

Technical Information

**Consulting on the Technical Support for the
Assessment of APR1000 Compatibility with
European Requirements**

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1.0 PURPOSE

KEPCO E&C has developed a new NPP design of APR1000 to comply with the safety requirements of latest IAEA, WENRA and EUR Rev. E to provide the most competitive NPP in the overseas market including Europe. KEPCO E&C is responsible for the design of the APR1000 which also applies for the EUR design assessment.

Although most of the APR1000 design concepts have already been completed, there are still several areas that need further development and/or independent peer review by a third party because those areas include new evolutionary design concepts or European region-specific design requirements.

The purpose of this contract is to assist KEPCO E&C to complete the APR1000 standard design

2.0 TECHNICAL SCOPE OF WORK

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

Task 1: I&C Common Cause Failure (CCF) Design

The objective of this item is to have consultation on the conformance to EUR Rev.E requirements of the APR1000 design regarding CCF-resistant and inherent robust features. The contractor shall provide consultation services for the following sub-items.

Providing review result on APR1000 I&C CCF coping design for the compatibility with relevant EUR Rev.E requirement based on detailed design description in Defense-in-Depth and Diversity (D3) report provided by KEPCO E&C

- Providing proposal for improving KEPCO E&C's D3 strategy based on above review results
- Providing licensing experience and information for CCF Coping I&C design in Europe

Task 2: Methodology and Technical Background for Dependability Analysis of I&C Systems

EUR Rev.E (Vol.2 Chapter 10, Section 6.4.4) requires that an analysis of the effectiveness of the measures implemented shall be performed in the design process for the I&C architecture to achieve the required independence. Dependability, which encompasses availability (reliability and maintainability) and credibility (integrity and safety), has to be assessed to show the conformance of the APR1000 I&C design to EUR Rev.E. The contractor shall provide consultation services for the following sub-items.

- Providing Evaluation methodology on dependability consisting of availability (reliability and maintainability) and credibility (integrity and safety) for I&C systems based on EUR Rev.E (Volume 2, Chapter 10, Section 6.4.4.2) All the attributes which can either directly or indirectly affect the I&C system dependability shall be included in the methodology.
- Providing Experience of precedents on how dependability of existing I&C systems of NPPs built in Europe

Task 3: IEC Codes & Standards

APR1000 I&C system is designed basically based on IEEE standards instead of IEC, which is European standards. It is needed to have a mapping between IEEC standards applied to the APR1000 and its corresponding IEC standards in order to show the conformance of APR1000 I&C design to EUR Rev.E. Alternative mapping approach could be comparison of existing I&C design (rather than IEEC standards) against the IEC standards starting from the upper level standards such as IEC 61513 and subsequent comparison with other lower level standards. The contractor shall provide consultation services for the following sub-items.

- Providing review result on the adequacy of Mapping Table on IEEE standards (applied to APR1000) with corresponding IEC standards to be provided by KEPCO E&C
(Additional IEC standards are to be listed up by the Contractor as required. The scope is limited to Diverse Protection System (DPS), Diverse Indication System (DIS), Qualified Indication and Alarm System (QIAS-P), and NSSS Process Control System (NPCS))

Task 4: BDPS (Boron Dilution Prevention System) Design

Boron Dilution Prevention System is implemented in the APR1000 as Safety Class2. The information related to the instrumentations and sensors used as safety grade in Europe is needed, especially a sensing methods and safety grade sensors including advantage and disadvantage of direct method (e. g. measuring boron density) and indirect method (e, g. measuring ex-core detector signal) to detect boron dilution accident. The contractor shall provide consultation services for the following sub-items.

- Providing review result on the specific design requirement of the Boron Dilution Prevention System in Europe, specifically in EUR Rev.E
- Providing experience and information related to sensing methods and safety grade sensor including advantage and disadvantage to detect boron dilution accident directly (measuring boron concentration) or indirectly (measuring ex-core detector signal)

Task 5: Bypass Leakage of Secondary Containment

APR1000 shall apply double containment to enhance radioactive material leak-tightness. The secondary containment building HVAC system serves the annulus area between the primary containment wall and the secondary containment wall to maintain the annulus area under a negative pressure to collect and filter any leakage from the primary containment prior to release to the environment. The contractor shall provide consultation services for the following sub-items.

