

MDEP Design-Specific Technical Report TR-APR1400WG-05

APR1400 WORKING GROUP

Technical Report on the Comparison of the Regulatory Requirements for Probabilistic Risk Assessment (PRA) of the APR1400 nuclear power plants, for the MDEP Member Countries

Participation

Regulators and TSOs involved in the MDEP working group discussions:	FANR (UAE), KINS (Korea)
Regulators and TSOs which support the present report:	FANR (UAE), KINS (Korea)
Regulators with no objection:	none
Regulators that disagree:	none

Table of Contents

1. Introduction	3
2. Comparison of the regulatory requirements for the Probabilistic Risk Assessment (PRA) of APR1400 nuclear power plants in the MDEP member countries	4
3. Comparison Results	19
4. Revision Summary.....	21

1. Introduction

The objective of this report is to provide the basic information related to the comparison of the regulatory requirements for the Probabilistic Risk Assessment (PRA) of the existing APR1400 nuclear power plants in operation, or are under construction or undergoing design review in the MDEP member countries.

Although the PRA is widely used in the regulatory decision-making, it is not always clear whether the performance and the use of PRA is a formal regulatory requirement, which shall be met, or a desirable one.

Besides, the requirements for the PRA may be different depending on the phase of the NPP program (construction, design certification, combined operating license, operation, periodic safety review, decommissioning) and type of NPPs (existing plant or new plant).

The PRA comparison elements are mainly related to the regulatory requirements of the member countries and summarized to the following aspects:

1. Regulation and Regulatory Guides for PRA
2. Probabilistic Safety Goal
3. Scope of PRA
4. Quality Control of PRA
5. Technical Adequacy
6. Peer Review
7. PRA Maintenance and Update
8. Use of PRA (Mandatory)
9. Voluntary PRA Application for Licensing Basis Change
10. Documentation

The comparison is developed in Table. 1 that include the main comparison elements and in a form of question and response to the detailed comparison elements from the MDEP member countries Korea and United Arab Emirates (UAE).

2. Comparison of the regulatory requirements for the Probabilistic Risk Assessment (PRA) of APR1400 nuclear power plants in the MDEP member countries.

		Country Requirement	
PRA Element		Korea	UAE
1. Regulation and Regulatory Guides for PRA	1.2	Does the performance and the use of PRA is a mandatory regulatory requirement? If yes, describe general structure of the regulations and relevant regulatory guides for the performance and the use of the PRA.	
		<p>Performance and use of the PRA is a mandatory regulatory requirement in Korea. The Nuclear Safety Act for Periodic Safety Review (PSR) was amended in 2014 to include PSA as one element of the PSR. The Nuclear Safety Act for operating license was amended in 2015 for requiring the Accident Management Program (AMP), which include PSA.</p> <p>[Periodic Safety Review]</p> <ul style="list-style-type: none"> - In 2014, the enforcement regulations of the Nuclear Safety Act were amended to include PSA as one element of the PSR, which is performed every 10 years to review the safety of operating NPPs. - Following items are stated in the enforcement regulations of the Nuclear Safety Act. - Information concerning PSA: To check if the existing PSA maintains valid considering changes in the design and operational conditions of the NPP, the PSA method, operational experience, and technologies and following information shall be included. <ul style="list-style-type: none"> a. Gap between existing and current PSA in area of assumptions, possible initiating events, PSA method, computer codes 	<p>Performance and use of the PRA is a mandatory regulatory requirement in UAE and the relevant regulations are summarized below.</p> <ul style="list-style-type: none"> • FANR REG-03, Regulation for the Design of Nuclear Power Plant, provides the regulation for the design of nuclear power plants. It requires to perform a design and site specific PRA in accordance with FANR-REG-05 and to submit a summary report to the Authority for review. • FANR REG-05, Regulation for the Application of Probabilistic Risk Assessment (PRA) at Nuclear Facilities, provides overall regulation for the performance and the use of PRA. The regulation provides the requirements for all the aspects of the PRA. Article (8) indicates that, The Licensee shall provide a summary of the PRA results to the Authority in connection with the applications for construction and operating licences. • FANR-REG-06, Regulation for an Application for a Licence to Construct a Nuclear Facility. Requirements for PSAR, Article (6), The applicant shall include the following (without limitation) in the PSAR: Level 1 and Level 2 PRAs • FANR REG-14, Regulation for an Application for a License to Operate a Nuclear Facility, requires that the summary of

