June 15, 2010

MEMORANDUM TO: David Terao, Chief
Component Integrity, Performance,
and Testing Branch 1
Division of Engineering
Office of New Reactors

FROM: Thomas G. Scarbrough ***/RA/***
Component Integrity, Performance,
and Testing Branch 2
Division of Engineering
Office of New Reactors

SUBJECT: FOLLOW-UP AUDIT OF DESIGN AND PROCUREMENT SPECIFICATIONS FOR PUMPS, VALVES, AND DYNAMIC RESTRAINTS FOR AP1000 REACTOR

On May 17, 2010, the Component Integrity, Performance, and Testing Branch of the Division of Engineering in the Nuclear Regulatory Commission (NRC), Office of New Reactors, conducted a follow-up audit of design and procurement specifications for pumps, valves, and dynamic restraints to be used for the AP1000 reactor at the Westinghouse office in Rockville, MD.

The purpose of the follow-up audit was to review the revisions to design and procurement specifications prepared as a result of an NRC staff audit conducted in October 2008.

Attached is a summary of the results of the NRC follow-up audit.

Enclosure:
Follow-up Audit of Design and Procurement Specifications for Pumps, Valves, and Dynamic Restraints for AP1000 Reactor

CONTACT: Thomas G. Scarbrough, NRO/DE/CIB2
301-415-2794

June 15, 2010

MEMORANDUM TO: David Terao, Chief
Component Integrity, Performance,
and Testing Branch 1
Division of Engineering
Office of New Reactors

FROM: Thomas G. Scarbrough ***/RA/***
Component Integrity, Performance,
and Testing Branch 2
Division of Engineering
Office of New Reactors

SUBJECT: FOLLOW-UP AUDIT OF DESIGN AND PROCUREMENT SPECIFICATIONS FOR PUMPS, VALVES, AND DYNAMIC RESTRAINTS FOR AP1000 REACTOR

On May 17, 2010, the Component Integrity, Performance, and Testing Branch of the Division of Engineering in the Nuclear Regulatory Commission (NRC), Office of New Reactors, conducted a follow-up audit of design and procurement specifications for pumps, valves, and dynamic restraints to be used for the AP1000 reactor at the Westinghouse office in Rockville, MD.

The purpose of the follow-up audit was to review the revisions to design and procurement specifications prepared as a result of an NRC staff audit conducted in October 2008.

Attached is a summary of the results of the NRC follow-up audit.

Enclosure:
Follow-up Audit of Design and Procurement Specifications for Pumps, Valves, and Dynamic Restraints for AP1000 Reactor

CONTACT: Thomas G. Scarbrough, NRO/DE/CIB2
301-415-2794

DISTRIBUTION:
Publicly Available
CIB R/F
LDudes
MNorato
BGleaves

ADAMS ACCESSION NUMBER: ML101650024 NRO-002

OFFICE	NRO/DE/CIB2	NRO/DE/CIB1
NAME	TScarbrough/TYB	DTerao
DATE	06/15/10	06/15/10

OFFICIAL RECORD COPY

FOLLOW-UP AUDIT OF DESIGN AND PROCUREMENT SPECIFICATIONS FOR PUMPS, VALVES, AND DYNAMIC RESTRAINTS FOR AP1000 REACTOR

Introduction

The AP1000 Design Control Document (DCD) Tier 2 discusses the functional design and qualification of safety-related valves and dynamic restraints in several sections. Subsection 3.9.3.2, "Pump and Valve Operability Assurance," in AP1000 DCD Tier 2, Chapter 3, "Design of Structures, Components, Equipment and Systems," refers to operational tests to verify that the valve opens and closes prior to installation. AP1000 DCD Tier 2, Subsection 3.9.3.2.2 specifies cold hydro tests, hot functional tests, periodic inservice inspections, and periodic inservice operations to be performed in situ to verify the functional capability of the valves. Section 5.4.8, "Valves," of Section 5.4, "Component and Subsystem Design," in AP1000 DCD Tier 2, Chapter 5, "Reactor Coolant System and Connected Systems," includes provisions regarding design and qualification, and preoperational testing of valves within the scope of Chapter 5, and refers to these activities for other safety-related valves. AP1000 DCD Tier 2, Section 5.4.9, "Reactor Coolant System Pressure Relief Devices," includes provisions for design, testing, and inspection of relief devices in the reactor coolant system. AP1000 DCD Tier 2, Section 5.4.10, "Component Supports," includes provisions for design, testing, and inspection of component supports in the reactor coolant system. These AP1000 DCD sections provide general guidance for the functional design and qualification of safety-related equipment that is acceptable for AP1000 Design Certification. AP1000 DCD Tier 2, Subsection 3.9.6.1, "Inservice Testing of Pumps," specifies that the AP1000 reactor design does not include pumps with safety-related functions with the exception of the coastdown of the reactor coolant pumps.

