Study on the Correlation between PSR and Korean Stress Test for Continued Operation of Aging NPP

JuneHo Chung*, Tae-Ryong Kim
Department of NPP Engineering, KEPCO International Nuclear Graduate School
**Corresponding author: juneho.chung@email.kings.ac.kr*

1. Introduction

Extended periodic safety review (PSR) has been the regulatory requirement for the Continued Operation (CO) of a NPP beyond its original design life in Korea. After Fukushima accident, the government announced in early 2013 that CO of the old NPPs would be strictly reviewed in accordance with the EU style stress test in addition to the extended PSR. Accordingly Nuclear Safety and Security Commission (NSSC), Korean nuclear regulatory authority established the stress test guideline based on the EU stress test, and KHNP prepared the execution plan in response to the guideline for the CO of Kori Unit 1 and Wolsong Unit 1[1,2].

PSR is a comprehensive safety review program for long term operation of NPP, which was developed by IAEA[3]. Korea adopted PSR in 1999 as the regulatory requirement for CO of NPP. The IAEA standard guideline for PSR program was updated in 2003[4].

However, the Korean PSR has not been revised yet to apply the new IAEA guidelines. Additionally, national legal systems and guidelines associated with the adoption of stress tests are urgently required as well.

These revisions are imperative in order to ensure the reliability of NPPs, and to promote public acceptance and understanding. This study presents the technical basis and proposals for review actions necessary to address the issues and controversies surrounding the continued operation and decommissioning of aging NPPs in Korea.

2. Current Status and Review

2.1 Characteristics of Korean Stress Test

The Korean Stress Test guideline was developed based on the evaluation method of the EU Stress Test. However, its characteristics are slightly different with the EU Stress Test. Thus, the characteristics of Korean Stress Test will be reviewed by comparing with the EU Stress Test in this section before discussing the correlation between PSR and Korean Stress Test for CO of aging NPP.

The Korean Stress Test has characteristics that is more comprehensive and covers a wider range of safety assessments than the EU Stress Test, and which come from the fact that the Korean Stress Test focus on the safety assessment for CO of aging NPPs rather than test itself[1].

Table 1: Assessment Scope of Stress Test

EU (by ENSREG)		Korea (by NSSC)	
Category	No. of Subsection	Category	No. of Subsection
1. Initiating events - Earthquake - Flooding - Other extreme natural events	3	1. Safety of SSCs against Earthquake	7
		2. Safety of SSCs against Tsunami and other natural events	3
2. Loss of safety functions	3	3. Effects on safety function	3
3. Severe accident management	3	4. Severe accident management	5
-	-	5. Emergency preparedness	3

As shown in Table 1, the EU Stress Test has 3 categories and 9 subsections, whereas the Korean Stress Test covers 5 categories and 21 subsections[1,5]. The higher number of subsections in the Korean Stress Test is due to the additional extensive assessments of accidents caused by global fire, human error, and decision-making errors. The Korean Stress Test also includes comprehensive assessment to be conducted by both deterministic and probabilistic method[6].

Furthermore, the Korean Stress Test incorporated the inadequate indication points of the EU Stress Test that were raised by Greenpeace. In addition, it adopted parts of the safety measures and assessment established by the IAEA, U.S. NRC and Japan Nuclear Regulation Authority after Fukushima[7].

2.2 PSR and Continued Operation in Korean Regulation Systems

Korean PSR programs have been conducted 11 times for 18 nuclear power plants as of June 2013, since it was introduced under the recommendation of the IAEA in 1999. The Korean PSR program has adopted the 11 Safety Factors recommended by IAEA PSR guidelines,

such as the actual condition of NPP, safety analysis, equipment qualification, and management of aging, etc. which are maintained until now[3].

However, the Korean PSR program has not yet incorporated the revised IAEA PSR guideline which has been expanded to 14 safety Factors in 2003[4].

Article 37 of Enforcement Decree of Nuclear Safety Act requires an Assessment of life of major equipment in consideration of the period of CO and an Assessment of change in radiation environmental impact after operating license. Both of these, together with PSR, are requirements in the Korean Evaluation of CO for NPPs.

2.3 Correlation between PSR and Korean Stress Test

The 14 Safety Factors of the revised IAEA PSR guideline are similar to the safety assessment items of Korean Stress Test in many aspects.

Table 2: Correlation between PSR and Korean Stress Test

IAEA PSR 14 Safety Factors	Korean Stress Test Subsections
SF 1: Plant Design	1-1, 1-3, 2-1
SF 2: Actual Condition of SSCs	1-2, 1-3, 2-2
SF 3: Equipment Qualification	1-2, 3-1
SF 4: Ageing	1-2, 1-4, 2-2
SF 5: Deterministic Safety Analysis	1-1, 2-1
SF 6: Probabilistic Safety Analysis	1-1, 1-4, 1-5, 1-6, 2-1, 2-3, 3-2, 3-3
SF 7: Hazard Analysis	1-1, 1-3, 1-4, 1-5, 1-6, 1-7, 2-1, 2-2, 2-3, 3-2, 3-3
SF 8: Safety Performance	1-2
SF 9: Use of Experience from Other Plants and Research Findings	1-1, 1-2, 2-1, 2-3
SF 10: Organization and Administration	4-1, 4-2, 4-3, 5-1, 5-2, 5-3
SF 11: Procedures	1-2, 1-6, 1-7, 2-2, 2-3, 3-1, 3-2
SF 12: Human Factors	1-6, 1-7, 2-3, 3-2, 5-1, 5-2
SF 13: Emergency Planning	1-2, 1-3, 1-6, 1-7, 2-2, 2-3, 3-1, 3-2, 3-3, 4-1, 4-2, 4-3,4-4, 4-5, 5-1, 5-2, 5-3
SF 14: Radiological Impact on the Environment	3-1, 5-1

Table 2 shows the correlation between IAEA PSR Safety Factors and Korean Stress Test. For instance, Safety Factor No. 1 (Plant Design) is correlated with Korean Stress Test Subsections 1-1, 1-3 and 2-1, i.e. Assessment of Design Basis Earthquake (DBE), indirect effect of the earthquake, and Assessment of Design Basis Flooding (DBF), respectively. Similarly, Safety Factor No. 2 (Actual Condition of SSCs) is correlated with Korean Stress Test Subsections 1-2, 1-3 and 2-2, i.e. provision to protect the plant against DBE, indirect effect of the earthquake, and provision to protect the plant against DBF, respectively.

3. Conclusions

As discussed earlier in characteristics of Korean Stress Test, it is more comprehensive than the EU Stress Test in terms of its multilateral evaluation which includes equipment durability, plant operation, human factors, and safety margins, hence substantially raising the significance and value of the evaluation process.

Thus, the addition of Korean Stress Test to the existing Korean Evaluation of CO is expected to greatly increase the quality of safety assessment of aging NPPs in Korea due to its stricter safety policies, hence providing a more meaningful evaluation process.

However, a one-time application of the Korean Stress Test to only Kori Unit 1 and Wolsong Unit 1 would be a waste of the great effort that has been done thus far to improve the Korean Evaluation of CO and develop the Korean Stress Test. By extending the Korean Stress Test to all NPPs in Korea would maintain and ensure the reliability of NPPs as well as public acceptance.

Therefore, it is highly recommended and necessary to include the Korean Stress Test into the regulation system of CO evaluation. In that event, it is advisable that the related guidelines and regulations should be revised based on the updated IAEA PSR guideline. The correlation of assessment items between the PSR and the Korean Stress Test should also be reflected in the revision.

REFERENCES

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