Country Requirement		
PRA Element	Korea	UAE
	<p>b. PSA guidelines considering operator actions, common cause events, cross link effects, redundancy and diversity and etc.</p> <p>c. Consistency between accident management program and PSA model and results</p> <p>d. Assessment and comparison of possible alternatives to remove vulnerabilities from NPP design and operation.</p> <p>PSR safety review guidelines of KINS chapter 4, 'PSA' is used for regulatory safety review.</p> <p>[Accident Management Program]</p> <ul style="list-style-type: none"> - By the amendment of the Nuclear Safety Act for Accident Management Program, licensee shall evaluate the capabilities for accident management using deterministic and probabilistic method. (Regulations on Technical Standards for Nuclear Reactor Facilities, etc. Article 85-22) - Details of the evaluation are stated in the Notice of NSSC (Nuclear Safety and Security Commission) 2017-34 Article 9 (Risk Evaluation) <p>Article 9 (Risk evaluation)</p> <p>① Technical adequacy, level of details and scope of PSA should be appropriate for comprehensive evaluation of risk from the accident of the NPP.</p> <p>② Risk targets for PSA are as follows.</p>	<p>Level 1 and Level 2 PRAs shall be included in the FSAR.</p> <ul style="list-style-type: none"> • FANR REG-16, Operational Safety Including Commissioning, specifically requires that the PRA shall complement the deterministic safety assessment of the periodic safety review, which shall be done every 10 years of operation. In addition, the regulation requires that the frequency of maintenance, testing, surveillance and inspection shall consider the insights from the PRA and that a PRA shall be used, as appropriate, to demonstrate that the risks are not significantly increased prior to removal of SSCs from service for Maintenance. <p>The guidance for implementing the PRA to meet the regulatory requirements listed above is presented in the regulatory guides below;</p> <ul style="list-style-type: none"> • FANR-RG-003: Probabilistic Risk Assessment: Scope, Quality and Applications • FANR-RG-004: Evaluation Criteria for Probabilistic Safety Targets and Design Requirements • Regulatory Guides in UAE are issued to describe methods and/or criteria acceptable to the Authority for meeting and implementing specific requirements in the Authority's regulations. Regulatory Guides are not substitutes for regulations, and compliance with them is not required. Methods of complying with the requirements in regulations different from the

Country Requirement		
PRA Element	Korea	UAE
③	<p>1. The prompt fatality or cancer fatality risks of the population near an NPP from the accident should not exceed 0.1% of the sum of risks resulting from all other causes; or the equivalent performance goals (CDF, LERF) should be satisfied.</p> <p>2. The sum of frequencies for the accident scenarios in which the amount of Cs-137 release exceeds 100 TBq should be less than 1.0E-06/ry.</p> <p>PSA results should be utilized to enhance the capability for prevention and mitigation of severe accidents.</p> <ul style="list-style-type: none"> - Related regulatory standards and guidelines of KINS are as follows. <p>Regulatory standard</p> <p>16.5 Probabilistic Safety Assessment</p> <p>Regulatory guideline</p> <p>16.5 Level 1 Internal events PSA 16.6 Level 1 External events PSA 16.7 Level 2 PSA 16.8 Level 3 PSA</p> <p>16.9 An approach for using PSA in risk-informed decisions on plant-specific changes to the licensing basis</p> <p>16.10 An approach for plant-specific, risk-informed decision-making technical specifications</p>	<p>guidance set forth by the Regulatory Guide can be acceptable if the alternatives provide assurance that the requirements are met.</p>
2. Probabilistic Safety Goal	2.1 Is there a probabilistic safety goal specified in the regulatory requirement? If yes, describe the safety goal.	
	Technical adequacy, level of details and scope of PSA are stated in the NSSC rules Article 9.	The Authority probabilistic targets are provided in the Article (6) of the FANR RG-04 as follows:

Country Requirement		
PRA Element	Korea	UAE
	<p>As presented in response 1.1, risk targets for PSA are stated in the Notice of NSSC 2017-34.</p> <p>The Equivalent performance goals are stated in the chapter 16.5 of regulatory standard of KINS.</p> <ul style="list-style-type: none"> - CDF for operating plants should be less than 1.0E-04/yr <p>LERF for operating plants should be less than 1.0E-05/yr</p> <ul style="list-style-type: none"> - CDF for new plants (after the Shinkori Unit 3) should be less than 1.0E-05/yr - LERF for new plants (after the Shinkori Unit 3) should be less than 1.0E-06/yr 	<ol style="list-style-type: none"> 1. The NPP should be designed, operated and maintained so as to limit its overall core damage frequency (CDF) to < 10⁻⁵/yr (mean value from the PRA1 considering internal and external events and all modes of Operation). 2. The NPP should be designed, operated and maintained so as to limit its overall large release frequency (LRF) to < 10⁻⁶/yr (mean value from the PRA considering internal and external events and all modes of Operation). 3. The NPP should be designed, operated and maintained so as to avoid a disproportionate concentration of risk resulting from any single SSC failure or human action. 4. Sensitivity studies, using the PRA, should be performed to determine whether small variations in SSC and human performance (e.g., reliability, availability) would cause any of the above evaluation criteria to be exceeded. If the results of the sensitivity studies show any of the above evaluation criteria are exceeded, a review should be conducted and documented to see if corrective action is warranted.
	<p>2.2 Is the numerical safety goal regarded as a limit that must be met or an objective desirable to be met?</p>	
	<p>Risk value stated in the Notice of NSSC is considered as an objective value rather than limit value. But numerical safety goals described in NSSC are considered as acceptance criteria from a regulatory perspective.</p>	<p>Since the Authority probabilistic target is provided in the regulatory guide, the safety target is not considered as a limit that must be met. However, it is required that the licensee should do a risk management action when the plant is in a condition that does not meet the safety target</p>

		Country Requirement	
PRA Element	Korea	UAE	
	2.3 If LERF (Large Early Release Frequency), SRF (Small Release Frequency), LRF (Large Release Frequency) and/or frequency of soil contamination is used as a risk measure for the safety goal, how to define 'small', 'large', 'early', and 'soil contamination'?		
	Among various containment failure modes, 'early containment failure', 'containment isolation failure', 'containment bypass' failure modes are considered to release large amount of radioactive materials in the early phase of accident and sum of these failure modes' frequency is defined as LERF. However, there is no specific definition for 'small', 'large' and 'early'.	As presented in the response 2.1 above, one of the risk measures for the safety target is LRF (Large Release Frequency). There is no specific definition for the "Large" in the regulations or regulatory guides. Licensee adopted the definition of "Large" described in the NUREG/CR-6595 Rev. 1 (An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events), App. A. The definition for the "large" is considered acceptable.	
	2.4 What scope of PRA is required to perform for the comparison with the safety goal? (internal events, external events including seismic, at-power PRA, LPSD PRA, SFP PRA, etc.)		
	<p>Scopes of PSA for AMP are stated in the chapter 16.5 of regulatory standard of KINS.</p> <p>For an existing plant, the licensee needs to submit following PSA:</p> <p>Full power Level 1, 2 for internal, external events and low power shutdown Level 1 for internal, external events.</p> <p>For new plant, the licensee needs to submit following PSA:</p> <p>a. For construction permit and design certification</p> <ul style="list-style-type: none"> - Full power Level 1, 2 for internal and external events <p>b. For operating license</p> <ul style="list-style-type: none"> - Full power Level 1, 2, 3 for internal, external events and low power shutdown Level 1, 2 for internal, external events 	As presented in the response 2.1 above, the safety targets should be met considering the risk from internal and external events and all modes of operation. There is no specific description with respect to the risk from SFP PRA. The licensee does not include the results from the SFP PRA for comparison with the safety target and it is considered acceptable	

		Country Requirement	
PRA Element	Korea	UAE	
	2.5 Is there any complementary safety goal such as CCFP (Conditional Containment Failure Probability)? If it is, is this regarded as a limit or an objective?		
	CCFP is not considered as complementary safety goal in Korea.	<p>Article (12) of FANR RG-04 mentions about the safety target of CCFP as follows;</p> <p>“The Containment should be designed to have a high probability of withstanding the loads associated with Severe Accident phenomena. This should be done by demonstrating that the Containment will maintain its role as a reliable, low leakage barrier for approximately 24 hours following the onset of core melt accident. After 24 hours, releases from the containment should be controlled or ensure that a containment failure probability of 0.1 is achieved.”</p> <p>As described above, demonstrating the CCFP of 0.1 is one of the options that Licensee could do. Licensee adopts the other option and does not demonstrate the CCFP of 0.1. It is considered acceptable.</p>	
	2.6 How to treat uncertainty in the numerical results when applying the safety goals?		
3. Scope of PRA	3.1 Describe the mandatory scope of PRA in view of hazards (internal events and external events), operation mode (At-power or LPSD) and level of PRA (Level 1, Level 2 and Level 3).		
	Please see response 2.4	Article (3) of FANR REG-05 requires that the PRA shall include an	