During a public meeting with the Nuclear Regulatory Commission (NRC) staff on March 26 and 27, 2008, Westinghouse discussed its development of procurement specifications for the AP1000 reactor design. In Request for Additional Information (RAI) RAI-SRP-3.9.6-CIB1-01, the NRC staff requested that Westinghouse provide a schedule for the availability of the procurement specifications for components to be used in the AP1000 reactor for NRC staff review. In its response to this RAI in a letter dated July 18, 2008, Westinghouse reported that the safety-related design specifications would be available for audit later in 2008.

On October 14 and 15, 2008, NRC staff members from the Component Integrity, Performance, and Testing Branch of the Division of Engineering in the NRC Office of New Reactors conducted an onsite review of design and procurement specifications for pumps, valves, and dynamic restraints to be used for the AP1000 reactor at the Westinghouse offices in Monroeville, PA. During that audit, the NRC staff found that significant effort was underway at Westinghouse to prepare design and procurement specifications for pumps, valves, and dynamic restraints to be used for the AP1000 reactor. Piping and instrumentation diagrams and isometric diagrams for AP1000 plant systems were available for review. The staff found that Westinghouse is addressing lessons learned from operating experience at current nuclear power plants in the design and procurement specifications. Westinghouse will review vendor analyses for plant components as part of its oversight of the procurement process. In its procurement process, Westinghouse will verify the inservice testing (IST) provisions specified in the AP1000 DCD Tier 2, Table 3.9-16.

At the exit briefing for the October 2008 audit, the NRC staff discussed the results of the onsite review of AP1000 design and procurement specifications. Westinghouse indicated that the

NRC comments would be addressed in a future revision of the specifications. The following items remained open from the October 2008 audit: (1) absence of a reference to American Society of Mechanical Engineers (ASME) QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," in Section 3.9 of the AP1000 DCD Tier 2, (2) need for clarification of the basis for seat coefficient of friction assumptions for gate and globe valves, (3) need for clarification that vendors must satisfy the QME-1-2007 qualification requirements in addition to the specific testing indicated in the design specifications, and (4) need for resolution of the difference between the RAI response for check valve testing and the piping diagram for Core Makeup Tank Discharge Check Valves PXS-V016A/B and V017A/B. The NRC staff documented the results of the October 2008 audit in a memorandum dated November 6, 2008, from T. Scarbrough to D. Terao (ADAMS Accession No. ML083110154).

In a submittal dated January 26, 2010, Westinghouse provided a supplemental response to RAI-SRP-3.9.6-CIB1-01 to address follow-up items from the October 2008 audit. First, Westinghouse stated that AP1000 DCD Tier 2, Section 3.9.3.2.2, "Valve Operability," would be revised to reference the ASME Standard QME-1-2007, and that the standard would be listed in Section 3.9.9, "References." Second, Westinghouse stated that the coefficient of friction values in the design specifications are considered to be a starting point for initial actuator sizing, and that the final basis will be derived from the methodology contained in ASME Standard QME-1-2007. Third, Westinghouse stated that the applicable design and procurement specifications will include provisions that valve functional qualification must satisfy the provisions in ASME Standard QME-1-2007. Fourth, Westinghouse stated that the applicable piping diagram in AP1000 DCD Tier 2, Section 6.3, "Passive Core Cooling System," would be revised to indicate that test connections will be installed to allow Check Valves PXS-V016A/B and V017A/B to be tested in both the forward and reverse flow directions in accordance with ASME Operation and Maintenance Code provisions.

