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

August 26, 2019

Mr. Maury A. Pressburger, Chairman
ASME Committee on Qualification
of Active Mechanical Equipment
Used in Nuclear Facilities (QME)
Sargent & Lundy LLC
55 East Monroe Street
Chicago, IL 60603-5713

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION WHITE PAPER ON MECHANICAL COMPONENT QUALIFICATION FOR FUNCTIONAL CAPABILITY IN ADVANCED REACTORS

Dear Mr. Pressburger:

The purpose of this letter is to transmit a U.S. Nuclear Regulatory Commission (NRC) staff White Paper on Mechanical Component Qualification for Functional Capability in Advanced Reactors. During its April 2019 meeting, the American Society of Mechanical Engineers (ASME) QME Standards Committee solicited NRC staff recommendations regarding the qualification of active mechanical equipment used in advanced reactors for the purpose of updating ASME Standard QME-1, "Qualification of Active Mechanical Equipment Used in Nuclear Facilities."

Some advanced reactors will operate at high temperatures that exceed the temperatures assumed in the functional qualification of mechanical equipment used in current light-water reactors (LWRs). If active mechanical equipment in advanced reactors exposed to temperatures within the creep temperature regime are not qualified properly, the equipment might not be capable of performing its safety functions.

Enclosed is a White Paper that describes the background and provides a proposal for the QME Standards Committee on this topic. The White Paper recommends that the QME Standards Committee develop guidance for the qualification of mechanical equipment to be used in advanced reactors exposed to temperatures within the creep temperature regime. This White Paper is an NRC staff recommendation and not an official Agency position.

The QME Standards Committee might consider this recommendation for incorporation as a nonmandatory appendix in Section QR, "General Requirements," of a future edition to the ASME QME-1 Standard. The QME Standards Committee might also consider this recommendation for incorporation into the new ASME Standard QME-2, which is being planned for development. The NRC staff proposes that the guidance preparation be initiated by the fall of 2019, to allow the QME Standards Committee to begin its review of the guidance during its fall 2019 telephone conference.

The NRC staff recommends that the QME Standards Committee reach out to advanced reactor designers to determine if there are unique components in advanced reactors that may benefit

from specific qualification requirements to ensure proper functioning to support risk assumptions, special treatments, or defense-in-depth considerations.

We thank you for providing the NRC staff with the opportunity to participate in the work of the QME Standards Committee.

Sincerely,

/RA/

Kamal Manoly
Senior Level Advisor
NRC Representative QME Committee
Office of Nuclear Reactor Regulation

/RA/

Thomas G. Scarbrough
Senior Mechanical Engineer
NRC Representative QVA Subcommittee
Office of New Reactors

Enclosure:
White Paper on Mechanical Component
Qualification for Functional Capability
in Advanced Reactors

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION WHITE PAPER ON MECHANICAL COMPONENT QUALIFICATION FOR FUNCTIONAL CAPABILITY IN ADVANCED REACTORS, DATED August 26, 2019.

DISTRIBUTION:
TBoyce, RES
AYeshnik, NRO
HPhan, NRO
KManoly, NRR
NHansing, NRO
NMcMurray, NRO
TLupold, NRO
TScarbrough, NRO
WReckley, NRO

ADAMS Package Accession No.: ML19225B470

OFFICE	NRR/DE	NRO/DAR	NRO/DAR
NAME	KManoly	WReckley	HPhan
DATE	8/13/2019	8/13/2019	8/14/2019
OFFICE	NRO/DESR	NRO/DESR	RES/DE
NAME	TScarbrough	TLupold	TBoyce
DATE	8/14/2019	8/15/2019	8/26/2019

OFFICIAL RECORD COPY

WHITE PAPER ON MECHANICAL COMPONENT QUALIFICATION FOR FUNCTIONAL CAPABILITY IN ADVANCED REACTORS

Background

Some advanced reactors will operate at high temperatures that exceed the temperatures assumed in the functional qualification of mechanical equipment used in current light-water reactors (LWRs). American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPV Code), Section III, Division 5, "High Temperature Reactors," addresses the structural capability of materials and time-temperature dependent failure mechanisms (such as creep and creep-fatigue), which would be applicable to advanced reactors that operate at high temperatures.