Country Requirement		
PRA Element	Korea	UAE
		assessment that takes into consideration internal and external events and all modes of plant operation. Article (4) of FANR-REG-05 requires that the PRA shall assess accident sequences leading up to and including reactor core damage and loss of containment integrity, and the corresponding quantity and composition of Radioactive Material available for release to the environment (i.e. Level 2 PRA).
	3.2 Is there any requirement for multi-units PRA located at a same site? If yes, describe the requirement.	
	There is no explicit regulatory requirement for multi-unit PSA. However, multi-unit PSA research is currently on-going due to the increased level of public concerns.	There is no explicit requirement to perform a multi-units PRA at a site. Licensee includes the multi-unit site initiators (e.g., multi-unit LOOP events), which may impact the availability of shared systems (i.e., AAC DG, mobile DG, etc.), in the model. It is considered acceptable.
	3.3 Is there any requirement for SFP PRA? If yes, describe the requirement	
	Similar to the multi-unit-PSA, there is no explicit regulatory requirement for spent fuel pool PSA. However, spent fuel pool PSA research is currently on-going in Korea.	Article (4) of FANR REG-05 requires that a high quality PRA shall be performed and used to complement the Nuclear Facility Design, Construction, Operation and Safety analysis. It is interpreted that the Nuclear Facility includes spent fuel pool. Licensee includes the SFP PRA in the scope of PRA.
	3.4 Does the scope of the PRA above apply to the plants at the construction phase? If not, describe the difference.	
	Please see response 3.1	Article (10) of FANR RG-03 states that the PRA may be completed in a phased fashion, consistent with the various stages of Design and Construction. Licensee includes at-power Level 1 and Level 2 internal events PRA in the construction permit application.

		Country Requirement	
PRA Element	Korea	UAE	
		It is accepted on the condition that the operating license application would include all the scope of PRA described in 3.1 and 3.3 above.	
	3.5 Is there any PRA requirement for decommissioning plants? If yes, describe the requirement.		
	There is no explicit PSA requirement for decommissioning plants.	There is no requirement for the PRA for decommissioning plants.	
	3.6 Is there any different requirement for existing conventional nuclear power plants in the scope of PRA? If yes, describe the difference.		
	Please see response 3.1	UAE does not have any existing conventional plants.	
4. Quality Control of PRA	4.1 PRA is not a part of design basis and is generally not subject to the QA requirements. Is there any specific requirement for the quality control of PRA? If yes, describe the requirement for the quality control.		
	<p>Quality of PSA is stated in the chapter 16.5.3 of the regulatory standards and details are as follows.</p> <ul style="list-style-type: none"> - Quality of PSA should be adequate for the purpose of analysis. - PSA model should be maintained to reflect as-operated plants. - Quality assurance process should be performed using PSA standards such as ASME/ANS PRA standard and etc. 	<p>Article (3) of FANR REG-05 requires that measures should be implemented consistent with the applicant's/licensee's management system to ensure the quality of the PRA, including data and information used in the analyses.</p> <p>Article (16) of FANR-RG-03 states, "The PRA should be based on a secure and traceable process in which all details of the PRA,</p> <p>The Articles of FANR-RG-03 listed below provides a specific guidance for PRA quality control.</p> <ul style="list-style-type: none"> • Procedures - Article (17) • Responsibilities - Article (18) • Interfaces – Article (19) • Qualifications – Article (20) • Technical Reviews – Article (21) • Audits – Article (22) • Software Quality – Article (23) • Non-Conforming Items –Article (24) • PRA Documentation – Article (25) • PRA Configuration Control – Article (26) 	