NRC Staff Follow-Up Audit

On May 17, 2010, the NRC staff conducted a follow-up audit at the Westinghouse office in Rockville, MD, to review the revisions to the design and procurement specifications since the October 2008 audit. The staff conducted telephone conferences with Westinghouse personnel on May 19 and 28, and June 10, 2010, to support close-out of the audit. The staff also discussed topics related to the audit with Westinghouse personnel during the NRC staff's observation of an AP1000 squib valve test in Erie, PA, on May 12, 2010. A list of individuals participating in the audit discussions is provided in Table 1 of this report. A list of documents provided for the May 2010 audit is included in Table 2.

Based on the audit, the NRC staff found that Westinghouse has updated the AP1000 design and procurement specifications to address NRC comments provided during the October 2008 audit. For example, the staff found that the design and procurement specifications require the application of ASME Standard QME-1-2007 for the qualification of mechanical equipment to be used in an AP1000 reactor. Further, the staff found that the equipment qualification specification requires non-metallic components to be environmentally qualified using the provisions of Appendix QR-B, "Guide for Qualification of Nonmetallic Parts," to ASME Standard QME-1-2007. The revised design and procurement specifications sufficiently address additional comments provided by the staff during the October 2008 audit.

In response to NRC staff questions, Westinghouse indicated that motor-operated valves (MOVs) to be supplied for the AP1000 reactor will be within the scope of the Joint Owners'

Group (JOG) Program for MOV Periodic Verification. During the follow-up audit, the NRC staff found that the AP1000 design and procurement specifications do not reference the JOG program, but include provisions for the evaluation of the valve design, material, and conditions. For example, AP1000 Design Specification APP-PV01-Z0-001, "3" and Larger Motor Operated Gate and Globe Valves, ASME Boiler and Pressure Vessel Code Section III, Class 1, 2 and 3," requires the review of valve design, material, and conditions, such as disc, seat, and guide material and edge configurations. As the AP1000 IST Program will apply the JOG program for MOV periodic testing, the Combined Operating License (COL) licensee will confirm that MOVs provided by the valve supplier are within the scope of the JOG program.

The AP1000 design and procurement specifications provide valve friction coefficients for gate and globe valves, and butterfly valve bearing friction coefficients, to be used as a starting point with the valve vendor justifying the final values during the qualification testing required by ASME Standard QME-1-2007. The COL licensee will be responsible for justifying the qualification and set-up of safety-related valves during NRC inspection of the Inservice Testing and MOV Testing operational programs during plant construction.

AP1000 Design Specification APP-PV70-Z0-001, "Squib (Pyrotechnic Actuated) Valves, ASME Boiler and Pressure Vessel Code, Section III, Class 1," in Section 3.4.3.1 and Appendix E specifies that the squib valve must be supported to accommodate applicable seismic and operational loads (including loading due to actuations) and that valve outlet end loads due to operational fluid flow will be applied simultaneously. The NRC staff discussed these provisions with Westinghouse personnel. The design specification requires the piping and pipe support design process to address all applicable loads, including actuation loads and fluid reaction loads following opening of the squib valve. Westinghouse stated that these loads are being evaluated as part of the AP1000 piping and pipe support analysis. The NRC staff is reviewing the AP1000 piping and pipe support design process in conjunction with its review of piping design acceptance criteria (DAC).

AP1000 Design Specification APP-PV70-Z0-001 specifies that a functional design test be performed for the AP1000 squib valves. Westinghouse will be performing flow tests during the qualification process based on the provisions in ASME Standard QME-1-2007. The staff noted that these tests might constitute qualification testing to satisfy the inspection, test, analysis, and acceptance criteria (ITAAC) requirements for squib valve qualification. Westinghouse should notify the NRC staff of the planned test schedule with sufficient advance notice to enable the staff to conduct an ITAAC inspection if deemed appropriate.

