RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**437-8540**
SRP Section:	**08.01 – Electric Power – Introduction**
Application Section:	**8.1**
Date of RAI Issue:	**03/08/2016**

Question No. 08.01-19

In RAI 8166, Question 08.01-7, dated August 31, 2015, the staff stated that DCD Table 8.1-2 indicated that BTP 8-1, "Requirements on Motor-operated Valves in the ECCS Accumulator Lines," was applicable to sections 8.3.1 and 8.1.3.3, and Table 1.9-2 also indicated that the APR1400 design conforms to BTP 8-1. The staff also indicated that Standard Review Plan (SRP) section 8.1 states in part that the safety analysis report should discuss the applicability of the criteria and guidelines listed and include a statement to the effect that they will be implemented or are implemented in the design of electrical power systems and the criteria and guidelines are listed in Table 8-1. Since the DCD did not include a discussion related to BTP 8-1, the staff asked the applicant to provide such discussion in the DCD. In response to RAI 8166, Question 08.01-7, dated January 26, 2016, ADAMS Accession ML16026A461, the applicant stated that the design of motor operated valves in the ECCS accumulator lines conforms to BTP 8-1 and is addressed in DCD Tier 2 sections 6.3.2.5.1, 7.3.1.4, 7.6.1.4 and Figure 7.6-2. The applicant added a reference in section 8.3.1.2.3 and Table 1.9-2 to indicate conformance to BTP 8-1. The staff reviewed the response and found that there was no specific mention in the referenced sections (6.3.2.5.1, 7.3.1.4, and Figure 7.6-2) about BTP 8-1. Therefore, the staff requests that the applicant provide a clear reference to the applicability of BTP 8-1 in the referenced section(s).

Response

The design of the motor operated valves in the ECCS accumulator lines conforms to BTP 8-1 as currently addressed in DCD Tier 2, Subsections 6.3.2.1.1, 6.3.2.5.1, 6.3.5.3.2, 7.3.1.3, and Figure 7.6-2. DCD sections 7.3.1.4 and 7.6.1.4 referenced in the response to RAI 8166 Question 08.01-7 are not related to BTP 8-1.

BTP 8-1 will be included in the referenced subsections to provide a clear reference to the applicability of BTP 8-1.

Impact on DCD

DCD Tier 2, Subsection 6.3.2.1.1, 6.3.2.5.1, 6.3.5.3.2, 7.3.1.3, 6.3.8, 7.6.5 and 8.3.1.2.3 will be revised.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

pressurized with nitrogen. The SITs are provided with connections for filling, draining, pressurizing, venting, relieving, and sampling. In addition, pressure and level instrumentations with appropriate alarms are provided to assure that technical specifications are met during normal power operation.

A fluidic device (Reference 3, Figure 6.3.2-2), which is installed in each of the SITs, provides two operational stages of a safety water injection into primary coolant system and results in more effective use of borated water in the SITs in the event of a LOCA.

SIT water is delivered into the vortex chamber through both the supply and control nozzles at the early stage of LBLOCA when the SIT starts to operate and the standpipe is covered with water. The SIT provides a large injection flow rate of SIT water, which is required during the refill phase of an LBLOCA. When the SIT water level is lowered to below the top of the standpipe, the flow path through the supply nozzle is absent and all SIT water is delivered only through the control nozzle. As a result, the injection flow rate of the SIT water is decreased, but is still sufficient to remove decay heat during the reflood phase, extending the total duration of the SIT water injection.

The fluidic device consists of a vortex chamber, supply port, control ports, and standpipe. The device has a supply port at the center and four control ports around the supply port with an equal circumferential angle of 90 degrees at the surface top. The supply port is connected to a standpipe that extends vertically. The vortex chamber is a flat slice of cylinder and is installed horizontally, with its axis overlapping with the centerline of the SIT.

