MEB-CQ-201505 3.6.3 Responses

Issue #1

The potential for water or steam hammer in a particular piping system could represent a loading condition which would need to be evaluated when considering whether or not a piping system meets LBB requirements.

NUREG-0927, "Evaluation of Water Hammer Occurrence in Nuclear Power Plants," provides recommendations to be included in operating and maintenance procedures which include: A) prevention of rapid valve motion, B) proper filling and venting of water-filled lines and components, C) introduction of voids into water-filled lines and components, D) introduction of steam or heated water that can flash into water filled lines, E) introduction of water into steam-filled lines or components, F) proper warm-up of steam-filled lines, G) proper drainage of steam-filled lines, and H) the effects of valve alignments on line conditions.

Please provide additional information in the APR1400 FSAR Section 3.6.3 regarding how each of the items A) through H) is, or is not, implemented within the APR1400 design in each of those systems being proposed for LBB to ensure that water hammer will not be a concern in those systems during plant operation.

Response

Each of the items A) through H) in Section 3.12 of NUREG-0927 is, or not, implemented within the APR1400 design as follows:

A) Prevention of rapid valve motion

Valve discharge loads associated with the PZR have been identified and included in the component design basis.

There are no fast-acting valves in the DVI and SC piping systems. The stroking times of the valves on DVI and SC lines are approximately 30 to 80 seconds. Therefore, there is little potential to water hammer loading due to rapid valve movement as described in the Subsection 3.6.3.4.2.3.

B) Proper filling and venting of water-filled lines and components

The reactor coolant gas vent system (RCGVS) is used to vent/discharge non-condensable gases and steam from the high points of the RCS. Non-condensable gases from the reactor vessel closure head and the pressurizer steam space will be vented during plant startup process to fill the RCS.

For DVI and SC lines, high-point vents are designed to prevent water hammer by providing proper venting capability of the lines.

The COL applicant is to provide the appropriate procedure for initial filling and venting of the piping.

C) Introduction of voids into water-filled lines and components

Voids are vented appropriately during plant startup and the reactor coolant loop is designed to operate at a pressure greater than the saturation pressure of the coolant. The RCS is operated at higher pressure than other connecting systems. Therefore, there is little potential of void introduction into the RCL piping and surge line from the connecting systems.

For DVI and SC lines, high-point vents are designed to prevent water hammer by providing proper venting of the lines. The cover gas of the SIT is initiated after the tanks are filled with water, so the possibility of gas intrusion into the water filled piping in the DVI line does not need to be assumed.

The COL applicant is to provide the appropriate procedure for initial filling and venting of the

piping.

D) Introduction of steam or heated water that can flash into water filled lines

The reactor coolant loop is designed to operate at a pressure greater than the saturation pressure of the coolant and there is no valve in the loop. The RCS is operated at higher pressure than other connecting systems. Therefore, there is little possibility of introduction of steam or heated water into the RCL piping and surge line.

For DVI lines, high temperature RCS leakage to cold DVI line can be monitored by pressure indication and alarm installed the downstream of DVI check valve. Therefore, the MCR operator can take action to prevent potential water hammer due to check valve leakage and the probability of water hammer is not to be assumed.

Under normal power operation, the valves in the line are closed and the fluid in the line is at ambient temperature. Thus, a low vapor pressure and steam bubble formation do not occur. During SC operation, the system is open to the RCS and has the same vapor pressure as the RCS, which would be subcooled due to the hydrostatic head formed by the water and steam in the PZR. Therefore, steam bubble formation is precluded by the characteristics inherent to the system.

E) Introduction of water into steam-filled lines or components

The reactor coolant loop is designed to operate at a pressure greater than the saturation pressure of the coolant. Therefore, there is little possibility of introduction into the RCL piping and surge line and of a water hammer occurrence.

Because there is no steam filled lines or components in DVI/SC systems, this issue is not a cause of water hammer in the systems.

F) Proper warm-up of steam-filled lines

Because there is no steam filled lines in the APR1400 LBB applied piping, this issue is not a cause of water hammer in the systems.

G) Proper drainage of steam-filled lines

Because there is no steam filled lines in the APR1400 LBB applied piping, this issue is not a cause of water hammer in the systems.

H) The effects of valve alignments on line conditions.

Because valve alignments are not required in the APR1400 LBB applied piping, this issue is not a cause to the water hammer in the systems.

