

## 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.:** 249-8323  
**SRP Section:** 03.08.01 – Concrete Containment  
**Application Section:** 03.08.01  
**Date of RAI Issue:** 10/14/2015

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### Question No. 03.08.01-15

10 CFR 50.55a and Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50, provide the regulatory requirements for the design of the concrete containment. Standard Review Plan (SRP) Sections 3.8.1 and 3.8.5, Subsection II.4, discuss the requirements of the computer programs used in the design and analysis of safety-related structures.

APR1400 DCD Tier 2, Section 3.8.1.4.2, "Containment Structure," identifies the use of the computer program ANSYS and DCD Section 3.8A.1.4.2.3, "Analysis and Design Procedures," identifies the use of the computer program DARTEM. The applicant stated that "The calculated design forces and moments are used as input in the concrete section design program DARTEM for the design of flexural reinforcement and shear reinforcement." The staff could not find any description in the DCD that validates and verify the use of this computer program. Therefore, per 10 CFR 50.55a; Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50; and SRP 3.8.1 and 3.8.5, the applicant is requested to identify if any other computer programs are utilized in the analysis and design of all seismic Category I structures, and for all programs utilized describe the computer program, identify what structural evaluations it is used for, and describe how they have been validated.

Additionally, DCD Section 3.8A, Table 3.8A-2, "Section Forces of Containment Wall Design Sections," identifies six member forces used for the containment wall design sections. The applicant is requested to explain why only six member forces are given for design and why the in-plane shear forces are not also presented.

### Response – (Rev. 1)

The computer programs, utilized in the analysis and design of Seismic Category I structures, are described in Table 1 of this response. Table 1 contains the program list, the analysis method, the model which is generated and analyzed by the program, the analysis scope including loads applied, and how the program has been validated. [Table 1 and a brief](#)

description regarding Table 1 will be included in DCD Tier 2, Table 3.8-11 and Subsection 3.8.1.4.1, respectively.

The DARTEM & LBAP programs in the table are verified and validated using a program which satisfies the requirements of SRP 3.8.1, Section II.4.F. DCD Tier 2, Subsection 3.8.1.4.5.2 and 3.8.1.4.10 will be revised, as indicated in the attachment associated with this response.

The section forces in DCD Tier 2, Table 3.8A-2 are based on the results of the structural analysis, and are used as input to DARTEM to check the stresses of concrete and reinforcing steel. In the process of converting the results of the structural analysis to DARTEM input, tangential shear force and torsional moment are added to the membrane force and flexural moment, respectively, in order to consider the effect of tangential shear force and torsional moment. The definitions of section forces in DCD Tier 2, Table 3.8A-2 will be revised, as shown on the attachment associated with this response.

Table 1 Computer Programs for Seismic Category I Structures

Program	Analysis Method	Analysis Model	Analysis Scope	Validation & Verification
ANSYS (E-P-CE-1327-14.0/DC)	• Modal analysis	• Reactor containment building (shell & dome, internal structure)	• Eigenvalue analysis	- ANSYS was procured with a Quality Assurance Service Agreement and meets the applicable requirements of the NQA-1, Subpart 2.7, quality assurance requirements of computer software.
		• Spent fuel pool & aux. feed water storage tank	• Eigenvalue analysis	
	• Response spectrum analysis	• Reactor containment building (shell & dome, internal structure)	• Structural analysis of seismic load for RCB	
	• Static analysis	• Reactor containment building (shell & dome, internal structure)	• Structural analysis of RCB for structure design (e.g. dead and live loads, etc.)	
		• Auxiliary building (including spent fuel pool, aux. feed water storage tank)	• Structural analysis of AB for structure design (e.g., dead and live loads, etc.) • Local analysis of spent fuel pool and aux. feed water storage tank (e.g., hydrostatic and hydrodynamic loads, etc.)	
		• Emergency diesel generator building	• Structure analysis of EDGB for structure design (e.g., dead and live loads, etc.)	
		• Diesel fuel oil storage tank building	• Structural analysis of DFOT for structure design (e.g., dead and live loads, etc.)	
	• Heat transfer analysis	• Reactor containment building (shell & dome)	• Temperature analysis	
		• Spent fuel pool	• Temperature analysis	
	• Nonlinear analysis	• NI common basemat	• Structural analysis of basemat for structure design considering nonlinear soil spring (compressive only spring, reaction of superstructures)	
	• Nonlinear analysis	• Emergency diesel generator building basemat	• Structure analysis of EDGB for structure design considering nonlinear soil spring (compressive only spring, reaction of superstructures)	
		• Diesel fuel oil storage tank building basemat	• Structural analysis of DFOT for structure design considering nonlinear soil spring (compressive only spring, reaction of superstructures)	

Program	Analysis Method	Analysis Model	Analysis Scope	Validation & Verification
ANSYS (E-P-CE-1327-14.0/DC) (cont.)	• Equivalent static analysis	• Auxiliary building (including spent fuel pool, aux. feed water storage tank)	• Structural analysis of seismic load for AB	
		• Emergency diesel generator building	• Structural analysis of seismic load for EDGB	
		• Diesel fuel oil storage tank building	• Structural analysis of seismic load for DFOT	
	• Direct integration time history analysis	• IRWST hydro-dynamic analysis	• Generation of floor response spectrum (FRS) due to POSRV sparger discharge load for mechanical and piping design	
ABAQUS (E-P-CE-1245-6.10)	• Nonlinear analysis	• Reactor containment building	<ul style="list-style-type: none"> <li>• Ultimate pressure capacity evaluation corresponding to RG 1.216, Position 1 using nonlinear material model</li> <li>• Combustible gas control inside containment evaluation corresponding to RG 1.216, Position 2 using nonlinear material model</li> </ul>	- ABAQUS is validated in accordance with the registration procedure for computer software of KEPCO E&C.
DARTEM (E-P-CE-1139-1.1)	• Static analysis	• Reactor containment building (shell & dome, internal structure, RCB basemat)	• Structural analysis and design of reinforced concrete section subjected to mechanical and thermal loads	- DARTEM is validated in accordance with the registration procedure for computer software of KEPCO E&C.
LBAP (E-P-CE-1138-2.0)	• Static analysis	• Reactor containment building (liner plate anchorage system)	• Structural analysis of liner plate anchorage system when liner plate buckled	- LBAP is validated in accordance with the registration procedure for computer software of KEPCO E&C.
GTstrudl (E-P-CE-1163-31)	• Static analysis	• Auxiliary building (concrete slab analysis model)	• Structural analysis to obtain design forces for concrete slab design (e.g, dead and live loads, etc.)	- GTstrudl was procured with a Quality Assurance Service Agreement and meets the applicable requirements of the NQA-1, Subpart 2.7, quality assurance requirements of computer software.

**Impact on DCD**

DCD Tier 2, Subsection [3.8.1.4.1](#), [3.8.1.4.5.2](#), [3.8.1.4.10](#), [Table 3.8A-2](#) and [Table 3.8-11](#) will be revised, as indicated in the attachment associated with this response.

**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.