

Technical Information

**Consulting for technical support on the key licensing
issues for innovative small modular reactor**

January, 2023



한국전력기술주식회사
KEPCO ENGINEERING & CONSTRUCTION COMPANY, INC

[Appendix A - SCOPE OF SERVICES AND METHOD OF PERFORMANCE]

1.0 PURPOSE

KEPCO E&C is developing a system design for the innovative Small Modular Reactor(i-SMR) under the support of Korean government and Korea Hydro and Nuclear Power, Co. (KHNP). i-SMR will adopt many innovative key technologies which may invoke some licensing concerns from Korean nuclear regulating body.

The purpose of this Contract is to assist KEPCO E&C by providing technical solutions listed below with bases for licensing to complete the system design of i-SMR.

The results of this Contract will be shared by KHNP according to the contract between KEPCO E&C and KHNP.

2.0 TECHNICAL SCOPE OF WORK

Contractor shall provide engineering consulting services to KEPCO E&C including the following tasks:

Task 1: Review and recommendation on the Support Design of Reactor Vessel and Steel

Containment

(1) Required completion date: Execution Date + 4 Months

(2) Activity description

- Review of Support Design for Reactor Vessel and Steel Containment for SMR
 - Review of Codes and Standards
 - Review of Materials Selection
 - Review of Design Requirements for Supports
 - Review of Conceptual Design
 - Consideration of Heavy Vessel Support installed in Limited Area
 - Consideration of Interface Design between RV and CV
 - Recommendation for Development of i-SMR Supports
- Review of Procedure for Manufacture and Installation for Supports
 - Requirements of Manufacture and Installation
 - Review of Procedure for Manufacture and Installation
 - Recommendation of Manufacture and Installation
 - Requirements of Inspection and Maintenance

Task 2: Operation experiences and related system requirements for the soluble boron-free Chemical and Volume Control System(CVCS) for SMR

(1) Required completion date: Execution Date + 6 Months

(2) Activity description

- Providing technical issues and considerations for the application of plate-and-shell heat exchanger instead of shell-and-tube heat exchanger for the CVCS, including applicable codes and standards and licensing issues.
- Providing modular design for SMR CVCS including configuration and component lists, design requirements for the components, design and licensing experience, and lessons learned related to the compact design of SMR CVCS. Suggestions shall be provided to reduce the size, capital and operating cost of CVCS.
- Recommendation of facilities for removing ion and insoluble impurities rather than ion exchangers or filters. Suggestions shall be provided for alternative purification facilities for SMR other than ion exchanger. Design and licensing experience and lessons learned shall also be provided related to the alternative purification facilities for the SMR.

Task 3: Structural Design and Leakage Integrity Assurance of Steel Containment for SMR

(1) Required completion date: Execution Date + 3 Months

(2) Activity description

- Providing the followings for the structural design requirements for Steel Containment Vessel and penetration design
 - The requirements of codes and standards for the structural design
 - The design method and procedure for the steel containment
 - Review of penetration and piping interface design and adequacy of number of penetration SMR
- Review on the design of Steel Containment Vessel structure
 - Codes and standards for the Steel Containment structural design
 - Design requirements, design method, and procedure for the steel containment
 - Loads and load combinations
 - Acceptance criteria for the containment structural integrity on design basis event and beyond design basis event
 - Methodology on mass/energy release analysis and its resulting

containment pressure and temperature (P/T) analysis to confirm the integrity of steel containment vessel

- Providing the followings for UPC (Ultimate Pressure Capacity) evaluation method for Steel Containment Vessel
 - Methodology to determine the UPC of the steel containment vessel
 - Analysis procedure and requirement for UPC (NUREG/CR-6906, RG. 1.216, etc.)
 - Validation review of assumption for UPC
 - ◆ Failure criteria, Stud preload, FE model, material properties, weld residual stress, static coefficient of friction and buckling, etc.
- Providing the followings for Containment Vessel Leakage Integrity Assurance
 - Applicable requirements including code and standards for containment vessel leakage integrity assurance
 - Methodology to ensure leakage integrity
 - Design and analysis to provide leakage integrity assurance for the containment vessel
 - Pre-service and in-service inspection (PSI and ISI) and testing method for each inspection locations
 - Leakage integrity assurance methods regarding material selection and aging degradation