A motor-operated isolation valve provided in each SIT discharge line is administratively controlled to open in the MCR to provide reasonable assurance of the tank's availability during normal operation. Power to the motor operator of each valve is removed to prevent inadvertent closure. To provide further reasonable assurance of SIT availability, each SIT isolation valve receives an automatic open signal if an SIAS occurs due to low pressurizer pressure or high containment pressure. During startup and shut down operations, a variable low pressurizer pressure SIAS setpoint is used, as described in Subsection 7.3.1.9.

Each motor-operated SIT isolation valve is also provided with an "auto-open" and "permissive close" interlock based on pressurizer pressure. During startup, the interlock automatically opens the valves when RCS pressure is increased above 42.2 kg/cm^2A

Add — in accordance with BTP 8-1 (Reference 11)

(600 psia). During plant cooldown, the interlock prevents the valves from being closed until RCS pressure is reduced to 33.4 kg/cm^{2}A (475 psia).

The SITs are normally pressurized to a nominal operating pressure of 42.9 kg/cm^2 (610 psig) for normal operation. During startup, the operator pressurizes the SITs when pressurizer pressure reaches 45.0 kg/cm^{2}A (640 psia). Failure to do so results in an alarm when pressurizer pressure reaches 50.3 kg/cm^{2}A (715 psia).

Add — in accordance with BTP 8-1 (Reference 11)

During plant cooldown, SIT pressure is reduced to 28.1 kg/cm^2 (400 psig) before RCS pressure reaches 45.0 kg/cm^{2}A (640 psia). Inadvertent repressurization of the SITs during this mode of operation from a leaky nitrogen supply valve or by accidental tripping of a nitrogen supply valve switch is prevented by having two fail-closed valves in series with separate hand switches on each SIT nitrogen supply line. The air supply actuating the nitrogen supply valves is controlled by solenoid valves. The two nitrogen supply valve solenoids on each SIT are connected to separate electrical buses through redundant and physically separated electrical trains. The solenoids provide reasonable assurance that a fault in one of the trains does not cause a spurious opening of both nitrogen supply valves.

Redundant level and pressure instrumentation described in Subsection 6.3.5.3 and Table 7.5-1 are provided to monitor the condition of the tanks. Sufficient visual and audible indications are made available to the operator so that maintaining the SITs within the required technical specifications during various modes of plant operation. Provisions are made for sampling, filling, draining, and correcting boron concentration. Atmospheric vent valves are provided for tank venting. The valves are locked closed, and the power to each valve is removed during normal operation to prevent inadvertent SIT venting.

The SIT relief valve set at 49.2 kg/cm^2 (700 psig) is installed in the SIT to prevent the overpressure. The two check valves installed in SIT discharge line are held by pressure differential between the RCS and SIT operating pressure.

The nitrogen supply system is designed such that all four SITs can be pressurized to 44.29 kg/cm^2 (630 psig) from 0 kg/cm^2 (0 psig) within approximately 8 hours assuming minimum fluid level in the tank. The two nitrogen system isolation valves (SI-642, 649, SI-632, 639, SI-622, 629, and SI-612, 619) are provided and maximum gas volume in the tank is 17.2 m^3 (610 ft^3) each SIT. The capacity of SIT relief valve (SI-211, 221, 231, and 241) is 169.9 m^3 (6,000 ft^3) per minute.

6.3.2.5 System Reliability

6.3.2.5.1 Safety Injection Tanks

The performance evaluation in Subsection 15.6.5 demonstrates the adequacy of the quantity of coolant supplied. In order to prevent accidental discharge from the SCS suction relief valves (SI-179 and SI-189), SIT pressure is decreased to an acceptable value before reactor coolant pressure is below 45.0 kg/cm^2A (640 psia) and subsequently, the isolation valves on the tanks are closed. An interlock with pressurizer pressure prevents these valves from being closed if pressurizer pressure is greater than 33.4 kg/cm^2A (475 psia).

Add: in accordance with BTP 8-1 (Reference 11)

Inadvertent repressurization of the SITs during shutdown cooling due to a leaky nitrogen supply valve or the accidental tripping of a valve switch is prevented by having two fail-closed supply valves in series with separate hand switches. The air supply actuating the nitrogen supply valves is controlled by solenoid valves. The nitrogen supply line inside the containment is not normally pressurized.

