UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

November 15, 2016

The Honorable Stephen G. Burns
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: REPORT ON THE SAFETY ASPECTS OF DOMINION VIRGINIA POWER COMBINED LICENSE APPLICATION FOR NORTH ANNA UNIT 3

Dear Chairman Burns:

During the 638th meeting of the Advisory Committee on Reactor Safeguards (ACRS), November 3-5, 2016, we reviewed the NRC staff's advanced final safety evaluation report (SER) for the Dominion Virginia Power (Dominion or the applicant) combined license application (COLA) for North Anna Unit 3. Dominion proposes to construct and operate an Economic Simplified Boiling Water Reactor (ESBWR) on the site of their two operating nuclear units, North Anna Units 1 and 2. In October 2010, we completed our safety review of the General Electric-Hitachi (GEH) application for certification of its ESBWR passive nuclear power plant design and concurred with the staff's recommendation to certify that design. In April 2014, we found the revised analysis procedure for the structural and functional integrity of the ESBWR steam dryer to be acceptable.

Our ESBWR Subcommittee held an informational briefing on September 22, 2016, and a subcommittee meeting on October 20, 2016, to review the North Anna Unit 3 COLA and the staff's advanced final SER. During our meetings, we met with representatives of the staff, Dominion and its vendors, and the public. We also had the benefit of the documents referenced. This letter fulfills the requirement of 10 CFR 52.87 that the ACRS report on those portions of the application that concern safety.

CONCLUSIONS AND RECOMMENDATION

1 There is reasonable assurance that North Anna Unit 3 can be built and operated without undue risk to the health and safety of the public. The COLA for North Anna Unit 3 should be approved.

2 Site-specific departures and exemptions from the ESBWR design control document (DCD), including those in the areas of seismic design and analysis, electrical power distribution system, liquid effluent discharge, and design for hurricane wind generated missiles, are acceptable and should be approved.

3. There is reasonable assurance that the ESBWR design and the North Anna Unit 3 site satisfy the requirements resulting from the Fukushima Near-Term Task Force recommendations.

BACKGROUND

On November 26, 2007, Dominion submitted an application to the NRC for a combined license (COL) to construct and operate a GEH ESBWR at the North Anna site pursuant to 10 CFR Part 52, "Licenses, Certification, and Approvals for Nuclear Power Plants." The application incorporated, by reference, the ESBWR DCD and an early site permit (ESP) for the North Anna site which was issued based on a site safety analysis report.

The ESBWR nuclear reactor design is a 4,500 megawatt thermal reactor that uses natural circulation flow within the vessel under normal operation and has passive safety features. This reactor is identified as North Anna Unit 3 and will be located on Dominion's existing North Anna site in Louisa County, Virginia, approximately 40 miles north northwest of Richmond, Virginia. There are two existing Westinghouse pressurized water reactors, North Anna Units 1 and 2, in operation at the site, as well as an independent spent fuel storage installation. North Anna Unit 3 will be located adjacent to and generally west of the existing units.

In June 2010, Dominion revised its application to instead reference the United States Advanced Pressurized Water Reactor technology for North Anna Unit 3, but then reverted to the ESBWR reactor technology in April 2013.

On June 24, 2014, Dominion submitted a revised application that followed the design centered review approach (DCRA), based on the DTE Electric Company Fermi 3 COLA, which referenced the codified version of the ESBWR design certification rule contained in 10 CFR Part 52, Appendix E, "Design Certification Rule for the ESBWR Design." The DCRA allows the staff to perform one technical review and reach a decision for a reference COLA (RCOLA) addressing issues outside the scope of the design certification, and to use that review and decision to support subsequent COLAs. The first COLA submitted for NRC staff review for a certified design is designated as the RCOLA, and subsequent applications are designated as subsequent COLAs (SCOLAs).