Task 4: Review on the Sealing for the control rods drive mechanism

(1) Required completion date: Execution Date + 6 Months

(2) Activity description

- Survey of available industry sealing technologies
- Review on the applicable design of the sealing units for in-vessel control element drive mechanism(IV-CEDM) cables and ICIs
- Recommendations on the design of the sealing units for the In-vessel Control Element Drive Mechanism cables and in-core instrumentations
- Evaluation and recommendation for improvement of the conceptual maintenance procedures for the sealing units
- Recommendations on the qualification method and criteria for the sealing units
- Providing applicable codes and standards in the United States with regulatory

requirements

Task 5: Review on the Requirements for the Materials Integrity of SMR

(1) Required completion date: Execution Date + 6 Months

(2) Activity description

- Review on major materials, fabrication and examination requirements for the design phases
- Review on the possible materials degradation for SMR
- Expected licensing issues for material-related areas of SMR
- Review applicable material list of SG Helical Tube
- New technologies for welding, cladding, and forgings for SG helical tubing applicable to SMR
- Qualification requirements of IV-CEDM including wiring for materials integrity in SMR
- Expected water chemistry modifications applicable to SMR
- Provide any applicable references, codes and standards in the United States with regulatory requirements

Task 6: Design, Fabrication, Inspection and Maintenance for Nozzles Header and Tubes of SMR Steam Generator

(1) Required completion date: Execution Date + 6 Months

(2) Activity description

- Review on the conceptual design for nozzles and tubes of SMR Steam Generator (SG)
- Recommendation for the design improvement of SG headers and nozzles considering fabrication
- Recommendation for the solution of licensing issues for in-service inspection of SG
- Recommendation for exempting schemes from in-service inspection of tubes
- Recommendation for steam generator maintenance program applicable for SMR SG
- Recommendation for methods to minimize flow induced vibration and wear of

tubes

- Providing applicable codes and standards for SMR SG

3.0 METHOD OF PERFORMANCE

Consulting Schedule

The consulting will be finished by December. 31,2023 according to the design and engineering schedule of KEPCO E&C for the tasks listed in Appendix A. Contractor shall provide, for approval by KEPCO E&C, the detailed schedule of each task for technical meetings and reports in the Task Order.

Method of Performance

Contractor shall start the consulting service in accordance with each of the Task Orders(TOs) and perform the activities specified in the TOs. The methods to issue the TOs and to perform activities are described as follows:

A. Preparation and Issuance of Task Orders

KEPCO E&C is responsible for preparation of a draft TO. However, if it is considered more efficient, KEPCO E&C may request Contractor to prepare the draft TO on behalf of KEPCO E&C. It is recommended to use the template (Attachment 1. Task Order Form) given in this Contract. The draft TO shall include the following information:

- (a) Title of the Task Order
- (b) Schedule of activities for the Task
- (c) Scope of work
- (d) Methods of performance
- (e) Deliverables
- (f) Price information(man-hours and hourly rates for the task)
- (g) Others

Draft deliverables shall be submitted to KEPCO E&C for review and comment, and shall be incorporated into the final deliverables after resolving between both parties. The draft TO shall be reviewed, agreed and approved by the project managers of the both parties. Then, the signed (approved by the project managers of both parties) final TO is officially issued by the project manager of KEPCO E&C.

B. Task Orders

The Task Order Form is provided in Attachment 1-

Contractor shall keep confidential all the data and information from this Contract, and shall not divulge them to any third parties.

Deliverables

Deliverables issued per the TOs shall be provided in accordance with the above article (method of performance) mentioned.

4.0 SCHEDULE

The Contract is effective until December 31, 2024.

The time schedules of tasks are subject to change after agreement between the Contractor and KEPCO E&C, and will be specified in each of the TOs.