The two nitrogen supply valve solenoids on each SIT are connected to separate electrical buses through redundant and physically separated electrical trains in order to provide reasonable assurance that a fault in one of the trains will not cause a spurious opening of both nitrogen supply valves.

The motor-operated isolation valves on the SIT discharge are interlocked with pressurizer pressure to open the valves automatically as system pressure is increased to 42.2 kg/cm^2A (600 psia). When RCS pressure increases to 45.0 kg/cm^2A (640 psia), the operator repressurizes the SITs. Failure to do so results in an alarm at a pressurizer pressure of 50.3 kg/cm^2A (715 psia).

Add: in accordance with BTP 8-1 (Reference 11)

Further details of valve control are provided in Section 7.6.

The atmospheric vents on the SIT are locked closed, fail closed, and power to their solenoid valve is interrupted during operation when the RCS pressure is greater than 50.3 kg/cm^2A (715 psia). This procedure provides reasonable assurance that the tank is not vented during RCS power operation.

6.3.5.3 Instrumentation during Operation

The instrumentation provided for monitoring SIS components during SIS operation is described in this section. The instrument readout location is described in Figure 6.3.2-1.

6.3.5.3.1 Pressure

a. SIT pressure

Pressure transmitters mounted on each SIT provide indication of the pressure in each SIT. Wide range pressure channels P-311D, 321B, 331C, and 341A provide pressure indication in the MCR and remote shutdown room. Narrow range pressure channels P-312, 322, 332, 342, 313, 323, 333, and 343 provide pressure indication in the MCR. Alarms are provided in the MCR to alert the operator to high or low SIT pressure conditions.

b. SI pump discharge pressure

Pressure channels P-306, 307, 308, and 309 provide an indication of SI pump discharge pressure in the MCR. The operator uses the pressure channels to monitor SI pump operation.

6.3.5.3.2 Valve Position

a. SIT isolation valve position

Redundant valve position indication is provided in the MCR and RSR for valves SI-614, 624, 634, and 644. The position indication verifies the fully open or fully closed position with an alarm if the valve is not fully open.

b. Hot leg injection isolation valve position

Open/closed valve position indication is provided in the MCR for valves SI-604 and 609.

in accordance with BTP 8-1 (Reference 11) Add

3. APR1400-Z-M-TR-12003-P (Proprietary) & NP (Non-Proprietary), “Fluidic Device Design for the APR1400,” Rev. 0, KHNP, December 2012.

4. Regulatory Guide 1.1, “Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System,” Rev. 0, U.S. Nuclear Regulatory Commission, November 1970.

5. Regulatory Guide 1.82, “Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident,” Rev. 4, U.S. Nuclear Regulatory Commission, March 2012.

6. Regulatory Guide 1.79, “Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors,” Rev. 1, U.S. Nuclear Regulatory Commission, September 1975.

7. 10 CFR 50.55a(f), “Inservice testing requirements,” U.S. Nuclear Regulatory Commission.

8. Regulatory Guide 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” Rev. 4, U.S. Nuclear Regulatory Commission, June 2013.

9. 10 CFR 20.1406, “Minimization of Contamination”, U.S. Nuclear Regulatory Commission.

10. Regulatory Guide 4.21, “Minimization of Contamination and Radioactive Waste Generation-Life Cycle Planning,” Rev. 0, U.S. Nuclear Regulatory Commission, June 2008.

Add

11. BTP 8-1, "Requirements on Motor-Operated Valves in the ECCS Accumulator Lines"

The SIT permissive interlocks are used to allow isolation of the SITs below the pressure required for mitigation following a loss of coolant accident (LOCA). See Figure 7.6-2 for the interlock logic.

The isolation valves are manually closed when RCS pressure drops below the setpoint in Table 7.6-1 so that the SITs cannot cause overpressurization of the SCS while the SITs are maintained above atmospheric pressure.

As RCS pressure increases, the valves automatically reopen at the set pressure.

The opening of the SIT isolation valves provides reasonable assurance that the SITs are available for injection during plant startup.

