UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION REPORT

DOCKET NOS. 72-1031, 72-64
EXEMPTION REQUEST FOR DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE NUCLEAR STATION
INDEPENDENT SPENT FUEL STORAGE INSTALLATION

SUMMARY

By letter dated January 16, 2020 (Agencywide Documents Access and Management System Accession No. ML20035C759), as supplemented on March 19, 2020 (ADAMS Accession No. ML20086K860), Dominion Energy Kewaunee, Inc. (Dominion) submitted an application requesting an exemption pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 72.7, for the Kewaunee Nuclear Station (Kewaunee) independent spent fuel storage installation (ISFSI) to be able to use two exceptions to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code for the storage of spent fuel using the MAGNASTOR storage cask, Amendment 6 (ADAMS Package Accession No. ML16319A064) of CoC 1031. Specifically, Dominion requested an exemption from the requirements of 10 CFR 72.212(a)(2), 10 CFR 72.212(b)(3), 10 CFR 72.212(b)(5)(i), 10 CFR 72.214, and the portion of 10 CFR 72.212(b)(11), which requires compliance with the terms and conditions set forth in the certificate of compliance for each spent fuel cask used by an ISFSI general licensee.

Dominion's exemption requested use of two exceptions to the ASME B&PV Code, one for the Section III, Division 1, Subsection NG-2300, Charpy V-notch testing direction requirement for carbon steel plate material greater than 0.625 inches thick and the other to the post-heat treatment ultrasonic testing (UT) requirements in Section III, Division 1, Subsection NG-2500, for rolled carbon steel plate material greater than 0.75 inches thick. The requested exemption does not change the fundamental design, components, contents, or safety features of the storage system.

This safety evaluation report documents the staff's review and evaluation of Dominion's exemption request for the Kewaunee ISFSI. The staff reviewed Dominion's application to determine whether it meets the criteria for an exemption specified in 10 CFR 72.7. The requirements in 10 CFR 72.7 authorize the Commission to grant exemptions from the requirements of 10 CFR Part 72 if the exemption is authorized by law and will not endanger life, property, or the common defense and security, and is otherwise in the public interest.

Authorized by Law

The Commission has the legal authority to issue exemptions from the requirements of 10 CFR Part 72 as provided in 10 CFR 72.7. 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, issuance of the exemption is authorized by law.

Will Not Endanger Life, Property or the Common Defense and Security

The staff reviewed Dominion's exemption request for the Kewaunee ISFSI and concludes, as discussed below, that the proposed exemption from certain requirements of 10 CFR Part 72 will not cause the MAGNASTOR® storage cask to encounter conditions beyond those for which it has already been evaluated and demonstrated to meet the applicable safety requirements in 10 CFR Part 72, and thus, will not endanger life, property or the common defense and security. The staff followed the guidance of NUREG-1536 Revision 1, "Standard Review Plan for Spent Fuel Dry Cask Storage Systems at a General License Facility," July 2010. The staff's safety evaluation includes only the materials area of review, since it is the only technical area affected by this exemption.

Evaluation of Charpy V-notch Requirements

Regarding the requested exception to the ASME B&PV Code requirements for Charpy V-notch impact testing, the licensee stated that test specimens were removed from the fuel basket plate material in an orientation that was parallel (longitudinal) to the rolling direction of the plate, rather than transverse to the rolling direction as required by Article NG-2322.2(a)(4) of the ASME B&PV Code. The Charpy test involves striking a notched specimen and measuring how much the material plastically deforms outward as the specimen breaks, which is defined as "lateral expansion." It is a measure of the ductility and toughness of a material when subjected to a rapid load, such as could occur in an accident.

The staff notes that the ASME B&PV Code requirement for test specimen orientation is in place because steel plate properties can vary depending on the direction the material is being tested. Orienting the test specimens in a direction that is transverse to the plate rolling direction is generally considered to yield the lowest measured lateral expansion and, as a result, provides the most conservative measurement to compare against the minimum allowable values in the ASME B&PV Code.

To demonstrate that the fuel basket plates do not present a safety issue, the licensee provided an analysis to show that the material would reasonably be expected to have met the minimum allowable lateral expansion if the material had been originally tested with transverse specimens (via NAC Calculation Package No. 71160-WP-020, Revision 3, "NAC International Assessment of Longitudinal Versus Transverse Charpy Impact Testing for A537 and A516, provided in the licensee's response to the NRC's request for additional information dated March 12, 2020). The analysis reviewed the original Charpy test results from all affected steel plates, and it calculated the degree to which the measured lateral expansion from longitudinal specimens could be scaled down and still meet the minimum allowable value under the ASME B&PV Code. The analysis then compared those levels of reduction to new and historical observations on the effects of test specimen orientation on Charpy measurements, including testing that was performed on the same steel grades that were used to construct the fuel baskets. Based on those observations, the licensee concluded that the original test results of the basket plate material could be conservatively scaled down to account for specimen orientation and still meet the minimum lateral expansion required in the ASME B&PV Code.

