

# **Technical Service on Seismic Probabilistic Risk Assessment for Shin Wolsong Unit 1&2 Nuclear Power Plants**

**2020. 5**



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## 1. GENERAL INFORMATION OF THE SERVICE

KEPCO E&C will select four (4) items of building structurers, seven (7) items of RCS (Reactor Coolant System) equipment and thirty (30) items of the BOP components from Unit 1&2 Shin Wolsong Nuclear Power Plants. Contractor will develop seismic fragilities of items above using the plant-specific design information by the approaches described in below ;

Besides, Contractor shall review plant response analysis results developed by KEPCO-E&C, which are review of screening level, the initiating event by seismic event, the ET(Event Tree)/FT(Fault Tree) including the seismic failure event of SSCs (Structures, Systems, Components), the uncertainty/sensitivities, and the detailed HRA(Human Reliance Analysis) calculation for seismic event.

Seismic fragility calculations for the SSCs will be performed using the Separation-of-Variables approach based on ASME/ANS PRA Standard (RA-Sb-2013, Part 5-SFR&SPR) and the EPRI Seismic Evaluation Guidance - Screening, Prioritization and Implementation Details (SPID) criteria delineated in EPRI 1025287. And the seismic fragility evaluations will be performed following the 2013 ANS/ASME PRA Standard requirements for Capability Category II, based on the SSE response provided by KEPCO E&C. The review on plant response analysis results developed by KEPCO-E&C shall be performed by following ASME/ANS RA-Sb-2013, Part 5-SPR and EPRI SPID.

The prime contract which contains this technical service is summarized as below.

A. Title : Seismic Design/Capacity Enhancement (Area 1, 3)

B. Owner : KHNP

C. Prime contract No. : H17S036000

D. Period : 2017/08/21 ~ 2021/12/31

E. Prime contract amount : 7,029,847,000 Korean won

F. Business Objective :

■ Final Objective

- Establishing of the methodology for seismic capacity enhancement based on latest licensing criteria abroad and reinforcing strategy for existing SSCs

■ Performance Objective

- Evaluation of response capability of Unit 1&2 Shin Wolsong Nuclear Power Plants (representative Units of KNPP, Korea Nuclear Power Plants) using ASME/ANS

PRA Standard (RA-Sb-2013, Part 5-SFR&SPR) and the EPRI Seismic Evaluation Guidance - Screening, Prioritization and Implementation Details (SPID) criteria delineated in EPRI 1025287

## 2. SCOPE OF THE SERVICE

The work scopes are divided into 2 Tasks and there will be 3 technical meetings. (The 1<sup>st</sup> and 3<sup>rd</sup> meetings at Contractor's office, 2<sup>nd</sup> meetings in Korea.)

### ■ Task 1 – Development of Seismic Fragility (SOV method)

Four (4) building structures, seven (7) RCS equipment and thirty (30) BOP equipment for Shin Wolsong Unit 1&2 Nuclear Power Plants

- Development of Seismic Fragility including stabilities for Buildings (4EA)
  - ✓ Reactor building (Including Internal Structures)
  - ✓ Aux. building
  - ✓ Two Underground structures
- Development of Seismic Fragility for RCS equipment (7EA)
  - ✓ Reactor Vessel
  - ✓ Reactor Vessel Internal
  - ✓ Steam Generator
  - ✓ Pressurizer
  - ✓ Reactor Coolant Pumps
  - ✓ Fuel Assembly
  - ✓ CEDM
- Development of Seismic Fragility for BOP Equipment (30EA)
  - ✓ 30EA electrical, mechanical equipment and distribution system. (Cabinets, Panels, Tanks, Pumps, Coolers, Heat Exchangers, Piping and its support, HVAC and its support, Cable tray and its support)
  - ✓ To be determined by KEPCO-E&C
- Submittal of Seismic Fragility Calculations/Report
  - ✓ 4 building structures calculations including each building's stability
  - ✓ 7 RCS equipment calculations

- ✓ 30 BOP equipment calculations
- Submittal of 1 (one) Seismic Fragility Report
- \* 2<sup>nd</sup> technical meeting is required in Korea to collect RCS information with KEPCO E&C.

## **■ Task 2 – Review on Plant Response Analysis Results developed by KEPCO-E&C**

- Review the screening level
- Review the initiating events
- Review the method of calculating seismic initiating event frequency
- Review the ET/FT including the seismic failure event of SSCs (Level 1&2)
- Review the Uncertainties/Sensitivities
- The detailed HRA calculation for seismic event
- Review the result of seismic CDF (Core damage Frequency) / LERF (Large Early Release Frequency)
- Submittal of 1 (one) SPRA Review Report

## **3. Methods of Performance**

### **A. Domain of Responsibility**

- **KEPCO E&C**
  - Provides sufficient information so that the Contractor could perform the tasks.
  - Reviews the technical calculations/reports which are prepared by the Contractor.
- **Contractor**
  - Provides the consulting services that are defined in Task 1 through Task 2.
  - Provides the deliverables to KEPCO E&C as defined in Section 3.B.
  - Takes part in 3 technical meetings.
- **Technical meeting**
  - Kick off meeting will be held in Contractor's office within 3 working day with responsible people participated.
  - 2<sup>nd</sup> technical meeting will be held in Korea within 5 working day with 1 responsible person participated.
  - 3rd technical meeting will be held in Contractor's office with 5 working day with responsible people participated.

## B. Deliverables

The final deliverables are fully verified technical calculations/reports which incorporate the KEPCO E&C's comments.

No	Activities/Deliverables	Submittal Due Date *	Remarks
1	• 4 buildings Seismic Fragilities Calculations including Stabilities and submittal (Task 1)	T0 + 5 months	
2	• 7 RCS Seismic Fragilities Calculations in the containment and submittal (Task 1)	T0 + 8 months	
3	• 30 BOP equipment Seismic Fragilities Calculations and submittal (Task 1) • Draft Seismic Fragility Report (Task 1)	T0 + 12 months	
4	• Draft SPRA Review Report (Task 2)	T0 + 15 months	
5	• Final Seismic Fragility Report (Task 1) • Final SPRA Review Report (Task 2)	T0 + 16 months	All final reports shall incorporate KEPCO E&C's comments and its resolutions by Contractor

\*T0 : Execution Date (Contract signing date)

## 4. Schedule

Duration of the work activities is 16 months after the Contract signing (Execution Date). Details of the schedule and milestones are delineated in the following Table. Detailed time schedule can be adjusted during the kick-off technical meeting through discussion between the Contractor and KEPCO E&C.

Activity	Month after Contract signing (Deliverables)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Kick-off Meeting (Contractor Office)																
Task 1- 4 buildings fragilities																

2 <sup>nd</sup> Tech. Meeting for RCS information (Korea)																
Task 1 – RCS equip. fragilities																
Task 1 – BOP equip. fragilities																
Task 1 - Final Seismic Fragility Report																
Task 2 – Plant Response Analysis																
Task 2 - Final SPRA Review Report																
3 <sup>rd</sup> Tech. Meeting (Contractor Office)																

\* The above schedule including technical meetings can be changed with a mutual agreement.