If the isolation valves are closed and an SIAS is initiated, the isolation valves automatically open. The SIAS overrides the interlock or any manual signal.

The alarm associated with the SITs is activated if the RCS [illegible] determined values and the SITs have not been repressurized.

Add: in accordance with BTP 8-1 (Reference 13)

Physically separate and independent signals are provided for SIT isolation valve interlocks. Refer to Section 6.3 for SIS and Subsections 3.9.6.3.1 and 6.3.4 for valve tests.

7.6.1.4 Component Cooling Water Supply and Return Header Tie Line Isolation Interlocks

Add: in accordance with BTP 8-1 (Reference 13)

The CCW system removes heat from all safety components required for normal power plant operation, and normal and emergency shutdown of the plant, and transfers the heat to the essential service water through the CCW heat exchangers. The CCW system also provides cooling water for some non-safety components required for plant operation.

Non-essential supply and return header isolation valves are provided to isolate the non-essential supply and return headers from the essential supply and return headers in the event of an accident. These valves are two series electric motor operated valves and can be remotely operated.

These valves are automatically closed on an SIAS or low-low CCW surge tank level signal. The valve closure times are set to prevent complete loss of surge tank volume due to a

11. Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems," Rev. 3, U.S. Nuclear Regulatory Commission, April 1995.

12. NUREG-0737, Item II.D.3, "Clarification of TMI Action Plan Requirements," 1980.

Add

13. BTP 8-1, "Requirements on Motor-Operated Valves in the ECCS Accumulator Lines"

RAI 177-8166 - Question 08.01-7

RAI 437-8540 - Question 08.01-19

NRC RG 1.160 endorses Revision 4A of NUMARC 93-01 (Reference 45), which provides methods for complying with the provisions of 10 CFR 50.65 with some provisions and clarifications. Conformance with NRC RG 1.160 is addressed in Section 1.9.

NRC Regulatory Guide 1.204

NRC RG 1.204 is related to the guidelines for lightning protection of nuclear power plants.

The APR1400 onsite ac power system is designed to meet the requirements of IEEE Std. 665, IEEE Std. 666, IEEE Std. 1050, and IEEE Std. C62.23 (Reference 46), which are related to the lightning protection of nuclear power plants.

NRC Regulatory Guide 1.218

NRC RG 1.218 provides the cable design and maintenance criteria for the performance of periodic testing as part of the condition-monitoring techniques for the electric cables that are used in nuclear power plants. The inaccessible cable condition-monitoring techniques related to NRC RG 1.218 are addressed in Subsection 8.3.1.1.10.

Add

8.3.1.2.3 Conformance with Branch Technical Positions

BTP 8-1, "Requirements on Motor-Operated Valves in the ECCS Accumulator Lines" The design of motor operated valves in the ECCS accumulator lines conforms with BTP 8-1 (Reference 62). Conformance with BTP 8-1 is addressed in DCD Tier 2, Subsection 6.3.2.5.1, ~~7.3.1.4, 7.6.1.4~~, and Figure 7.6-2.

Add 6.3.2.1.1, 6.3.5.3.2, 7.3.1.3

8.3.1.3 Electrical Power System Calculations and Distribution System Studies for AC System

The analysis of load flow, voltage regulation, and short-circuit studies is performed by using ETAP, version 12.0.0N, which is qualified for nuclear power plants in accordance with 10 CFR Part 21, 10 CFR Part 50, Appendix B (Reference 47), and ASME NQA-1 (Reference 48).

8.3.1.3.1 Load Flow/Voltage Regulation Studies and Under/Overvoltage Protection

Load flow studies of onsite power systems are performed to demonstrate that acceptance voltage regulation is maintained within 90 to 110 percent of the rated voltage at the equipment terminals under the worst-case condition among normal, startup, hot standby, and LOCA operation mode. Lager motor starting studies calculate the voltage drop so that motor terminal voltages are maintained at not less than acceptance voltage of 75 percent of motor rating for Class 1E motors and 80 percent of motor rating for non-Class 1E motors.