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

November 26, 2019

Ms. Margaret M. Doane
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: INTERIM LETTER: THE NRC STAFF'S SAFETY EVALUATION REPORT WITH NO OPEN ITEMS FOR CHAPTERS 8 AND 18 AND THE ADVANCED ACCUMULATOR TOPICAL REPORT RELATED TO THE CERTIFICATION OF THE US-APWR DESIGN

Dear Ms. Doane:

During the 668th meeting of the Advisory Committee on Reactor Safeguards, November 6-8, 2019, we met with representatives of Mitsubishi Heavy Industries, Ltd. (MHI), and the NRC staff to review the safety evaluation reports (SERs) with no open items associated with the following US-APWR design certification application topics:

- Design Control Document (DCD), Chapter 8, "Electric Power,"
- DCD, Chapter 18, "Human Factors Engineering," and
- Topical Report MUAP-07001, "The Advanced Accumulator."

Our US-APWR Subcommittee reviewed these chapters and the topical report on September 19, 2019. We also had the benefit of the referenced documents.

CONCLUSIONS AND RECOMMENDATION

1. Our review of the SERs for Chapters 8 and 18 did not identify any safety issues that would preclude issuance of a design certification at this stage of our review. We will continue to consider integral effects of system interactions as we complete our final review.

2. Our review of the SER for the topical report on the advanced accumulator did not identify any safety issues.

3. The SERs should be issued.

BACKGROUND

MHI submitted a design certification application for the US-APWR on December 31, 2007. Our review is being conducted on a chapter-by-chapter basis to identify technical issues that may

merit further consideration by the staff. This process will aid in resolution of concerns and facilitate timely completion of the design certification application review. The staff's SERs and our review of these chapters address Design Control Document (DCD), Revision 4, and supplemental material, including MHI responses to staff requests for additional information.

DISCUSSION

We have previously reviewed these chapters, the topical report and the staff SERs with open items during meetings on October 24, 2008; November 9, 2010; September 8, 2011; September 20, 2012; September 17, 2013; December 5, 2013; and August 20, 2015. The following discussion reflects our reviews of the updated SERs.

Electric Power

Safety-related emergency alternating current (AC) power for the US-APWR is supplied by four gas turbine generators (GTGs). The design includes two additional smaller non-safety GTGs that can be started and aligned manually as alternate AC (AAC) power supplies if the offsite power fails, and power is not available from the safety-related GTGs. The safety-related GTGs are designed to start and be ready to accept load within 100 seconds after loss of power at their respective buses, which is longer than that for a comparably rated diesel generator. The US-APWR design incorporates advanced accumulators that provide extended passive coolant injection, thus allowing a longer interval for GTG starting and loading for all design basis loss of coolant accident (LOCA) conditions.

The use of GTGs for safety-related AC power is a departure from the historical use of diesel generators. An issue raised during our earlier subcommittee meetings was the need to confirm MHI's reliability estimates for the GTG emergency power systems, accounting for support equipment. MHI presented the results of their qualification testing program. This program, among other attributes, performed 150 start tests without failure to demonstrate a reliability criterion of 0.975 with 95 percent confidence. Successful completion of the testing program presented by MHI resolves our GTG reliability concern.

Human Factors Engineering

Human Factors Engineering (HFE) involves twelve areas of review that are needed for successful integration of human characteristics and capabilities into nuclear power plant design. These areas of review are: HFE Program Management, Operating Experience Review, Functional Requirements Analysis and Function Allocation, Task Analysis, Staffing and Qualifications, Human Reliability Analysis, Procedure Development, Training Program Development, Human-System Interface Design, Human Factors Verification and Validation, Design Implementation, and Human Performance Monitoring.

MHI has modified a predecessor Japanese control room design and associated procedures to be consistent with U.S. operational practice. The approach is thorough and makes extensive use of experienced U.S. crews operating a full-scale plant simulator. For the remainder of the HFE tasks, implementation plans and Inspections, Tests, Analyses, and Acceptance Criteria have been developed.

Advanced Accumulator

In the US-APWR design, the emergency core cooling system (ECCS) injection functions are provided by the high-head safety injection system (HHSIS) and the advanced accumulator (ACC) system. The HHSIS contains four divisions of pumps, normally aligned to deliver water from the refueling water storage pit to the reactor vessel. Four ACCs, one for each loop, passively provide the functions of both conventional accumulators and a low-head safety injection system. Thus, the US-APWR ECCS does not contain a separate low head safety injection system typically found in conventional pressurized water reactors. The ACCs are designed to provide injection flow at a high rate to rapidly refill the reactor vessel lower plenum and the downcomer during the blowdown phase of a large-break LOCA. This initial large injection flow is followed by passive switching to a much lower injection flow rate needed to maintain downcomer level during the core reflood phase. The accumulator is designed to ensure that the calculated peak cladding temperature and cladding oxidation level remain within acceptable regulatory limits in both the blowdown and reflood phases.

MHI initially qualified the ACC using a combination of testing and computational fluid dynamics (CFD) analysis. We reviewed the previous qualification analysis that used half-scale testing with extrapolation to full scale using CFD. Although the methodology was acceptable, we concurred with the staff's recommendations to increase the uncertainties that are used in LOCA analyses for the high-flow and low-flow injection regimes. The increased uncertainties account for the use of CFD analysis models to extend the half-scale test results to predict full-scale accumulator performance. MHI has subsequently performed full-scale testing of the ACC to justify removing scaling uncertainties. The characteristic equations developed from the full-scale test facility are applicable to the full-scale accumulator with the remaining uncertainties and bias described in their updated report. MHI confirmed that the Chapter 15 LOCA analysis will be rerun with the new correlation equations.

SUMMARY

Our review of the SERs for the topical report on advanced accumulators and Chapters 8 and 18 did not identify any safety issues that would preclude issuance of a design certification at this stage. The staff safety evaluation reports should be issued.

We are not requesting a formal response from the staff to this letter report.

Sincerely,

/RA/

Peter Riccardella
Chairman

REFERENCES

1. Mitsubishi Heavy Industries, LTD., Design Control Document for the US-APWR, September 19, 2013 (ML13262A488)

2. U.S Nuclear Regulatory Commission, US-APWR Design Certification Application – Safety Evaluation with no Open Items for US-APWR Design Certification Safety Evaluation Chapter 8, “Electric Power,” August 18, 2019 (ML19219A217)

3. U.S Nuclear Regulatory Commission, US-APWR Design Certification Application – Safety Evaluation with no Open Items for US-APWR Design Certification Safety Evaluation Chapter 18, “Human Factors Engineering,” July 17, 2019 (ML19176A077)

4. U.S Nuclear Regulatory Commission, Advanced Pressurized Water Reactor Advanced Topical Report Safety Evaluation for Topical Report MUAP-07001, Revision 7, “The Advanced Accumulator,” July 29, 2019 (ML19154A122)

5. Mitsubishi Heavy Industries, LTD., Topical Report MUAP-07001, Revision 7, “The Advanced Accumulator,” May 2018 (ML18178A282)

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