The final SER for the Fermi 3 COLA documents the staff's review of both standard and site-specific information and is the first complete SER for a COLA in the ESBWR design center. To ensure that the staff's findings on standard content documented in the final SER for the Fermi 3 COLA are equally applicable to the North Anna Unit 3 COLA, the staff undertook the following reviews:

- The staff compared the North Anna Unit 3 COL final safety analysis report (FSAR), Revision 8, to the Fermi 3 COL FSAR, Revision 8. In performing this comparison, the staff considered changes to the Fermi 3 COL FSAR (and other parts of the COLA, as applicable) resulting from requests for additional information (RAIs) and open and confirmatory items identified in the Fermi 3 SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation (the Fermi 3 final SER) were acceptable for North Anna Unit 3.

- The staff verified that the site-specific differences between Fermi 3 and North Anna Unit 3 sites are adequately addressed.

DISCUSSION

Site Characteristics

Site characteristics include potential hazards in proximity of the plant, as well as meteorology, hydrology, geology, seismology, and geotechnical parameters. An applicant must identify these characteristics and demonstrate that they, along with site-related design parameters specified in the ESP, are bounded by the site parameters for the certified design, or justify departures or exemptions where applicable. The staff reviewed the North Anna Unit 3 COLA, the referenced ESBWR DCD, and the North Anna Unit 3 ESP, to ensure that the combination of the information in these documents appropriately represents the complete scope of information relating to site characteristics. The staff concluded that the applicant has provided sufficient information and that, except as discussed under Departures and Exemptions below, the North Anna Unit 3 site characteristics are bounded by the requirements of the ESBWR DCD.

Departures and Exceptions from the ESBWR DCD

Ground Response Spectra for Seismic Structural Loads and Floor Response Spectra

The site-specific ground motion response spectra and foundation input response spectra for North Anna Unit 3 exceed the DCD certified seismic design response spectra. In the current application, Dominion revised its seismic hazard characterization using the methods prescribed in NUREG-2115. The updated North Anna Unit 3 probabilistic seismic hazard analysis using the Central and Eastern U.S. seismic source characterization model considers an updated catalog of earthquakes potentially affecting the site and incorporates the most recent ground motion model (Electric Power Research Institute, 2013) to develop uniform hazard response spectra; i.e. response spectra associated with specific annual exceedance frequencies).

The probabilistic seismic hazard analysis considered the magnitude 5.8 2011 Mineral, Virginia earthquake, which occurred approximately 11 miles southwest of the North Anna site and was one of the largest magnitude earthquakes instrumentally recorded in eastern North America. Despite its magnitude, the CEUS SSC model found the Mineral earthquake to have an insignificant effect on the resulting seismic source characterization for the site. Indeed, the resulting acceleration response spectra being used for the seismic design of North Anna Unit 3 demonstrates substantial margins relative to the accelerations measured at the North Anna site during the Mineral earthquake. The applicant also considered the potential for surface faulting, and the stability of surface materials and foundations at the site.

The uniform hazard response spectra at $1x10^{-4}$ and $1x10^{-5}$ per year exceedance frequencies were further analyzed to address transmission of the seismic waves through the site-specific geologic columns above hard rock, for determination of the ground motion response spectra and the foundation input response spectra for the seismic category I structures: reactor building/fuel building, control building and fire water support complex. These spectra were input to detailed structural models of each building to determine seismic load demands on the structures as well as in-structure response spectra (ISRS) for analysis of systems and components.

Since the updated seismic load demands exceed those based on the certified seismic design response spectra at some frequencies, the two spectra were bounded. Bounding spectra were then combined with standard design non-seismic loads in the same analysis models used for the standard design to determine their acceptability. The analyses confirmed the adequacy of the seismic category 1 structures. No changes were required to DCD concrete structures such as slab and wall thickness, although some minor structural modifications were required to some steel components to withstand the higher loads.

Interaction with non-seismic category I structures was also considered. Inspection, test, and analysis acceptance criteria are included for those buildings to verify that the as-built structures meet applicable acceptance standards under the higher, site-specific loads. Site-specific ISRS that exceed standard design ISRS will be used for seismic design and qualification of North Anna Unit 3 equipment and components.

The staff confirmed that the North Anna Unit 3 seismic design methodology for plant structures, systems, and components is acceptable. Their review included an independent geological assessment of the Mineral earthquake, which concluded that the applicant's assessment was sufficient. Staff experts, including geologists, also evaluated the behavior of a previously discovered fault, commonly referred to as fault "a", near the North Anna site. This is a geologically old structure, i.e., at least one million years old, and the staff determined it was not a potential seismic source. There was no evidence of rupture or deformation of fault "a" as a result of the Mineral earthquake. The staff performed an independent probabilistic seismic hazard analysis and confirmed the applicant's site amplification and ground motion response spectra calculations.

