REVISED 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.:	**415-8503**
SRP Section:	**15.06.05 – Loss of Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary**
Application Section:	**15.6.5**
Date of RAI Issue:	**02/22/2015**

Question No. 15.06.05-21

SRP Section 6.3, "Emergency Core Cooling System," Review Procedure 22.A states that the lower limit of break size for which emergency core cooling system (ECCS) operation is required needs to be established, which is also the maximum break size for which normal reactor coolant makeup systems (i.e. chemical and volume control system (CVCS)) can maintain reactor pressure and coolant level.

The capability of the ECCS to actuate and perform at this lower limit of break size needs to be confirmed. Currently, the applicant has analyzed small break LOCAs down to and including a break size of 18.6 cm^2 (0.02 ft^2). Breaks smaller than 18.6 cm^2 have not been presented to the staff for review. It is unclear to the staff if 18.6 cm^2 is the smallest small break for which the ECCS actuates and performs satisfactorily, i.e., it is unclear if a break smaller than 18.6 cm2 can be handled by the CVCS system.

The staff needs to confirm that the ECCS actuates and performs satisfactorily at the lower limit of SBLOCAs. Please provide information regarding:
1. The smallest break size for which the APR1400 ECCS is used;
2. The calculation which shows the largest break size that is handled by normal CVCS;
3. The analysis results for the smallest break size event in which the ECCS is used for mitigation;
4. If 18.6 cm^2 is indeed the smallest break size for which the APR1400 ECCS is used, the staff only needs to see a calculation showing that the CVCS can handle break sizes up to 18.6 cm^2.

Response – (Rev. 1)

1. The smallest break size using the calculation of CENPD codes is 0.02 ft^2 DVI line break. On the other hand, the only hand calculation without CENPD codes is applied for the evaluation of instrument tube rupture. The break size of instrument tube rupture is 0.003 ft^2. Therefore, the smallest break size for which the APR1400 ECCS is used is 0.003 ft^2.

2. The largest break size that is handled by normal CVCS is 0.00032 ft^2 (0.0461 in^2) for the APR1400. During normal operation, only one charging pump is available. The smallest break size was determined by equivalent break area with charging pump flow rate at normal operating condition. The result of calculation is as follow.

Amin = Wcharging pump / Gc
where, Wcharging pump = 1 (pump) × 70.4 = 70.4 [gpm]
Gc = critical mass flux from Henry Fauske-Moody model

Thermal properties at cold leg condition are

Temperature = 555.0 ^{o}F
Pressure = 2250.0 psia
Density = 46.533 lbm/ft^3
Enthalpy = 553.40 Btu/lbm

From Henry Fauske-Moody critical flow model, use h = 553.40 [Btu/lbm] as stagnation enthalpy.

Pressure(psia)	Enthalpy(Btu/lbm)	Mass flux(lbm/ft^2sec)
2200	487.511	26883.875
	643.400	16218.000
2400	464.778	29708.444
	674.000	15746.000
then, 2200	553.40	22375.771
2400	553.40	23794.249

Therefore, at 2250 psia, Gc = 22730.391 [lbm/ft^2sec]

Amin = W × Density / Gc / 448.83 = 70.4 × 46.533 / 22730.391 / 448.83
= 0.00032[ft^2]
= 0.0461 [in^2]

where, 1.0 [gpm] × 2.228E-03 = 1 [ft^3/sec]

3. The smallest DVI line break size analyzed applying the CENPD code in the APR1400 DCD is 0.02 ft^2. For the case of 0.02 ft^2, the core uncovery doesn't occur as described in the DCD and also the core uncovery will not occur for a smaller break size than 0.02 ft^2. Therefore, the additional analyses are not necessary.

Even for a smaller break size than 0.02 ft^2, RCS pressure is gradually decreased and when the time has elapsed, pressure reaches the set pressure that ECCS is working and then SIP flow is injected. The smaller the break size, reaching time to operate the ECCS can be delayed. However, there is no LOCA accident that RCS pressure doesn't decrease to the set pressure.

4. During SBLOCA, the major phenomena during SBLOCA are break flowrate and loop seal clearing and also the major parameters are core level and peak cladding temperature. For the cases of break size under the 18.6 cm^2 (0.02 ft^2), the core uncovery and the loop seal clearing do not occur during SBLOCA. So, the fuel rod heat-up caused by core uncovery(boil-off) is no longer generated below this break size. And also, the fuel rod heat-up caused by the effect of Departure Nucleate Boiling occurring right after reactor trip does not increase the break size under the 18.6 cm^2 (0.02 ft^2). Therefore, the smallest break size during SBLOCA of APR1400 is determined as the 18.6 cm^2 (0.02 ft^2).

Impact on DCD

There is no impact on the DCD.

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 Environment Report.