Attachment 1. Task Order Form

TASK ORDER	No. TO-N-001	Rev.0
<p>To : <u>Name of Project Manager</u> of <u>Name of Contractor</u></p> <p>I, the undersigned, hereby authorize this Task Order (TO) under which Contractor shall provide the required Services described below in accordance with the terms and conditions of the Contract between <u>Contractor</u> and KEPCO E&C, dated <u>mm/dd/yyyy</u>, which shall govern this Task Order.</p> <p>1. TITLE</p> <p><u>XXXXXXXXXX</u></p> <p>2. BRIEF DESCRIPTION</p> <p><u>XXXXXXXXXX</u></p> <p>3. START/END DATES AND DURARTION</p> <ul style="list-style-type: none">• Assignment Start Date: <u>mm/dd/yyyy</u>• Assignment End Date: <u>mm/dd/yyyy</u>• Duration: <u>00 Months</u> <p>4. SCOPE OF WORK</p> <p>Contractor shall provide engineering services to KEPCO E&C for the following tasks:</p> <p>A. Sub-Task No.:</p> <p>The Contractor shall provide the following sub-tasks for each task item according to the Contract between Contractor and KEPCO E&C:</p> <p>(1.1) XXXXXXXX (1.2) (1.3)</p> <p><i>Describe scope of work and method of performance....</i></p>		

TASK ORDER	No. TO-N-001	Rev.0
------------	--------------	-------

5. PRICE

- Total Budget: USD 000,000

Activity or Item	Position Assigned	Rate (USD/hr)	Man-hours	Costs (USD)
Sub-task 1.1	Senior Engineer			
	Junior Engineer			
Sub-task 1.2	Senior Engineer			
	Junior Engineer			
...				
TOTAL				

6. DORMAIN OF RESPONSIBILITY

A. KEPCO E&C

- Provides explanation on the task defined in this Task Order so that the Contractor can perform the task.
- Reviews the deliverables prepared by the Contractor and provides comments on deliverables for the Contractor to revise the deliverables as needed.

B. Contractor

- Provides the consulting services described in this Task Order.
- Provides the draft deliverables to KEPCO E&C as defined in this Task Order.
- Provides the final deliverables to KEPCO E&C with all the comments resolved

7. TIME SCHEDULE

Sub-task No.	Activity	DOR	Schedule
1.1	Sub-task title	Contractor	
1.2	Sub-task title	KEPCO E&C	
...	...		
...	...		

TASK ORDER	No. TO-N-001	Rev.0
------------	--------------	-------

8. DELIVERABLES

No.	Deliverables	DOR	Schedule
1	Title of deliverable 1	KEPCO E&C	
2	Title of deliverable 2	Contractor	
3	Title of deliverable 3	KEPCO E&C	
...	...		

9. NAME(S) AND POSITION OF PERSONNEL TO CARRY OUT THE WORK

- (1) Name-1, Senior Engineer, Nuclear Engineering
- (2) Name-2, Senior Engineer, Fluid Engineering
- (3)

10. REFERENCES

- (1) Contract No. XXX
- (2) ...

11. ISSUE OF TASK ORDER

Preparation/Review (KEPCO E&C)	Position	Name	Signature
Issued by	Nuclear EGS		
Reviewed by	PA-GS		
Approved by	APM		

TASK ORDER		No. TO-N-001	Rev.0												
<p>Agreed by Contactor PM</p> <table><tr><td>_____</td><td>_____</td><td>_____</td></tr><tr><td>(Name)</td><td>(Signature)</td><td>(Date)</td></tr></table> <p>Authorized by KEPCO E&C PM</p> <table><tr><td>_____</td><td>_____</td><td>_____</td></tr><tr><td>(Name)</td><td>(Signature)</td><td>(Date)</td></tr></table>				_____	_____	_____	(Name)	(Signature)	(Date)	_____	_____	_____	(Name)	(Signature)	(Date)
_____	_____	_____													
(Name)	(Signature)	(Date)													
_____	_____	_____													
(Name)	(Signature)	(Date)													