The staff reviewed the licensee's justification and the technical literature to determine if there is reasonable assurance that the fuel baskets will fulfill their structural function under normal, off-normal, and accident conditions, despite the use of the longitudinal Charpy test specimens to qualify the plate materials.

The staff notes that NUREG-0800 (NRC, 2018) recommends that, for steel pressure vessel plates in older power plants that were originally tested with longitudinal Charpy specimens, the results of that testing can be reduced to 65 percent of their value to provide a conservative estimate of properties measured with transverse specimens. It must be considered that the NUREG-0800 guidance is related to the measurement of Charpy energy absorbed (not lateral expansion), which is an alternate measure of performance in the Charpy test. However, the technical literature shows that energy absorbed scales approximately linearly with lateral expansion at the ductility levels of subject steel plates, so the 65 percent scaling factor in NUREG-0800 is considered to be reasonably applicable to the applicant's analysis (Sreenivasan, 2006). Based on the NUREG-0800 guidance, the new and historical data provided by the applicant, and the staff's independent review of the fuel basket plate data and the technical literature, the staff has confirmed the applicant's assertion that the fuel basket plate materials would reasonably be expected to meet the ASME B&PV Code minimum allowable lateral expansion if they were tested with transverse specimen per the ASME B&PV Code requirements. In addition, the staff notes that the applicant performed the original Charpy testing of the fuel basket material at the lowest ambient service temperature -40 °F (-40 °C) to coincide with the off-normal coldest ambient temperature for this storage system. The staff considers this to add additional conservatism to the evaluation of the fuel basket performance, as the decay heat of the spent fuel assemblies is expected to maintain the fuel baskets at temperatures above -40 °F (-40° C), where the steel plate material would exhibit superior impact properties.

On the basis of the review above, the staff finds that this exemption will not endanger life or property because there is reasonable assurance that the fuel basket subcomponents, in which the materials of construction were originally evaluated with longitudinal Charpy specimens, are capable of fulfilling their structural function under all normal, off-normal, and accident conditions.

Evaluation of Post-Heat Treatment Ultrasonic Testing

Regarding the requested exception to the ASME B&PV Code requirements for post-heat treatment UT, the applicant stated that the fuel basket plate material was examined prior to the plate normalizing treatment. This differs from the requirements of Article NG-2537 of the ASME B&PV Code, which states that UT must occur after heat treatment. The staff notes that normalizing of low carbon steels is a final processing step whereby the material is heated to high temperatures to convert the steel to the austenite phase, then air-cooled to form a finer, more uniform microstructure of ferrite and pearlite that yields more favorable properties.

In support of the requested exception to the ASME B&PV Code, the licensee provided an assessment by a third-party engineering firm on the implications of performing the flaw examination before normalizing (Sperko letter provided by NAC International and attached to the application dated January 9, 2020). That assessment concluded that plates examined prior to normalizing should be acceptable because the normalizing process is not expected to be capable of introducing any indications (i.e., potential flaws) into the material. In addition, the licensee described the re-examination of a small number of plates that were originally examined prior to the normalizing treatment. No flaw indications were identified in that material after normalizing. As a result, the licensee concluded that the UT results prior to normalization are indicative of results that would have been observed had the examination occurred after normalization.

The staff reviewed the licensee's analysis and the technical literature to determine if there is reasonable assurance that the basket assembly subcomponents will fulfill their structural

function under normal, off-normal, and accident conditions, despite the plate UT examination occurring prior to the normalizing heat treatment.

The staff notes that the purpose of the ultrasonic examination of the plates is to identify flaws that arise from plate casting, hot rolling, and heat treatment. The platemaking process has the potential to create a variety of indications, such as porosity, cracks, non-metallic inclusions, and surface overlapping, or "laps". Because some heat treatment processes can impart significant stresses in the steel plate that could causing cracking, Article NG-2537 of the ASME B&PV Code requires that UT occur after the final heat treatment.