The review concluded that sufficient information has been provided to satisfy NRC regulations and guidance in the seismic area and, with identified changes, the ESBWR standard design is adequate to meet the site-specific seismic demand. Thus, the applicant resolved all COL items and license conditions in the seismic area.

Electrical Power Distribution System

The applicant has proposed two departures and an exemption to the certified design information.

One departure pertains to the use of Dominion transmission system standards for switchyard surge protection. Those standards are proposed in lieu of specific elements of an IEEE standard that is endorsed by Regulatory Guide 1.204, which is cited in Tier 2 of the DCD. The staff reviewed this departure and concluded that the applicant's measures provide equivalent protection.

The other departure and its associated DCD Tier 1 exemption pertain to a change in the configuration of the normal preferred power supply from the North Anna switchyard. The change introduces an intermediate switchyard that contains additional equipment not included in the certified design: three single-phase 500kV / 230kV transformers, a 500kV isolation circuit breaker, and three motor-operated disconnects. This configuration incorporates unit auxiliary transformers and reserve auxiliary transformers that have the same design specifications and voltage ratings. To better understand the potential risk significance of this change, we examined the relevant portions of the electric power system models and analyses in the design certification probabilistic risk assessment (PRA).

Failures of the additional equipment in the intermediate switchyard will increase the frequency for loss of normal preferred power to the unit auxiliary transformers, compared to the switchyard-related power failures that are evaluated in the design certification PRA. Depending on the specific failure modes, those failures may also functionally prevent recovery of normal preferred power from the 500kV switchyard during the nominal PRA mission time. It is not likely that equipment failures in the intermediate switchyard will directly affect availability of the 230kV alternate preferred power supply to the reserve auxiliary transformers. Nonetheless, the site-specific design will result in an increase in risk, compared to that evaluated for the certified design. The amount of that increase will be better understood when the final design is analyzed more completely in the North Anna Unit 3 site-specific PRA that will be performed prior to initial fuel load. Based on our comparative assessment, we have reasonable assurance that the increase will be small and that switchyard-related failures of normal preferred power will remain a small contribution to overall plant risk. Therefore, the proposed departure and exemption are acceptable.

Liquid Radioactive Waste Effluent Discharge Piping Flow Path

The North Anna Unit 3 COLA proposes an alternate flow path for routing of liquid radioactive waste effluent discharges to the environment that does not use the cooling tower blowdown line as specified in the DCD. This departure simplifies design and construction of the cooling tower blowdown line since it will not need to be designed with special features required for lines that contain liquid radioactive waste. Since the changes involve differences from both Tier 1 and Tier 2 portions of the DCD, they constitute both an exemption and a departure. The staff evaluated the radioactive waste discharge piping exemption/departure, and concluded that it is acceptable.

Design of Structures for Hurricane Wind Generated Missiles

The staff evaluated the exemption to the ESBWR DCD for the effects of hurricane-generated missiles. The staff requested that the applicant address site-specific hurricane missiles based on Regulatory Guide 1.221. In response, the applicant demonstrated that all seismic Category I structures are bounded by the DCD tornado missiles (330 mph wind speed). Some equipment subject to regulatory treatment of non-safety systems (RTNSS) is housed in non-seismic Category I structures, which are not designed for tornado-generated missiles. The DCD hurricane wind speed does not bound the Regulatory Guide 1.221 hurricane wind speeds at the North Anna site (140 mph). Therefore, this exemption modifies the DCD to specify that RTNSS structures will be designed to the most limiting hurricane-generated missile, either from the DCD or site-specific value calculated from Regulatory Guide 1.221. The staff finds that this exemption is acceptable.

Fukushima Requirements

In 2011, the Fukushima Near-Term Task Force issued a series of recommendations for improving nuclear power plant safety in the U.S. following the Fukushima earthquake and tsunami. Recommendations applicable to the North Anna Unit 3 COLA are: 4.2, Mitigation of Beyond-Design-Basis External Events, 7.1, Reliable Spent Fuel Pool Instrumentation, and 9.3, Emergency Preparedness Staffing and Communications.