- Providing review result on the APR1000 double containment design, specifically for leak-tightness, possible leakage paths of radioactive materials and role of secondary containment

and HVAC systems in adjacent buildings, regarding compatibility with European requirements

- Providing experience and information applied to European nuclear power plants on this consultation item

Task 6: Design of Core Catcher

Passive Ex-vessel corium retaining and Cooling System (PECS) will be implemented as a count measure features for severe accident in the APR1000. It consists of the core catcher, monitoring instrumentation, and two train gravity cooling water supply sub-system. In addition, a design concept relying to In-Vessel molten corium Retention (IVR) is considered as an alternative. These two approach have their own strengths and weaknesses regarding conformance to EUR Rev.E requirements. The contractor shall provide consultation services for the following sub-items.

- Providing review result on APR1000 core catcher, which is coping feature for severe accident, regarding compatibility with European requirement
- Providing assessment result on In-Vessel Retention of corium, which is an alternate design concept to core catcher to meet European requirement
- Providing experience and information applied to European nuclear power plants on this consultation item

Task 7: Radiation Monitors in NPP with Combined Heat and Power Generation

The APR1000 design considers application of cogeneration, where the heat from a portion of extraction steam is transferred to the district heating (DH) system using DH heat exchanger. In order to enhance safety of the DH system, radiation monitoring is needed to be implemented to detect possible leakages of radioactive materials to DH system through DH heat exchangers and identified required operator actions (e.g. manual or automatic isolation) if radioactivity in DH system is exceeding predetermined values. The contractor shall provide consultation services for the following sub-items.

- Providing review result on APR1000 district heating design for radiation sensing system to monitor the release of radioactive materials from nuclear plant
- Providing experience and information (applied design, operating and licensing experience) related to protective features for radioactive material release in Europe

Detailed descriptions and time schedule for the Tasks will be specified in ‘3.0 Method of Performance’ of this contract.

3.0 METHOD OF PERFORMANCE

Consulting Schedule

The period of the Contract shall be one(1) year from the Execution Date of this Contract.

Method of Performance

Detailed method of performance for each Task is described as follows:

A. Task 1 : I&C Common Cause Failure (CCF) Design

- (a) KEPCO E&C will provide the Defense-in-Depth and Diversity (D3) report to Contractor within four (4) months from Execution Date.
- (b) Contractor shall review the D3 report and submit the draft consultation report including review results and proposals for improvement within three (3) months after receipt of the D3 report.

B. Task 2 : Methodology and Technical Background for Dependability Analysis of I&C Systems

- (a) Contractor shall submit the draft consultation report for this task within five (5) months from Execution Date.

C. Task 3 : IEC Codes & Standards

- (a) KEPCO E&C will provide the Mapping Table to Contractor within two (2) months from Execution Date.
- (b) Contractor shall review the Mapping Table and submit the draft consultation report including review results and additional IEC Standards list (if necessary) within three (3) months after receipt of the Mapping Table.

D. Task 4 : BDPS (Boron Dilution Prevention System) Design

- (a) Contractor shall submit the draft consultation report for this task within four (4) months from Execution Date.

E. Task 5 : Bypass Leakage of Secondary Containment

- (a) Contractor shall submit the draft consultation report for this task within four (4) months from Execution Date.

F. Task 6 : Design of Core Catcher

- (b) Contractor shall submit the draft consultation report for this task within six (6) months from Execution Date.

G. Task 7 : Radiation Monitors in NPP with Combined Heat and Power Generation

- (c) Contractor shall submit the draft consultation report for this task within three (3) months from Execution Date.

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

provided by KEPCO E&C immediately after completion of all Tasks under the Contract.

Deliverables

KEPCO E&C will review deliverables for each task and give comments to Contractor. Iterative resolution phase shall continue until all the KEPCO E&C's comments are resolved for each Task. Contractor shall revise the deliverables [after reflecting](#) the resolved KEPCO E&C's comments and submit final deliverables to KEPCO E&C within one (1) month from KEPCO E&C's notice requesting for the [submittal of](#) final deliverables of each Task. However, Contractor shall submit all deliverables under this Contract [before the end of the Contract Period which shall be one \(1\) year from the Execution Date](#).