The NRC staff discussed the squib valve design and qualification specifications with Westinghouse personnel regarding the evaluation of the effects of propellant injection into the flow stream during valve actuation. The squib valve design and qualification process will include consideration of potential effects of the "propellant blow-by" on valve operation, overall collection in the containment or plant systems, and chemical reaction with other chemicals or materials in plant systems and components. These considerations will be part of the squib valve design and qualification process to satisfy the ITAAC requirements.

The NRC staff noted that the 8-inch squib valves are required to be qualified for submergence. Westinghouse indicated that some specifications need to be updated to reflect this qualification requirement. The submergence qualification for the 8-inch squib valves will be addressed as part of the ITAAC requirements.

In light of the updated design and safety significance of squib valves in passive new reactors, the need for improved surveillance activities for squib valves is being considered by the nuclear industry, ASME, and the United States and international nuclear regulators. The NRC staff discussed the status of efforts to establish appropriate surveillance activities for squib valves during plant operation. Westinghouse personnel indicated that the IST program for squib valves will incorporate lessons learned from the design and qualification process for these valves such that surveillance activities provide reasonable assurance of the operational readiness of squib valves to perform their safety functions.

Nuclear power plant operating experience has revealed the potential for adverse flow effects from flow-induced vibration (FIV) caused by hydrodynamic loads and acoustic resonance on reactor coolant, steam, and feedwater systems. The NRC staff discussed with Westinghouse personnel the evaluation of inservice vibration of components used in the AP1000 plant. Westinghouse indicated that the AP1000 DCD includes provisions for the evaluation of inservice vibration in several sections. For example, AP1000 DCD Tier 2, Section 3.9.2, "Dynamic Testing and Analysis," describes tests to confirm that piping, components, restraints, and supports have been designed to withstand the dynamic effects of steady-state FIV and anticipated operational transient conditions. AP1000 DCD Tier 2, Section 3.9.2.1, "Piping Vibration, Thermal Expansion and Dynamic Effects," specifies that the preoperational test program for ASME Code, Section III, Class 1, 2, and 3 piping systems simulates actual operating modes to demonstrate that components comprising these systems meet functional design requirements and that piping vibrations are within acceptable levels. Section 14.2.9.1.7, "Expansion, Vibration and Dynamic Effects Testing," in AP1000 DCD Tier 2, Chapter 14, "Initial Test Program," states that the purpose of the expansion, vibration and dynamic effects testing is to verify that safety-related, high energy piping and components are properly installed and supported such that, in addition to other factors, vibrations caused by steady-state or dynamic effects do not result in excessive stress or fatigue to safety-related plant systems. Westinghouse indicated the vibration testing program described in AP1000 DCD Tier 2, Section 14.2.9, "Preoperational Test Descriptions," and Section 14.2.10, "Startup Test Procedures," will confirm component installation in accordance with design requirements, and address the effects of steady-state (flow-induced) and transient vibration.

The NRC staff discussed with Westinghouse personnel the bases for the planned changes to the AP1000 DCD Tier 2, Appendix 3D, "Methodology for Qualifying AP1000 Safety-Related Electrical and Mechanical Equipment," specified in the Westinghouse submittal dated February 23, 2010. Westinghouse indicated that the changes were based on finalization of the design that resulted in updates to the environmental qualification (EQ) process and parameters. For example, Westinghouse will address some EQ aspects as part of the design-basis accident evaluation rather than the abnormal event evaluation. Westinghouse will incorporate the planned EQ changes in the next revision to the AP1000 DCD.

Conclusion

Based on the May 2010 audit, the NRC staff concludes that Westinghouse has resolved the follow-up items from the October 2008 audit on the AP1000 design and procurement specifications for pumps, valves, and dynamic restraints in support of the application to amend the AP1000 design certification.