In its review of the licensee's justification for the exemption request, the staff considered the potential for the normalizing treatment to initiate cracking or cause existing cracks to grow. The staff notes that the primary drivers of heat treatment cracking are internal stresses caused by (1) large temperature gradients, such as between a water-quenched plate surface and the hot interior and (2) microstructural transformations that involve large changes in volume that may vary from the surface to the interior of the plate. The staff does not consider these sources of stress to be significant for the subject fuel basket plates. First, the normalizing treatment involves heating the plate and allowing it to cool in air, rather than using a rapid quench with water. This minimizes stresses caused by large temperature gradients. Second, the normalized microstructures of the fuel basket steels are expected to be a mixture of ferrite and pearlite. The formation of this microstructure on cooling does not involve large changes in volume, such as are characteristic of other microstructures (e.g., martensite formed during rapid quenching of alloy steels).

On the basis of the review above, the staff finds that the exemption does not endanger life or property because there is reasonable assurance that that the fuel basket subcomponents are capable of fulfilling their structural function under all normal, off-normal, and accident conditions.

Physical Protection

This exemption only affects items inside the canister and therefore does not affect the ISFSI security plans. Accordingly, the Kewaunee ISFSI will continue to be physically protected under Kewaunee's ISFSI Physical Security Plan to the same level of security. In addition, Dominion's exemption request is not related to any security or common defense aspect of the ISFSI. Therefore, granting the exemption would not result in any potential impacts to common defense and security.

Based on these evaluations, the staff concluded that granting this exemption will be consistent with the requirements of 10 CFR Part 72 and will not endanger life or property or common defense and security.

Otherwise in the Public Interest

In determining whether granting the exemption is in the public interest, the staff considered the no-action alternative of denying the exemption request. Dominion evaluated replacing the affected components and stated that replacement would not provide the same level of reduced radiological risk as provided by the exemption. Dominion stated that replacement of the affected components would involve a series of infrequent, high-risk series of actions which includes moving the cask from the storage facility to a location to unload the spent fuel, removing the canister from the concrete overpack, grinding the welds on the lid to open the canister, removing the spent fuel, reloading it into a canister that has a basket that is in

compliance, and returning the storage cask back into storage operations on the pad. Dominion concluded that the necessary equipment, personnel, facilities, time, and radiological exposure required to perform these actions is not in the interest of the public because even without the two surveillance tests being performed, fuel basket subcomponents are capable of fulfilling their structural function under all normal, off-normal, and accident conditions. Removing these casks from service and placing the spent fuel into casks for which the two surveillance tests had been performed would expose individuals to doses that would be considered unnecessary and is not in accordance with the as low as is reasonably achievable NRC regulation in 10 CFR 20.1101.

Environmental Consideration

The NRC staff also considered in the review of this exemption request whether there would be any significant environmental impacts associated with the exemption. The NRC staff determined that this proposed action fits a category of actions that 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 this exemption from 10 CFR 72.212(a)(2), 72.212(b)(3), 72.212(b)(5)(i), 72.214, and 72.212(b)(11) only relieves the applicant from the inspection or surveillance requirements associated with performing Charpy V notch tests and UT examinations on certain components with regard to meeting Technical Specification 4.2 in Attachment A of Certificate of Compliance No. 1031, Amendment No. 6. A categorical exclusion for inspection or 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, as discussed above, the items subject to this exemption will perform as intended, therefore, under 10 CFR 51.22(c)(25):

(i) Granting the exemption does not involve a significant hazards consideration 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 the closure welds, because the exemption neither reduces the ability of the closure welds to confine radioactive material nor creates new accident precursors at the Kewaunee ISFSI.

Accordingly, this exemption meets the criteria for a categorical exclusion in 10 CFR 51.22(c)(25)(vi)(C).

Conclusion

Based on the above considerations, the staff concludes that the proposed action, to issue an exemption to authorize use of two exceptions to the ASME B&PV Code, including Section III, Division 1, Subsection NG-2300, for Charpy V-notch testing direction and the post-heat treatment UT requirements in Section III, Division 1, Subsection NG-2500, is authorized by law and will not endanger life, property, or the common defense and security, and is otherwise in the public interest and, therefore meets the exemption requirements in 10 CFR 72.7.

References

NRC, NUREG-0800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition – Reactor Coolant System and Connected Systems, Branch Technical Position 5-3, “Fracture Toughness Requirements,” Rev. 3, 2018.

P.R. Sreenivasan, “Charpy Energy-Lateral Expansion Relations for a Wide Range of Steels,” International Journal of Pressure Vessels and Piping, 83, 2006, pp. 498-504.