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.:	**296-8342**
SRP Section:	**06.02.01.01.A – PWR Dry Containments, Including Subatmospheric Containments**
Application Section:	**6.2.1.1 Containment Structure**
Date of RAI Issue:	**11/05/2015**

Question No. 06.02.01.01.A-3

In order to resolve the differences between the applicant's calculations as reported in the DCD and the staff's confirmatory calculations, the applicant is also requested to provide an electronic copy of the GOTHIC deck[s] for the APR1400 containment peak pressure and temperature calculations, along with any applicable reports. The reports can be made available through the APR1400 electronic reading room (ERR).

Response – (Rev.1)

GOTHIC decks used for containment peak pressure and temperature calculations will be submitted as a CD media. Documents related to the APR1400 GOTHIC decks, listed in the Table 1, will be submitted via the ERR.

Table 1. Description of GOTHIC Decks

NO.	DOCUMENT TITLE	SOURCE	IDENTIFICATION NO.	REV. NO.	FILE NAME
1	CONTAINMENT P/T SHORT-TERM ANALYSIS	APR1400 DC	1-310-N380-003	05	1-310-N380-003.pdf
2	CONTAINMENT P/T LONG-TERM ANALYSIS	APR1400 DC	1-310-N380-004	05	1-310-N380-004.pdf
3	GOTHIC THERMAL HYDRAULIC ANALYSIS PACKAGE USER MANUAL Ver. 8.0(QA)	NAI	NAI 8907-02	20	GOTHIC User Manual.pdf
4	GOTHIC THERMAL HYDRAULIC ANALYSIS PACKAGE TECHNICAL MANUAL Ver. 8.0(QA)	NAI	NAI 8907-06	19	GOTHIC Technical Manual.pdf

KHNP has performed sensitivity analyses regarding the condensation options in GOTHIC and the influence of the inertial length on containment analysis results. The following paragraphs discuss detailed descriptions of each case performed in the two sensitivity analyses.

Comparison of Condensation Options in GOTHIC

KHNP performed an analysis to estimate the effects on the containment peak pressure and temperature from using two different GOTHIC condensation options (Direct/DLM and Tagami). Table 2 provides the description of two cases, each of which selected Direct/DLM or Tagami as the surface option of the heat structure, with the peak pressure and temperature for the DBA LOCA (Double ended discharge log slot break with Max. SI).

The containment maximum pressure and temperature from the case that uses the Tagami option are higher than that of the Direct/DLM option by 0.31 psi and 0.4 ^{o}F, respectively. This seems to be a result of the difference between the two intrinsic models that calculate the condensing rate near the wall (i.e., Tagami option is based on the conservative empirical formula, whereas the Direct/DLM calculates the condensation rate and sensible heat transfer rate directly on the structure's surface using heat/mass transfer analogies. Generally the Direct/DLM gives less conservative pressure and temperature results compared to that of the Tagami).

Table 2. Effects of DLM and Tagami Condensation option on Containment P/T

Case	Surface Option	GOTHIC Deck	Pmax (psia)	Tmax (°F)

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Note:
The GOTHIC decks with associated calculation results will be provided to the NRC through the ERR

It should be noted that the Tagami option produces higher containment peak pressure and temperature, however they are also well bounded by the containment design pressure (74.7 psia) and design temperature (290 ^{o}F).

As a representative instance of using the Direct/DLM condensation option in containment analysis, Westinghouse uses the GOTHIC Direct/DLM option in its PWR containment analysis methodology which was approved by NRC (Reference 1).

Documents related to the GOTHIC decks, listed in the Table 2, will be submitted as a CD media.

Sensitivity Analysis on the Inertial length

NRC requested the analysis of sensitivity to the containment peak pressure and temperature using various inertial lengths. KHNP carried out a sensitivity analysis for the inertial length of each junction to verify the impact of the inertial length on the results.

In the APR1400 containment model, a total of 17 flow paths are included and a nominal value of 1.0 foot is used for the inertial length of each flow path since most of the flow paths connecting to the containment volume are used as the flow boundary input for the M/E release. Therefore, the inertial length of each flow path is deemed not to significantly impact the analysis results.

As shown in Figure 1, flow paths connecting to the containment volume consist of junction J1 for spray, junction J2 to IRWST, J12 for SIT Nitrogen gas release and four (4) junctions for M/E release (J3, J5, J13, and J15). The other junctions are used for the M/E release during the LOCA decay heat phase are after EOPR, thus have no impact on the peak containment pressure and temperature.

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Figure 1. APR1400 Containment Model

To estimate the individual influence on the peak pressure and temperature results from the variance of the inertial length of each flow path, a total of 17 cases (Case 1 ~ Case 17) are prepared and each of which has an inertial length set to the same value as the containment height (166 feet) with the others that are set to the default value of 1.0. Two cases are added to represent the reference case (Case 0) that has all of the inertial length set to 1.0. and the case (Case 18) that has 166 feet as the inertial length of all its flow paths. Table 3 presents the description of each case for the sensitivity analysis with the peak pressure and temperature results.

Table 3. Description of each case for sensitivity analysis

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Note

The GOTHIC decks and the associated results will be provided to the NRC through the ERR.

(1) Indicates the junction No. of which the inertial length is set to 166 feet. The inertial length of the other junctions are set to the default value, 1.0 foot.

(2) The inertial length of all the junctions (J1~J17) are set to 1.0 foot (Reference case).

(3) The inertial length of all the junctions (J1~J17) are set to 166 feet.

As seen in Table 3, the maximum containment pressure of the case (Case 18) which uses the value of 166 feet for the inertial length of all the flow paths yields higher peak pressure than that of the case (Case 0) which uses the value of 1 foot as the inertial length of all flow paths. The pressure variance is estimated to 0.34 psi. It is noted that the biggest influence on contributing peak pressure increase comes from the inertial length of the flow path (J15) for the M/E release during the blowdown phase.

By applying the inertial length of all flow paths to 166 feet, which is the longest height among the volumes used in the containment model, the containment maximum pressure and temperature are estimated to 66.14 psia and 274.64 ^{o}F, respectively. However the maximum pressure remains below the containment design pressure of 74.7 psia with a sufficient pressure margin of 14.2 percent (decreased by 0.6 percent). The containment temperature of the case (Case 18) is greater than that of the case (Case 0) by 0.48 ^{o}F, however which is also less than the containment design temperature.

Documents related to the GOTHIC decks, listed in the Table 3, will be submitted as a CD media via WDCC.

References

WCAP-16608-NP, “Westinghouse Containment Analysis Methodology,” Westinghouse Electric Company LLC, August 2006.

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 Environmental Report.