Dominion incorporated information related to mitigating strategies for beyond-design-basis external events from the Fermi 3 RCOLA into the North Anna Unit 3 COLA. The staff reviewed this information and found the Fermi 3 COL standard content to be directly applicable to North Anna Unit 3. The staff provided a license condition with the same provisions as the comparable license condition for Fermi 3 that reflects the same mitigating strategies. This license condition requires the applicant to have developed an overall plan of mitigating strategies 180 days before the date scheduled for initial fuel load and to fully implement the strategies and guidance required in the license condition before fuel load.

The applicant addressed spent fuel pool instrumentation in the North Anna Unit 3 COLA. In subsequent RAI responses, Dominion described spent fuel pool level instrument design features that ensure reliable indication of the water level in the spent fuel pool and buffer pools. The staff reviewed the Dominion submittal on this topic and found that it is consistent with the Fermi 3 RCOLA final SER. Therefore, the North Anna Unit 3 supplemental information on reliable spent fuel pool level instrumentation is acceptable. A license condition was imposed which verifies that the programmatic aspects of the Fukushima-related reliable spent fuel pool instrumentation Order are completed and implemented prior to initial fuel loading.

The Fukushima accident highlighted the need to better determine the levels of plant and offsite staffing needed to respond to a multi-unit event. Additionally, there is a need to ensure that communication equipment has adequate power to coordinate the response to an event during an extended loss of AC power. The applicant proposed and the staff accepted a license condition related to communications and staffing for emergency planning actions identical to that imposed at Fermi 3. The proposed license condition ensures that communications and staffing will be adequate for emergency planning operations.

We concur that the applicant's submittals and associated license conditions adequately address the applicable Fukushima Near-Term Task Force recommendations.

SUMMARY

There is reasonable assurance that North Anna Unit 3 can be built and operated without undue risk to the health and safety of the public. The North Anna Unit 3 COLA should be approved.

Sincerely,

/RA/

Dennis C. Bley
Chairman

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Advanced Final Safety Evaluation Report for North Anna Unit 3 Combined Operating License Application," (ML16095A218, ML16146A703, ML16203A355, ML16166A244, ML15092A729, ML15188A423, ML14056A093, 15343A123, ML16221A428, ML14218A747, ML338A139, ML348A042, ML15352A312, ML15176A443, ML15020A230, ML14128A045, ML15092A730, ML14063A491, ML16256A255, ML15338A212).

2. Dominion, "North Anna Unit 3 Combined License Application," Revision 4, July 2013 (ML13225A624).

3. Advisory Committee on Reactor Safeguards, "Report on the Safety Aspects of the General Electric-Hitachi Nuclear Energy (GEH) Application for Certification of the Economic Simplified Boiling Water Reactor (ESBWR) Design," October 20, 2010 (ML14107A263).

4. Advisory Committee on Reactor Safeguards, "Supplemental Final Safety Evaluation Report on the General Electric-Hitachi Nuclear Energy (GEH) Application for Certification of the Economic Simplified Boiling Water Reactor (ESBWR) Design," April 17, 2014 (ML14107A263).

5. U.S. Nuclear Regulatory Commission, "Final Safety Evaluation Report for the Fermi Unit 3 Combined License Application," November 18, 2014 (ML14296A540).

6. U.S. Nuclear Regulatory Commission, NUREG-2115, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities," January 2012 (ML12048A776).

7. Electric Power Research Institute (EPRI), 2013, EPRI (2004, 2006) Ground-Motion Model (GMM) Review Project: EPRI, Palo Alto, CA, 2013 Technical Report, 3002000717, Nuclear Regulatory Commission Accession No. ML13155A553.

8. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.204, "Guidelines for Lightning Protection of Nuclear Power Plants," November 2005 (ML052290422).

9. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.221, “Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants,” October 2011 (ML110940300).

10. U.S. Nuclear Regulatory Commission, EA-12-051, “Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,” March 12, 2012 (ML12056A044).