Country Requirement		
PRA Element	Korea	UAE
5. Technical Adequacy	5.1 Is there any specific requirement for the technical adequacy of PRA? If yes, describe the criteria for technical adequacy. ASME/ANS PRA Standard is available for some PRA areas. Is it mandatory to meet the technical requirements of the PRA standard? The PRA Standard presents three levels of PRA technical quality (Capability Category I, II and III). If yes, what is the minimum level of capability category that the PRA shall meet?	
	As presented in the response 4.1, regulatory standards indicate PSA quality. In regulatory review process, staff position is that PSA for operating NPP should meet capability category I in the ASME PRA standards and higher level of capability category can be required for some technical elements. Moreover, PSA for new build should meet capability category II and licensee is required to justify the technical element, which does not meet capability category II. However, this staff position is not stated in the regulatory documents.	<p>Article (4) of FANR REG-05 requires that a high quality PRA shall be performed and that the PRA shall be based upon the design of the nuclear power plant and site-specific information.</p> <p>Article (5) of FANR RG-03 states that the methods used in the analysis should be consistent with the state of the art and current best practices.</p> <p>Article (11) of FANR-RG-03 indicates that compliance with USNRC RG 1.200 is sufficient to meet the technical quality. It refers ASME/ANS RA-Sa-2009 as an internationally recognized PRA standard.</p>
	5.2 Is there any other (national) PRA Standard referred in the regulation or regulatory guides than ASME/ANS PRA Standard? If yes, describe briefly about the Standard and the difference from ASME/ANS PRA Standard.	
	There is no other PSA standard referred in Korean regulation or regulatory guides other than ASME/ANS PRA standard.	UAE does not have any national PRA standard. Article (11) of FANR RG-03 mentions IAEA Safety Standard Series No. SSG-3, "Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants Specific Safety Guide" and No. SSG-4, "Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants Specific Safety Guide"
	5.3 For some PRA areas, no Standard or only draft version standard is available. If meeting the Standard is mandatory, how to treat the PRA areas with draft Standard or without Standard in view of technical adequacy?	
	Meeting the Standard is not mandatory. A third party review process should be performed in the area which ASME/ANS PRA	There is no specific statement in the regulations and the regulatory guides about the technical adequacy of PRAs

Country Requirement		
PRA Element	Korea	UAE
	Standards is published and endorsed by USNRC. If only pilot version is available, it can be used for the review process.	with a draft standard or without standards. The Licensee states in the PRA summary report that the ANS LPSD PRA Standard is still in draft form and has not yet been endorsed by the NRC, it still provides the best available guideline for development of a technically adequate LPSD PRA.
6. Peer Review	6.1 Is peer review for the PRA mandatory? ASME/ANS PRA Standard provides general requirements for the PRA peer review. Does the peer review must meet the requirements in the Standard?	
	The peer review is not mandatory. A third-party review process can be used. A third party is performed after Shin-Kori unit 3.	Article (7) of FANR REG-05 requires that the Licensee shall conduct a PRA Peer Review of the PRA when it is initially developed and at each major update. It further indicates that the PRA Peer Review outcome compares the PRA against the characteristics and attributes, documents the results, and identifies both strengths and weaknesses of the PRA. The statements in the regulation and the regulatory guide are interpreted that peer review of PRA in consistent with ASME/ANS PRA standard is a mandatory regulatory requirement.
	6.2 Should the findings from the peer review be close out? If yes, describe the process for closing out findings, (e.g., self assessment, additional peer review and/or regulatory review)?	
	There is no specific statement in the regulations about closing out the facts and observations (F&Os). In regulatory review process, licensee may need to resolve some of F&Os.	There is no specific statement in the regulations and the regulatory guides about closing out the findings from the peer review. It is a general understanding that closing out findings for Capability Category I technical requirements is mandatory and that for Capability Category II is voluntary unless a specific PRA applications requiring the capability category II is implemented.

		Country Requirement	
PRA Element		Korea	UAE
7. PRA Maintenance and Update	7.1	Is the maintenance and update of the PRA mandatory regulatory requirement? If yes, provide the details about the relevant requirements.	
		PSA should be updated in every 10 years according to the Nuclear Safety Act for PSR.	Article (6) of FANR REG-05 requires that the Licensee shall update the PRA over the life of the Nuclear Facility at appropriate intervals to reflect the operating experience, design modifications, and other changes reflecting the as-built and as-operated plant that could affect the PRA.
	7.2.	Is there any specific requirement for regular or non-regular PRA update? The PRA Standard requires changes that would impact risk-informed decisions should be incorporated in the PRA as soon as practical. Is there any specific criteria for the significant changes? If yes, describe the criteria.	
		Licensee implements licensee's procedure, which requires to evaluate the effect of design change. Results of licensee's implementation is regulatory reviewed as a part of PSR.	Article (36) of FANR RG-03 requires that the PRA should be updated on a regular basis or when significant changes occur in Facility Operation, Maintenance or Design or there is an improved understanding of thermal-hydraulic or Accident phenomenology, new information, or advances in analytical techniques that could significantly impact PRA results. It further states, "Modifications that significantly impact the PRA results may require an immediate updating of the PRA. However, even if this type of modification does not arise for a longer period, it is still suggested that the updating process be performed every three years and the PRA formally amended at that time". Article (38) of FANR-RG-03 states that the risk impact can generally be considered small if increases in risk less than one percent of the Authority's probabilistic Safety targets for CDF, or LRF are considered small.

