and
3. creep or relaxation of the O-ring.

The O-rings are described in DOE's exemption request, as supplemented on June 1, 2015 (ADAMS Accession No. ML15153A280), as silver plated alloy X-750 in the work hardened condition. The O-rings are installed with a grease/lubricant to facilitate sealing and prevent damage to the O-rings during lid installation and compression of the O-rings. The presence of the grease, the materials of construction, and the limited amount of water in the vicinity of the O-rings reduce the possibility of corrosion of the O-rings and the O-ring seal area on the FSC.

The NRC staff reviewed the test methods, the test pressures generated by previous leakage rate tests, and the correlations between the leakage rate and the pressure drop across the seals used in EDF-10727 to estimate the O-ring seal leakage rates. The NRC staff finds that DOE used appropriate data and mechanistic relationships between the rate and the test pressure to predict June, 2017 FSC O-ring seal leakage rates. The staff determined that both the average and maximum estimated 2017 leakage rates of 3.75×10^{-4} and 6.76×10^{-4} ref-cm^3/s are acceptable and are below the required limit of 1×10^{-3} ref-cm^3/s.

The NRC staff also reviewed both Chapter 8, section 8.2.15 of the FSV FSAR and DOE's analytical results of the consequences associated with a radiological release from an FSC, and confirmed that even if the leakage rate of 1×10^{-3} ref-cm^3/s is grossly exceeded:

1. the radiological consequences at the controlled area boundary would be within the requirements of 10 CFR 72.106,
2. the radiological release caused by a leakage rate greater than 1×10^{-3} ref-cm^3/s past the redundant seals would be bounded by the maximum credible accident in the FSV FSAR, and
3. the failure of the redundant metallic seals (loss of confinement) can be considered a low probability event during the entire storage period.

Based on the findings above, NRC staff concludes that granting DOE's exemption to delay performance of the FSC O-ring leakage rate test in accordance with TS 3.1.1 and performance of the aging management surveillance to sample six FSCs for hydrogen until June 2016, would not endanger public health and safety or the common defense and security.

Otherwise in the Public Interest

As described in the application, delaying the FSC O-ring leakage rate test and FSAR aging management surveillance for one year would allow DOE to more effectively prioritize important activities at the FSV site. It would also reduce the administrative burden both on the licensee and on the NRC staff in the performance of the test. Therefore, issuance of the proposed exemption is otherwise in the public interest.

Environmental Consideration

The NRC staff evaluated whether there would be any significant environmental impacts associated with the issuance of the requested exemption. The NRC staff determined that this proposed action fits a category of actions which do not require an environmental assessment or environmental impact statement. Specifically, the exemption meets the categorical exclusion in 10 CFR 51.22(c)(25).

Granting an exemption from the requirements of 10 CFR 72.44(c)(1), and 10 CFR 72.44(c)(3) involves inspection and surveillance requirements associated with both the FSC O-ring leakage rate test required per TS 3.3.1 and the FSAR aging management surveillance of FSCs for hydrogen. A categorical exclusion for inspection and surveillance requirements is provided under 10 CFR 51.22(c)(25)(vi)(C) if the criteria in 10 CFR 51.22(c)(25)(i)-(v) are also satisfied. In its review of the exemption request, the NRC staff determined that, under 10 CFR 51.22(c)(25): (i) granting the exemption does not involve a significant hazards considerations, because granting the exemption neither reduces a margin of safety, creates a new or different kind of accident from any accident previously evaluated, nor significantly increases either the probability or consequences of an accident previously evaluated; (ii) granting the exemption would not produce a significant change in either the types or amounts of any effluents that may be released offsite, because the requested exemption neither changes the effluents nor produces additional avenues of effluent release; (iii) granting the exemption would not result in a significant increase in either occupational radiation exposure or public radiation exposure, because the requested exemption neither introduces new radiological hazards nor increases existing radiological hazards; (iv) granting the exemption would not result in a significant construction impact, because there are no construction activities associated with the requested exemption; and; (v) granting the exemption would not increase either the potential or consequences from radiological accidents such as a gross leak from an FSC, or the potential for hydrogen buildup or consequences from radiological accidents, because the exemption neither reduces the ability of the FSC to confine radioactive material nor creates new accident precursors at the FSV ISFSI. Accordingly, this exemption meets the criteria for a categorical exclusion in 10 CFR 51.22(c)(25)(vi)(C).

IV. Conclusions.

Accordingly, the NRC has determined that, under 10 CFR 72.7, this exemption is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. Therefore, the Commission hereby grants DOE an exemption from 10 CFR 72.44(c)(1) and 10 CFR 72.44(c)(3) to delay by one year the scheduled June, 2015 leakage rate test under SR 3.3.1.1 for one FSC from each vault to be leakage rate tested every five years, and to delay by one year the scheduled June, 2015 hydrogen buildup test described in Chapter 9 of the FSV FSAR. These tests shall be completed no later than June, 2016. This exemption is effective as of June 4, 2015.

Dated at Rockville, Maryland, this 4th day of June, 2015.

For the Commission.

/RA/

Mark Lombard, Director
Division of Spent Fuel Management
Office of Nuclear Material Safety
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