
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.: 170-8163

SRP Section: 15.06.01 – Inadvertent Opening of a PWR Pressurizer Pressure Relief Valve or a BWR Pressure Relief Valve

Application Section: SRP 15.6.1

Date of RAI Issue: 08/25/2015

Question No. 15.06.01-1

General Design Criteria (GDC) 10 requires that specified acceptable fuel design limits (SAFDLs) are not exceeded during an anticipated operational occurrence (AOO). 10 CFR 52.47(a)(9) requires that applicants for light-water cooled nuclear power plants, provide an evaluation of the standard plant design against the standard review plan (SRP) revision in effect 6 months before the docket date of the application. Where a difference exists, the evaluation shall discuss how the proposed alternative provides an acceptable method of complying with the Commission's regulations that underlie the corresponding SRP section.

GDC 10 is not satisfied in Section 15.06.01 of the APR4000 Design Control Document (DCD) because the result of an AOO appears to violate SAFDL limits. Section 15.6.1 of the SRP identifies a spurious electrical signal or operator error as potential scenarios for the inadvertent opening of a pressurizer relief valve (IOPRV). The SRP identifies the IOPRV as an AOO. Section 5.1 of the DCD identifies the ability of the pressurizer pilot operated safety relief valves (POSRVs) to be controlled manually. Therefore, the scenarios identified in the SRP are directly applicable to the APR1400 design. The IOPRV, however, is analyzed as a postulated accident (PA) in Section 15.6.5 of the DCD. The analysis of the IOPRV appears to show that SAFDL limits are exceeded because of the reduced pressure, flow, and level in the reactor vessel at full power as evidenced by Figures 15.6.5-32(A-H) in the DCD.

10 CFR 52.47(a)(9) is not satisfied because Section 15.6.1 of the DCD departs from the SRP and no justification is provided. Table 15.0-5 of the DCD states the IOPRV is a postulated accident, which is evaluated in DCD Section 15.6.5. Section 15.6.1 of the SRP states that the IOPRV is to be treated as an AOO. Additionally, Table 1.9-2 in the DCD states that the APR1400 conforms with SRP Section 15.6.1, which is not accurate.

NRC staff request that the applicant (1) resolve or justify the current treatment of this event in the DCD and (2) update the DCD with the appropriate resolution or justification.

Response

The pressurizer safety valves (PSVs) are designed as spring loaded safety valves and are currently in use at existing plants in Korea. The PSVs have extensive operating experience, and their valve failure probability due to failure of related equipment is extremely low, which is why an IOPSV was classified as a postulated accident (PA) for CE-fleet plants (e.g. System 80 and System 80+ DC), thus being limited to a small break loss of coolant accident (SBLOCA).

The data provided by the equipment supplier indicates that the pressurizer pilot operated safety relief valves (POSRVs), though they have less operating experience than the PSVs, have a lower probability of valve failure due to failure of the valves or failure of related equipment than those of the PSVs. The data from the equipment supplier shows that the frequency required for an inadvertent opening failure is 3.40×10^{-4} /year and the probability for a re-closing failure is 2.29×10^{-4} /demand. This frequency is calculated as a theoretical assumption, because there are no real cases of inadvertent opening or re-closing happened in an existing installation, and it is much lower than that of the PSV. The system designer would require that the probability for a re-closing failure should be 2.29×10^{-4} /demand and the frequency required for an inadvertent opening failure 3.40×10^{-4} /year for the APR1400.

Section 15.6.1 of the SRP identifies a spurious electrical signal or operator error as potential scenarios for the inadvertent opening of a pressurizer relief valve (IOPRV). And Section 5.1 of the DCD identifies the ability of the POSRVs to be controlled manually. Therefore, NRC says that the scenarios identified in the SRP are directly applicable to the APR1400 design.

However, the overpressure protection function of the POSRV is fully automatic as shown in Section 5.2 of the DCD (see below), and the main valve would be able to operate by opening double motor operated pilot valves for the rapid depressurization function of reactor coolant system when a total loss of feedwater event occurs. Therefore, there is no need to consider an operator error for the POSRV because this valve is fully automatic, while the PORV has the tendency of an operator error identified in SRP. Consequently, the scenarios identified in the SRP are not applicable to the APR1400 design.

Each pressurizer POSRV provides the overpressure protection function with a main valve and two spring-loaded pilot valve assemblies.

Each assembly consists of a motor-operated isolation valve, a spring-loaded pilot valve, a check valve, and a manual isolation valve. The spring-loaded pilot valve of each POSRV acts as a safety valve in the closed position during normal operation and opens automatically if the system pressure increases to the POSRV set pressure, thus opening the check valve and the main valve.

Based on the above, in APR1400 DC Tier 2, the POSRVs are assumed in the same way as the PSV, which mean that the IOPOSRV is described to be limited to SBLOCA.

The IOPOSRV, therefore, would be analyzed as a PA.

Impact on DCD

Section 5.2.2.4.1.1 will be revised as indicated on the attached mark-up.

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 Reports.

APR1400 DCD TIER 25.2.2.4 Equipment and Component Description5.2.2.4.1 Pressurizer Pilot-Operated Safety Relief Valves

The pressurizer POSRVs are pilot-operated, forged-steel valves. These valves are mounted on the top of the pressurizer. Further description of these valves is provided in Subsection 5.4.14. A schematic drawing of the pressurizer POSRVs is given in Figure 5.4.14-1. Valve parameters are given in Table 5.4.14-1.

Open and closed indications of each POSRV are provided in accordance with the recommendations of TMI Action Plan Item II.D.3 in 10 CFR 50.34(f) (2)(xi).

5.2.2.4.1.1 Pressurizer Pilot-Operated Safety Relief Valves Operation

Four pressurizer POSRVs are connected to the top of the pressurizer by separate inlet lines. There are two main discharge lines to the IRWST. The steam from two POSRVs is discharged through one common discharge line. Each pressurizer POSRV provides the overpressure protection function with a main valve and two spring-loaded pilot valve assemblies.

Each assembly

~~Each spring-loaded pilot valve in the assembly~~ consists of a motor-operated isolation valve, a spring-loaded pilot valve, a check valve, and a manual isolation valve. The spring-loaded pilot valve of each POSRV acts as a safety valve in the closed position during normal operation and opens automatically if the system pressure increases to the POSRV set pressure, thus opening the check valve and the main valve.

Motor-operated isolation valves are normally open but are manually closed by an operator to isolate the discharge from the POSRVs when the spring-loaded pilot valves fail to close. Manual isolation valves are normally open but are closed manually by an operator during maintenance or a setpoint test.

Each pressurizer POSRV inlet nozzle is designed to pass a maximum steam flow in consideration of the maximum pressure drop from the pressurizer to the POSRV.