		Country Requirement	
PRA Element	Korea	UAE	
	7.3 The PRA Standard requires that the PRA update process shall consider the cumulative impact of pending plant changes or model improvements. Is there any specific criteria for the cumulative impact or model improvements that should be considered in the PRA update? If yes, describe the criteria.		
	According to the licensee's procedure, PSA model is updated once in every 10 years so that configuration of NPP is consistent with PSA model. Although period for PSA update has not come yet, if cumulative risk due to the design change is estimated over 25% compared to the baseline risk for NPP, PSA model can be updated regardless of update period. Licensee's implementation is regulatory reviewed.	There is no specific criteria for cumulative impact considered in the PRA update in the regulation and regulatory guide. Article (38) of FANR RG-03 states that the risk impact can generally be considered small if the cumulative impact of changes in risk is considered and overall Facility probabilistic Safety targets are met.	
8. Use of PRA (Mandatory)	8.1 Is Configuration Risk Management mandatory? If yes, what scope of PRAs should be included in the configuration risk management model? In addition, what is the risk management action threshold level (CCDP, CLERP/CLRP)? (not allowed configuration, configuration requiring compensatory measures, etc.)?		
	Configuration management is not mandatory. However, licensee monitors and manages full power operation risks using RIMS and low power and shutdown operation risks using ORION program.	<p>Article (11) of FANR REG-16 requires that a PRA shall be used, as appropriate, to demonstrate that the risks are not significantly increased prior to removal of SSCs from service for Maintenance.</p> <p>Article (49) of FANR-RG-03 requires that prior to placing the Facility into a configuration involving removing normally operable equipment from service (e.g., for Maintenance), the risk impact should be assessed. This would include assessing the change in CDF and LRF associated with the configuration change and establishing criteria for judging the acceptability of the configuration.</p>	
	8.2 Is Risk Impact Assessment for Plant Modification (Design or Procedure) mandatory? If yes, describe the requirement		
	Evaluation of risk effects due to design change and change of	Article (5) of FANR REG-05 requires that the results of the PRA shall be	

Country Requirement		
PRA Element	Korea	UAE
	<p>procedure is not mandatory. However, evaluation can be performed if licensee decides that these changes can have effect on NPPs.</p>	<p>used to complement design, construction and operation of the facility.</p> <p>Article (10) of FANR REG-16 requires that the Licensee shall ensure that Safety related activities are adequately analyzed and controlled to ensure that the risks associated with harmful effects of Ionizing Radiation are kept as low as reasonably achievable.</p> <p>Article (38) of FANR RG-03 indicates that PRA information can complement decision-making by providing a perspective on the significance of new information, Safety issues and proposed changes to the Design or Operation.</p>
<p>8.3 Is Risk Significance Assessment for Operational Events (Inspection Findings, Operational Events, etc.) mandatory? If yes, describe the requirement.</p>		
	<p>Notice of NSSC requires ASP (Accident Sequence Precursor) analysis for operational events.</p>	<p>Article (5) of FANR REG-05 requires that the results of the PRA shall be used to complement design, construction and operation of the facility.</p> <p>Article (52) of FANR RG-03 requires that a programme should be established, implemented and maintained for using the PRA to assess the risk significance of operational events and Safety issues over the life of the Facility and that this should include assessing the risk significance of:</p> <ul style="list-style-type: none"> a) Inspection findings (e.g. inoperable equipment); b) Operational events (i.e. model the actual sequence of events to determine conditional CDF/LRF); and c) Newly identified Safety issues.