ASME Standard QME-1-2017, "Qualification of Active Mechanical Equipment Used in Nuclear Facilities," specifies provisions and guidelines for the qualification of active mechanical equipment whose function is required to ensure the safe operation or safe shutdown of a nuclear facility, including seismic qualification. ASME Standard QME-1 focuses on the functional capability of active mechanical equipment, such as pumps, valves, and dynamic restraints, to perform their safety functions. The combined provisions of the ASME BPV Code and ASME Standard QME-1-2017 address the various qualification aspects to demonstrate the capability of mechanical equipment to perform their safety functions in nuclear power plants. The NRC staff accepts ASME Standard QME-1-2007 in Revision 3 of NRC Regulatory Guide (RG) 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," with conditions (Reference 1). The staff is considering a proposed Revision 4 to RG 1.100 to accept ASME Standard QME-1-2017 with conditions.

If active mechanical equipment in advanced reactors exposed to temperatures within the creep temperature regime are not qualified properly, the equipment might not be capable of performing its safety functions because of interference between moving parts, growth or reduction in internal flow clearances, increased wear of internal parts, and other factors. A recent NRC report on the operating experience of advanced non-LWRs (Reference 2) indicates the importance of assuring the capability of mechanical equipment (including pumps and valves) used in high temperature applications.

During its April 2019 meeting, the QME Standards Committee solicited NRC staff recommendations regarding the qualification of active mechanical equipment used in advanced reactors for the purpose of updating ASME Standard QME-1. The NRC staff has previously provided suggestions to the QME Standards Committee for improvements to the qualification provisions that have been incorporated in the QME-1 Standard. The NRC staff notes that there are two current NRC activities related to material qualification (temperature, pressure, radiation, humidity, chemical effects, seismic, functional, etc.) for mechanical components (pumps, valves, freeze plugs, rupture disks, dynamic restraints, etc.). First, the staff is evaluating the use of structural materials that are not qualified under ASME BPV Code, Section III. Second, the staff is evaluating ASME BPV Code, Section III, Division 5, for NRC endorsement.

The nuclear industry's Licensing Modernization Project (LMP) described in Nuclear Energy Institute (NEI) 18-04 (Reference 3) and related NRC Draft Regulatory Guide DG-1353 (Reference 4) seek to develop a technology-inclusive, risk-informed, performance-based approach to licensing advanced non-LWRs. LMP is a process to select licensing basis events;

define the safety classification of structures, systems, and components including any associated risk-informed special treatments; and determine the defense-in-depth adequacy for advanced non-LWRs. A subset of the components identified in the LMP process could benefit from QME qualification. LMP uses the term "safety-significant," which generally encompasses the traditional terms of "safety-related" and "important to safety." The staff notes that incorporating LMP language into the ASME QME-1 Standard itself is outside of the scope of the Standard and will consider adding any necessary guidance for advanced non-LWRs into a future revision of RG 1.100.

Proposal

It is recommended that QME develop guidance for the qualification of mechanical equipment to be used in advanced reactors exposed to temperatures within the creep temperature regime. The guidance should relate to potential temperature, pressure, radiation, humidity, and chemical effects on mechanical equipment (pumps, valves, freeze plugs, rupture disks, dynamic restraints, etc.) for their seismic, environmental, and functional qualification as used in advanced reactors. The QME Standards Committee might consider this guidance for incorporation as a nonmandatory appendix in Section QR, "General Requirements," of a future edition to the ASME QME-1 Standard. The QME Standards Committee might also consider this guidance for incorporation into the new ASME Standard QME-2, which is being planned for development. It is proposed that the guidance preparation be initiated by the fall of 2019, to allow the QME Standards Committee to begin its review of the guidance during its fall 2019 telephone conference.

It is also recommended that the QME Standards Committee reach out to advanced reactor designers to determine if there are unique components in advanced reactors that may benefit from specific qualification requirements to ensure proper functioning to support risk assumptions, special treatments, or defense-in-depth considerations.

References

1. NRC Regulatory Guide, RG 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," Revision 3, dated September 2009 (ADAMS Accession No. ML091320468).
2. NRC Technical Letter Report, TLR-RES/DE/CIB-2019-01, "Advanced Non-Light-Water Reactors Materials and Operational Experience," dated March 2019 (ADAMS Accession No. ML18353B121).
3. Nuclear Energy Institute, NEI 18-04, "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development," Draft Report Revision N, dated September 28, 2018 (ADAMS Accession No. ML18271A172).
4. NRC Draft Regulatory Guide, DG-1353, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," dated April 30, 2019 (ADAMS Accession No. ML18312A242).