Table 1
Participants during NRC Audit or Follow-up Conferences
on AP1000 Design and Procurement Specifications
May 2010

Name	Organization
D. Terao	NRC
T. Scarbrough	NRC
J. Dixon-Herrity	NRC
R. Li	NRC
P. Clark	NRC
T. Spicher	NRC
D. Lindgren	Westinghouse
B. Carpenter	Westinghouse
M.E. Countouris	Westinghouse
E. Drake	Westinghouse
P. Kotwicki	Westinghouse
T. Matty	Westinghouse
T. Nowicki	Westinghouse
J. Regal	Westinghouse
R. Wessell	Westinghouse
M. Williams	Westinghouse
E. Grant	NuStart
J. Giles	SCANA
C. Herbst	Southern

Table 2
Westinghouse Documents provided for May 2010 Audit

AP1000 Design Calculation APP-PXS-M3C-162 (Revision 1, dated July 2, 1009), “AOV Functional Requirements for PXS CMT A/B Discharge Isolation Valves V014A/B and V015A/B”

AP1000 Design Calculation APP-RNS-M3C-030 (Revision 2, dated August 2009), “Pump Functional Requirements for the RNS Pumps”

AP1000 Design Calculation APP-SGS-M3C-034 (Revision 3, dated April 2010), “Safety/Relief Valve Functional Requirements for SGS Main Steam Safety Valves”

AP1000 Design Specification APP-GW-G1-002 (Revision 2, dated April 2010), “AP1000 Plant Equipment Qualification Methodology”

AP1000 Design Specification APP-GW-VP-010 (Revision 2, dated April 2010), “Equipment Qualification Methodology and Documentation Requirements for AP1000 Safety-Related Valves and Valve Appurtenances”

AP1000 Design Specification APP-GW-VP-020 (Revision 1, dated November 2008), “Equipment Qualification Methodology and Documentation Requirements for AP1000 Safety-Related Mechanical Equipment”

AP1000 Design Specification APP-MP08-Z0-001 (Revision 4, dated January 2010), “RNS Centrifugal Normal RHR Pumps,” and Datasheet Report APP-MP08-Z0R-001

AP1000 Design Specification APP-PV01-Z0-001 (Revision 3, dated September 11, 2009), “3” and Larger Motor Operated Gate and Globe Valves, ASME Boiler and Pressure Vessel Code Section III, Class 1, 2 and 3,” and Datasheet Report APP-PV01-Z0R-001

AP1000 Design Specification APP-PV03-Z0-001 (Revision 2), “Design Specification for 3" and Larger Manually Operated Gate, Stop Check, and Check Valves, ASME Boiler and Pressure Vessel Code Section III Class 1, 2 and 3 for Various Systems,” and Datasheet Report APP-PV03-Z0R-001

AP1000 Design Specification APP-PV11-Z0-001 (Revision 2, dated September 11, 2009), “Design Specification for Butterfly Valves, ASME Boiler and Pressure Vessel Code Section III, Class 2 and 3 for Various Systems,” and Datasheet Report APP-PV11-Z0R-001

AP1000 Design Specification APP-PV13-Z0-001 (Revision 2, dated July 21, 2009), “Solenoid Valves, ASME Boiler and Pressure Vessel Code, Section III, Class 1, 2 and 3,” and Datasheet Report APP-PV13-Z0R-001

AP1000 Design Specification APP-PV14-Z0-001 (Revision 2, July 21, 2009), “Air Operated Globe and Stop Check Valves, ASME Boiler and Pressure Vessel Code, Section III, Class 1, 2 and 3,” and Data Sheet Report APP-PV14-Z0R-001

AP1000 Design Specification APP-PV70-Z0-001 (Revision G, dated April 2010), “Squib (Pyrotechnic Actuated) Valves, ASME Boiler and Pressure Vessel Code, Section III, Class 1”

AP1000 Design Specification APP-PV95-Z0-001 (Revision 1, dated September 20, 2008), “Electric Motor Actuators for ASME Code Section III Class 1, 2 and 3 Nuclear Valves”

AP1000 Design Specification APP-PV98-Z0-001 (Revision C, dated April 2010), “Pyrotechnic Actuator for ASME Boiler and Pressure Vessel Code, Section III Class 1 Squib Valves (PV70)”

AP1000 Design Specification APP-PXS-M3-001 (Revision 2, dated May 27, 2009), “Passive Core Cooling System System Specification Document”

AP1000 P&ID APP-PXS-M6-001 (Revision 6), “Passive Core Cooling System”

AP1000 P&ID APP-SGS-M6-001 (Revision 2), “Steam Generator System”