		Country Requirement	
PRA Element	Korea	UAE	
	8.4 Is there any other mandatory use of PRA than those listed above? If yes, describe the use of PRA.		
	There is no other mandatory use of PSA than those listed above.	<ul style="list-style-type: none"> • Use of PRA in Establishing Performance Goals <p>Article (5) of FANR REG-05 requires that the PRA shall be used to establish performance goals for safety significant SSCs.</p> <ul style="list-style-type: none"> • Use of PRA in Periodic Safety Review <p>The periodic safety review is required to perform every 10 years of operation. The regulatory guide for the periodic safety review is not developed yet.</p>	
9. Voluntary PRA Application for Licensing Basis Change	<p>9. Voluntary PRA Application for Licensing Basis Change</p> <p>Below are potential representative PRA applications for changing the licensing basis.</p> <ul style="list-style-type: none"> • Risk Informed In-Service Inspection • Risk Informed In-Service Test • Safety Significance Categorization of SSCs • Risk Informed Technical Specification (Surveillance Frequency, Extension of Allowed Outage Time, Technical Specification Completion Time) • Risk Informed Performance Based Fire Protection (NFPA-805) <p>Are the PRA application are permitted for changing the licensing bases?</p>		
	Licensee submitted application for licensing basis change using risk information such as RI-STI (surveillance test interval), RI-AOT (Allowable outage time), RI-ISI and etc. KINS developed safety review guidelines to technically review these applications. Related regulatory guidelines are 16.9 'An approach for using PSA in risk-informed decisions on plant-specific changes to the licensing basis' and 16.10 'An approach for plant-specific, risk-informed	<p>The applications of PRA to change licensing bases are not specifically addressed in FANR regulation, but some of the applications listed below are described in the FANR RG-003;</p> <p>Article (39): Classification of Safety Significant SSCs</p> <p>Article (41): Graded Equipment Qualification (EQ)</p> <p>Article (42): Graded QA</p> <p>Article (48): Technical Specification</p>	

		Country Requirement	
PRA Element	Korea	UAE	
	decision making technical specifications’.	Article (51): Risk-Informed In-Service Testing and Risk-Informed In-Service Inspection	
10. Documentation	10.1 Is the submittal of PRA documentation mandatory regulatory requirements? If yes, what type of the PRA documentations are submitted for regulatory review?		
	There is no regulatory requirement for PRA documentation. As is in the response for 5.1, documentation for PSA is required to meet the one of capability categories in the ASME/ANS PRA standard. Moreover, requirement for PSA documentation is in the licensee’s procedure.	<p>Article (5) of FANR REG-14 requires that the License applicant shall include the results of Level 1 and Level 2 PRAs in the FSAR.</p> <p>Article (8) of FANR REG-05 requires that the PRA and related documentation shall be updated and made available at the licensee’s site, for the Authority’s inspection and audit upon request and that. The Licensee shall provide a summary of the PRA results to the Authority in connection with the applications for construction and operating licenses.</p> <p>Article (55) of FANR RG-03 provides the contents of summary report that should be covered in the summary report</p>	
	10.2 When the PRA is updated, what types of the PRA documentations are submitted to regulatory body?		
	When PSA is updated, both summary PSA report and detailed PSA report should be submitted	<p>Article (8) of FANR RG-05 requires that at the time of a major PRA update, the Licensee shall provide to the Authority a summary report describing the update, the reasons for the update and how it is using the results.</p> <p>Article (55) of FANR RG-03 requires that at the time of each PRA update, a summary report on the update should be provided to the Authority describing what was updated, the results of the update (e.g., changes in CDF, LRF, key insights) and how the updated information is being used</p>	

3. Comparison Results

This report provides the basic information related to the comparison of the regulatory requirements for the Probabilistic Risk Assessment (PRA) of the existing APR1400 nuclear power plants in operation, or are under construction or undergoing design review in the MDEP member countries (Korea and UAE). This document is intended to provide a common understanding of PRA regulatory requirements and to explore the similarities and differences that would support a future discussion if needed.