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Issue #2

In APR1400 FSAR Section 3.6.3, the applicant states that according to EPRI-MRP-111, "Resistance to Primary Water Stress Corrosion Cracking of Alloys 690, 52, and 152 in Pressurized Water Reactors", primary water stress corrosion cracking (PWSCC) in dissimilar metal Alloy 52/152 butt welds is unlikely. However, Alloy 52 welds are not completely immune to (PWSCC). Contributing factors which could increase an Alloy 52 butt welds susceptibility to PWSCC include factors, for example dilution effects on dissimilar metal welds, weld residual stresses, etc., which may be controlled by the implementation of specific welding processes/parameters (e.g., heat input).

Revise APR1400 FSAR Section 3.6.3 to state that welding procedures (including those for repairs) will be qualified to minimize tensile stresses on the internal diameters, dilution effects, etc. In addition, revise APR1400 FSAR Section 3.6.3 to state that weld repairs that will be in contact with the fluid will be made such that there will be compressive stress conditions on the wetted surface.

Response

The following two sentences will be added into the fourth paragraph of FSAR Section 3.6.3.4.4, FSAR Section 3.6.4 and Table 1.8-2 will be revised to identify the additional combined license information as follows:

FSAR 3.6.3.4.4

Welding procedures will be qualified by the COL applicant to minimize tensile stresses on the internal diameters and dilution effects. Weld repairs that will be contact with the fluid will be made such that there will be compressive stress conditions on the wetted surface (COL 3.6(5)).

FSAR 3.6.4

COL 3.6(5) The COL applicant is to provide the information on welding condition of Alloy 52/52M/152 containing the residual stress and dilution effects of welds.

Table 1.8-2

COL 3.6(5) The COL applicant is to provide the information on welding condition of Alloy 52/52M/152 containing the residual stress and dilution effects of welds.

Issue #3

The presence of potential unmitigated, active degradation mechanisms in a piping system would exclude it from considerations for LBB approval. One such potential active degradation mechanism is fatigue.

In the APR1400 FSAR Section 3.6.3, the applicant states that Class 1 piping which satisfies the requirements of the American Society of Mechanical Engineers (ASME) Code Section III, Subsection NB is designed for low cycle fatigue including thermal stratification. However, the applicant does not address the operational controls established to minimize vibrational fatigue.

Revise FSAR Section 3.6.3 to provide additional information regarding the controls that will be in place to address the potential for vibration-induced fatigue cracking or failure in piping systems under consideration for LBB approval, or explain why vibrational fatigue is not an issue in these systems.

Response

The potential for vibration-induced fatigue cracking within the RCL is primarily vibrations by the reactor coolant pumps (RCP) operation. The RCP-induced vibrations are minimized by limiting pump shaft and frame vibrations during hot functional testing and operation. Also, piping vibrations are tested during initial test program as addressed in subsection 3.9.2.1. During operation, RCP vibration monitoring system monitors the pump shaft and frame vibrations and the alarms are provided to the

operators in the Main Control Room (see subsection 7.7.1.5).

Safety Injection and Shutdown Cooling system that have LBB applied piping are not operated during Plant Full Power Operation Mode. Therefore these system piping will not experience of vibration and result in vibration fatigue problem.

Issue #4

In APR1400 FSAR Section 3.6.3, the applicant states that pipe degradation or failure from indirect causes such as fires, missiles, and component support failures is prevented by designing, fabricating, and implanting inspection criteria that provide reasonable assurance of a low probability of the event or its impact on safety-related structures.

Revise FSAR Section 3.6.3 to list the Sections in the APR1400 FSAR that provide a detailed description of the programs in place to prevent pipe degradation or failure from the indirect causes from the examples described above.

Response

The DCD sections that provide detailed description of the design to prevent pipe degradation or failure from the indirect causes on LBB applied piping (RCL, SL, DVI and SC) are provided below:

Seismic events: The LBB applied piping are designated as seismic category I (see subsection 3.2).

System over-pressurization: Over-pressure protection for RCS, primary side of auxiliary or emergency systems connected to the RCS, and secondary side of SG is described in subsection 5.2.2

Human error: Chapter 18 describes human factors engineering program to support the operator and minimize the potential for operator errors.

Fires: Fire prevention and protection are described in subsection 9.5.1.

Flooding: Flood protection and protection are described in subsection 3.4.

Missiles: Missile protection is described in subsection 3.5.

Damages from moving equipment: The containment polar crane is designed to maintain its integrity without dropping its load during an SSE. Subsection 9.1.5 describes the overhead heavy load handling system.

Failures of structures, systems or components (SSC): The SSCs in close proximity to the LBB applied piping are safety-related and seismically designed (see subsection 3.2).