The PRA comparison elements are mainly related to the regulatory requirements of the member countries. The main aspects considered for the comparison are: Regulation and Regulatory Guides for PRA, Probabilistic Safety Goal, Scope of PRA, Quality Control of PRA, Technical Adequacy, Peer Review, PRA Maintenance and Update, Use of PRA (Mandatory), Voluntary PRA Application for Licensing Basis Change and Documentation. The main insights for each PRA element are as follows.

a. Regulation and Regulatory Guides for PRA

In the Regulation and Regulatory Guides for PRA, both countries require PRA as a mandatory regulatory requirement. The general structure of the regulation is similar in that both countries require during construction and operation stage and periodic safety assessment. The difference is that Korea requires PRA within the scope of AMP and PSR, whereas UAE requires it to be included in the preliminary safety analysis report and final safety analysis report and to provide the summary of the PRA results to the Authority in connection with the applications for construction and operating licences.

b. Probabilistic Safety Goal

Regarding Probabilistic Safety Goal, safety goals in both countries are used as an objective value rather than limit values. But, in Korea, numerical safety goals described in the notice of the NSSC are considered as acceptance criteria from a regulatory perspective. The difference is that Korea uses LERF as performance goal for Level 2 PRA, whereas UAE uses LRF and CCFP. In Korea, LERF is defined with containment failure mode such as 'early containment failure', 'containment isolation failure', and 'containment bypass'. But there is no specific definition for the "Large" in the regulations or regulatory guides for LRF in UAE. UAE also require sensitivity study to determine whether small variations in SSC and human performance would cause large impact on safety goal.

c. Scope of PRA

The scope of PRA is similar in both countries. Both countries require internal and external events and all modes of plant operation for Level 1,2 PRA. But the difference is that Korea requires a Level 3 PRA. In addition, both countries do not require multi-unit PRA or decommissioning plant PRA and SFP PRA is required in UAE.

d. Quality Control of PRA

The Quality Control of PRA item is required to be carried out using ASME/ANS PRA standards in Korea, but the UAE provides guidance on PRA quality control by dividing it into 10 detailed items at FANR-RG-03.

e. Technical Adequacy

The method of assuring technical adequacy is same in both countries in that ASME/ANS PRA standard is used. And for the scope of PRA without any standard, the draft version of the ASME/ANS PRA standard is used in both countries.

f. Peer Review

Peer review is not mandatory in Korea, and a third-party review process is also acceptable. But, peer review is mandatory in the UAE. For findings derived through peer review, there is no requirement for closing out in both countries, but Korea uses findings at the regulatory review process. In the UAE, when the findings for Category I are found, it is a general understanding that a 'closing out' should be performed.

g. PRA Maintenance and Update

PRA Maintenance and Update must be updated in every 10 years through the PSR in Korea, and if a design change occurs that causes a difference of 25% or more in the power plant base line risk, the PRA model shall be updated immediately according to licensee's procedure. The UAE has similar requirements, requiring the updating process to be performed in every three years and the PRA formally amended at that time. In addition, if the risk change due to design changes is less than 1% of Authority's probabilistic safety targets for CDF and LERF, it is generally considered to be acceptably small.

h. Use of PRA (Mandatory)

Regarding Use of PRA (Mandatory), Korea does not have mandatory requirements for Configuration Risk Management and Risk Impact Assessment for Plant Modification, but the UAE has the requirements. Both countries are required to carry out a Risk Significance Assessment for operational event, and the UAE also uses PRA to establish Performance Goals for safety significant SSCs'.

i. Voluntary PRA Application for Licensing Basis Change

The Voluntary PRA Application for Licensing Basis Change is reviewed using Regulatory guidelines (16.9, 16.10) for RI-STI, RI-AOT, RI-ISI requested by licensee in Korea. Similarly, the UAE has FANR RG-003 for review of Classification of Safety Significant SSCs, Graded Equipment Qualification (EQ), Graded Quality Assurance (QA), Technical Specification, Risk-Informed In-Service Testing and Risk-Informed In-Service Inspection.

j. Documentation

Regarding documentation, Korea do not have specific regulatory requirement for PRA documentation. PSA documentation is required to meet the capability categories in the ASME PRA standard in Korea. The UAE requires to document level 1, 2 PRA results in PSAR and FSAR.

A comparison of 10 PRA elements from both countries shows that the most of the requirements were almost same in both countries. However, it was shown that differences existed in the PRA scope and PRA safety goals according to each country's regulatory environment.

4. Revision Summary

Revision No.	Date	Summary of Changes
	October 2019	First Draft Template: Comparison of the Regulatory Requirements (PRA) with FANR input
0	January 2020	Comparison of the Regulatory Requirements (PRA)- updated Template with inputs of FANR and KINS
1	February 2021	Revised report: Comparison of the Regulatory Requirements (PRA) - KINS and FANR inputs
2	19 April 2021	Final report: Comparison of the Regulatory Requirements (PRA) - KINS and FANR inputs